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UM NOVO MÉTODO PARA AVALIAÇÃO RÁPIDA DA TUNGÍASE EM ÁREAS ENDÊMICAS

LIANA DE MOURA ARIZA

FORTALEZA
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Tese submetida à banca examinadora do curso de Pós-graduação em Ciências Médicas da Universidade Federal do Ceará como requisito parcial para obtenção do grau de Doutor em Ciências Médicas.

Área de Concentração: Doenças Infecciosas e Parasitárias

Orientador: Prof. Dr. Jörg Heukelbach

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RESUMO

Introdução: Existe pouco conhecimento sistemático sobre a epidemiologia da tungíase em áreas endêmicas. São necessários métodos de avaliação rápida para delimitar áreas em risco e possibilitar a implementação e avaliação do impacto de intervenções.

Objetivo: Desenvolver e avaliar um método epidemiológico rápido para estimar a prevalência geral e a gravidade da tungíase em comunidades endêmicas com diferentes características demográficas, sócio-culturais e ambientais.

Material e Métodos: Análise de dez estudos transversais realizados em cinco comunidades, três do Brasil (dados secundários) e duas da Nigéria (dados primários), no período de 2001-2008. A tungíase foi diagnosticada clinicamente a partir da presença de lesões de *Tunga penetrans* na epiderme dos indivíduos. Para elaborar o método rápido, seis localizações topográficas dos pés foram selecionadas como potenciais indicadores de infestação em nível comunitário. Foram feitas regressões lineares, calculados coeficientes de determinação (R^2) e os valores *p.* Critérios operacionais como rapidez e facilidade do exame também foram utilizados para a escolha do método mais adequado.

Resultados: Ao todo, nos dez estudos transversais foram incluídos 7.121 indivíduos. As prevalências da tungíase variaram entre 21% e 54%. Nas duas comunidades nigerianas a prevalência geral da tungíase nas 302 pessoas examinadas foi 47% (intervalo de confiança 95%: 41%-53%). Os homens foram mais infestados do que as mulheres (51% vs. 44%, p=0,2), assim como as crianças em comparação aos indivíduos >15 anos (60% vs. 33%, p<0,0001). Na análise dos potencias métodos rápidos, os coeficientes de determinação foram altos, variaram entre 70% e 96% para as seis localizações topográficas, com valores p significantes (todos <0,002). A prevalência na area periungueal dos pés apresentou o mais alto coeficiente de determinação (96%), além da maior rapidez e facilidade do exame. As prevalências gerais estimadas a partir da equação da reta *Y= 1,12 x prevalência na área periungueal + 5,0* apresentaram média do erro absoluto de 1,9%. Prevalências graves (> 20 lesões), estimadas pela equação da reta *Y= 0,24 x prevalência na área periungueal - 3,4*, apresentaram erro absoluto médio de 0,9%.

Conclusão: A tungíase é um problema de saúde pública em comunidades pesqueiras na Nigéria. A identificação de *T. penetrans* na área periungueal dos pés pode ser usada como método rápido e confiável de avaliação epidemiológica. Sua aplicação auxiliará na delimitação de áreas endêmicas, bem como no planejamento de medidas que visem à redução da tungíase em áreas endêmicas.

Palavras-chave: Tungíase; *Tunga penetrans*; Epidemiologia; Método de avaliação rápida; Saúde Pública; África; Brasil.

ABSTRACT

Introduction: Systematic data of tungiasis epidemiology are still scarce in endemic areas. Rapid assessment methods are needed to delimitation of risk communities and to enable implementation and evaluation of impact interventions.

Objective: To develop and assess a rapid epidemiologic method to estimate the overall prevalence of tungiasis and severity of disease in endemic communities with distinct demographic, socio-cultural and environment characteristics.

Material and Methods: Analysis data from ten population-based surveys on tungiasis, performed in five endemic communities – three in Brazil (secondary data) and two Nigeria (primary data) – between 2001 and 2008. In all surveys, tungiasis was clinically diagnostic by presence of *Tunga penetrans* into epidermis of participants. To elaborate rapid assessment method six topographic sites of the feet were selected as potential infestation indicator in community level. Linear regression analyses were performed as well strength of associations (R^2) and p values were calculated. Estimated prevalences were calculated for each of the ten surveys and compared to true prevalences. The most useful topographic localization to define a rapid assessment method was select based on the strength of association and operational aspects.

Result: In total, 7121 individuals of the five communities were examined. Prevalence of tungiasis varied between 21.1% and 54.4%. In the two Nigerian communities the combined overall prevalence was 47% (142/302; 95% confidente intervale: 41%-53%). Tungiasis were more common in males than in females (51,5% vs. 46,3%; p=0,2). Children prevalence (<14 years) was statistically higher then adolescents and adults prevalence (60% vs. 33%, p<0,0001).

In the ten surveys, all strength coefficients were high for the six localizations (ranged between 70% and 96%) and p values were significant (all <0,002). The presence of periungual lesions on the toes showed the highest strength coefficient (R^2=96%; P<0.0001) and it was identified as the most useful and rapid localization to estimate the prevalence of tungiasis. Estimating prevalence of tungiasis by equation *[estimated prevalence] = 1,12 x [prevalence on periungual sites] + 5,0*), the mean absolute error was 1,9%. Tungiasis on this topographic site also reliably estimated prevalence of severe disease (>20 lesions) using the equation *[estimated prevalence] = 0,24 x [prevalence on periungual sites] – 3,4*); mean absolute error was 0,9%.

Conslusion: Tungiasis is a public health problem in the fishing communities in Nigeria. Identification of *T. penetrans* in the periungual area of the feet can be used as a rapid and reliable method to assess the epidemiological situation of endemic areas. This approach will help to delimit endemic communities and to plan control measures aimed at the reduction of tungiasis.

Key-words: Tungiasis; *Tunga penetrans*; Epidemiology; Rapid assessment method; Public Health; Africa; Brazil

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B	Balbino
DP	Desvio padrão
FD	Feliz Deserto
MS	Morro do Sandra’s
IC 95%	Intervalo de confiança de 95%
IIQ	Intervalo Interquartil
LGA	*Local Government Area* (Área de governo local)
O	Okunilage
OMS	Organização Mundial de Saúde
TCLE	Termo de Consentimento Livre e Esclarecido
Y	Yovoyan

SUMÁRIO

1 – INTRODUÇÃO

1.1 – TUNGÍASE

A tungíase é uma doença tropical de pele causada pela penetração da pulga fêmea *Tunga penetrans* (Linnaeus, 1758) na epiderme do homem e de outros mamíferos. Configura-se como um problema de saúde pública em comunidades de baixos recursos da América Latina, Caribe e África. Nas áreas endêmicas, os indivíduos sofrem de intensa infestação e apresentam um amplo espectro de patologias clínicas, que geram seqüelas e desfechos potencialmente evitáveis. Os quadros graves de tungíase ocorrem predominantemente em cenários de pobreza. Pode ser considerada uma Doença Tropical Negligenciada.

1.1.1 – A pulga *Tunga penetrans*

T. penetrans (Classe: Insecta; Ordem: Siphonaptera; Família: *Tungidae*; Sub-família: *Tunginae*; Gênero: *Tunga;* L., 1758), popularmente conhecida como "pulga de areia" ou "pulga de bicho" (CUNHA, 1914), é a menor espécie da ordem Siphonaptera conhecida, medindo somente um milímetro (LINARDI e GUIMARÃES, 2000). As larvas e os adultos vivem livremente em diversos tipos de solo (principalmente, os secos e arenosos) (CALHEIROS, 2007; LINARDI *et al.* 2010). Enquanto as larvas alimentam-se de material vegetal e outros detritos (HICKS, 1930; NASCIMENTO e ARIGONY, 1990), as pulgas adultas macho e fêmea necessitem alimentar-se de sangue para completar o ciclo vital (Figura 1) (WITT *et al.*, 2004). É somente a fêmea penetra na epiderme do hospedeiro de forma permanente para postura dos ovos, fechando assim o seu ciclo de vida (HEUKELBACH e CALHEIROS, 2009). Os hospedeiros *T. penetrans* podem ser o humano ou outros mamíferos (HEUKELBACH *et al.*, 2001; LINARDI, 2001; HEUKELBACH *et al.*, 2004b).

Figura 1: Macho e fêmea de *T. penetrans* adulta

O ciclo de *T. pentrans* no hospedeiro é dividido em fases e estágios de desenvolvimento de acordo com o padrão de alterações clínico-histopatológicas que provoca na epiderme, sendo denominado "Classificação de Fortaleza" (EISELE *et al.*, 2003). Desta forma, na fase vital, a pulga, que penetra a epiderme do hospedeiro pela cabeça (estágio 1; Figura 2a), permanece por inteiro embutida nesta (estágio 2; Figura 2b), com a exceção das partes posteriores do abdômen, que compreendem a abertura genital e quatro pares de espiráculos respiratórios. O segmento posterior deixa uma pequena abertura, de 240–500 μm em diâmetro, na epiderme.

(a) (b)

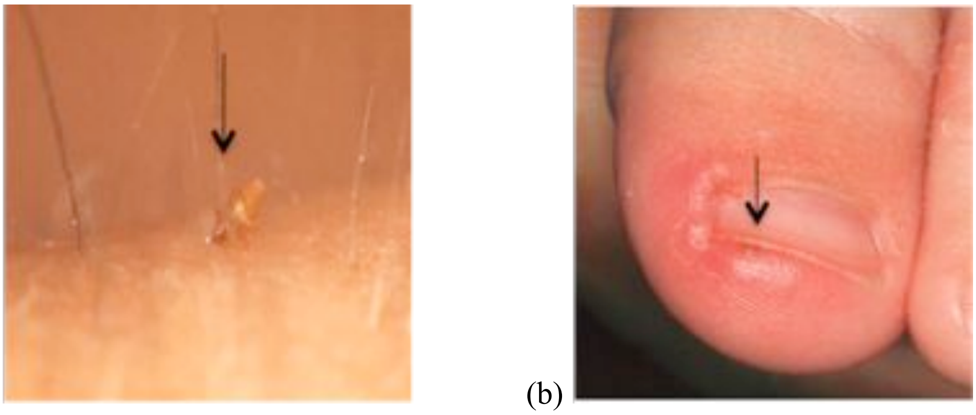


Figura 2: (a) *T. penetrans* penetrando a epiderme do hospedeiro (estágio 1); (b) pulga completamente penetrada (estágio 2)

Após a penetração na epiderme, a pulga necessita de 8 a 12 dias para atingir a maturidade. Durante esse processo (fase vital – estágio 3; Figura 3), o seu abdômen aumenta consideravelmente de tamanho (hipertrofia) até atingir um diâmetro de um centímetro, o qual contendo cerca de 200 ovos, os quais são eliminados no ambiente (GORDON, 1941; ZALAR e WALTHER, 1980). O intenso prurido neste estágio faz com que o hospedeiro coce a lesão, o que auxilia no processo de expulsão dos ovos (EISELE *et al.*, 2003).

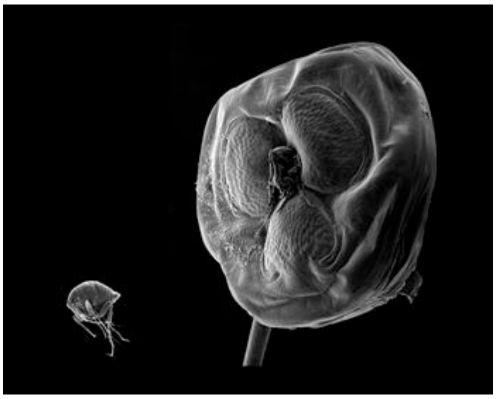
(a)  (b) 

Figura 3: (a) *T. penetrans* antes e após hipertrofia; (b) neosoma *in situ* (Eisele et al., 2003)

Após todos os ovos serem expelidos, a pulga morre, resseca-se *in situ* (LINARDI, 2001; 2005) e seus restos são expelidos da epiderme por mecanismos de reparação (fase avital – estágios 4 e 5; Figura 4b). Uma pequena cicatriz circular-limitada permanece na epiderme, a qual desaparecerá com o tempo. Todo esse processo pode levar de quatro a seis semanas (EISELE *et al.*, 2003).

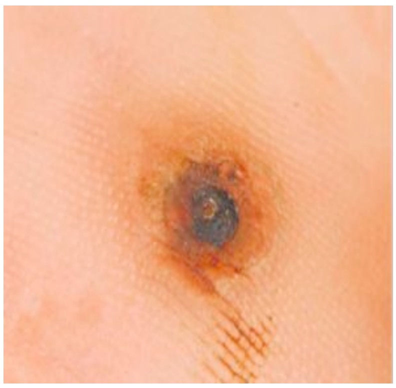
(a)  (b) 

Figura 4: (a) *T. penetrans* penetrada eliminando ovos (pequenos pontos brancos indicados pela seta); (b) resíduos na epiderme da pulga morta (Eisele *et al.*, 2003).

1.1.2 – Tungíase no Passado

Originalmente, a tungíase ocorria apenas na América do Sul e no Caribe. Os primeiros relatos escritos foram realizados no início do período colonial (século XV) após as expedições de Cristóvão Colombo nas Américas (HEUKELBACH *et al.*, 2001). Sua primeira descrição histórica foi feita em 1525, por um historiador espanhol, Gonzales Fernandez de Oviedo y Valdes, que a descreveu como uma das doenças que acometiam freqüentemente os conquistadores espanhóis no Haiti (GUYON, 1870; GORDON, 1941; HOEPPLI, 1963; HEUKELBACH e CALHEIROS, 2009). Por volta de 1538, Quesada, um conquistador espanhol em expedição na Colômbia, relatou que uma vila inteira em Bogotá foi abandonada por seus habitantes por causa da tungíase. Os seus soldados foram tão gravemente infestados que apresentavam dificuldade de andar. Em torno de 1556, a tungíase foi descrita em comunidades de índios Tupinambás no sudeste do Brasil pelo alemão Hans Staden von Homberg zu Hessen que conviveu com esses indígenas (TOSTI, 2000; HEUKELBACH, 2005). Dentre vários relatos deste período, havia descrição de comunidades indígenas que foram afetadas de forma maciça pela tungíase, e obrigadas a abandonar as localidades originais e construir novas habitações em área não infestada. A primeira descrição científica de *T. penetrans* é da autoria de Aleixo de Abreu, um médico português a serviço do governo no Brasil no início do século XVII (GUERRA, 1968; HEUKELBACH *et al.*, 2001).

Nos séculos XVII e XVIII, a pulga foi várias vezes introduzida, acidentalmente, na costa ocidental da África por navios negreiros que retornavam das Américas com carga de cascalho contaminada (HENNING, 1904; JANSELME, 1908; JEFFREYS, 1952). Entretanto, neste período ela não se espalhou no continente e parece ter desaparecido após pouco tempo (HEUKELBACH e UGBOMOIKO, 2007). Acredita-se que *T. penetrans* tenha sido então finalmente introduzida na África tropical em 1872 devido a uma carga contaminada transportada pelo navio *Thomas Mitchell*, do Brasil (Rio de Janeiro) para Angola (HESSE, 1899; HENNING, 1904; GORDON, 1941; HOEPPLI, 1963; FRANCK *et al.*, 2003). A partir desta entrada, a pulga disseminou-se rapidamente ao longo da costa oeste africana e então para toda a região subsaariana através das rotas comerciais (HESSE, 1899; HENNING, 1904; HICKS, 1930; GORDON, 1941; JEFFREYS, 1952; HOEPPLI, 1963).

No fim do século XIX, a pulga causou epidemias na costa ocidental e em grande parte da África subsaariana. Poucos anos depois alcançou a Libéria na costa oeste da África, e Zanzibar e Madagascar, no outro lado do continente (HEUKELBACH & UGBOMOIKO, 2007). Em 1899, *T. penetrans* foi introduzida em Bombai e Karachi por soldados indianos, que retornaram gravemente infestados de expedições na África (GORDON, 1941; BRUCE *et al.*, 1942; HOEPPLI, 1963). Apesar disto, existe apenas um relato de caso autóctone da Índia. Não se sabe as razões pelas quais a tungíase nunca se espalhou pelo sub-continente asiático (TURKHUD, 1928; SANE e SATOSKAR, 1985).

Durante todo o período colonial, a infestação por *T. penetrans* foi um assunto das expedições militares. Nessa época, as patologias freqüentemente relatadas por viajantes europeus para a América do Sul, África e Caribe, eram inflamação intensa, supuração, úlcera, gangrena e dificuldade de andar (COTES, 1899; GREY, 1901; BRUCE *et al.*, 1942; WATERTON, 1973; KONCZAKI, 1985).

No final do século XIX, em Angola, o ectoparasito causou graves problemas de saúde pública. Os indivíduos tinham dificuldade de andar e os relatos de mortes associados à tungíase eram comuns. Devido à dimensão do problema foi proposto o estabelecimento de um hospital especial em Luanda. Úlceras, causadas por *T. penetrans,* foram uma das patologias mais comumente tratadas. Além disto, a tungíase era a segunda mais frequente causa de morte, seguida apenas da varíola (DIAS, 1981).

Outro relato histórico, no final do século XIX de Lionel Decle (1900), ilustra como a tungíase afetou as comunidades rurais africanas: toda a população (homens, mulheres e crianças) estava repleta de úlceras em decorrência das lesões pela pulga. Muitos indivíduos passavam fome pois estavam incapazes de trabalhar no campo e sem poder coletar frutas com as quais se alimentavam. Segundo o autor, naquele período a tungíase era a maior praga que até então tinha ocorrido na África (DECLE, 1900).

No início do século XX, o médico brasileiro Jaime Silvado, em comunicação perante a Sociedade de Medicina e Cirurgia do Rio de Janeiro, declarou que o "bicho dos pés" era um inimigo que se devia ser evitado. Segundo o médico, durante sua infância, o que se ouvia dizer sobre *T. penetrans* era que no caso de uma invasão estrangeira a pulga era um elemento de defesa do território devido à devastação que causaria nas tropas inimigas (SILVADO, 1908).

1.1.3 – Tungíase no Presente

Embora atualmente a situação epidemiológica da tungíase não seja tão extremada quanto no passado, ainda hoje há inúmeras comunidades sofrendo por infestação grave. Devido ao seu caráter de doença tropical negligenciada e constitui-se ainda como problema de saúde pública em comunidades carentes da América Latina (do México a Argentina), Caribe e da África (Figura 5) (ARENE, 1984; CHADEE, 1994; GIBBS, 1996; IBANEZ-BERNAL e VELASCO-CASTREJON, 1996; HEUKELBACH *et al.*, 2001; HEUKELBACH *et al.*, 2002a; HEUKELBACH e FELDMEIER, 2004; HEUKELBACH, 2005).

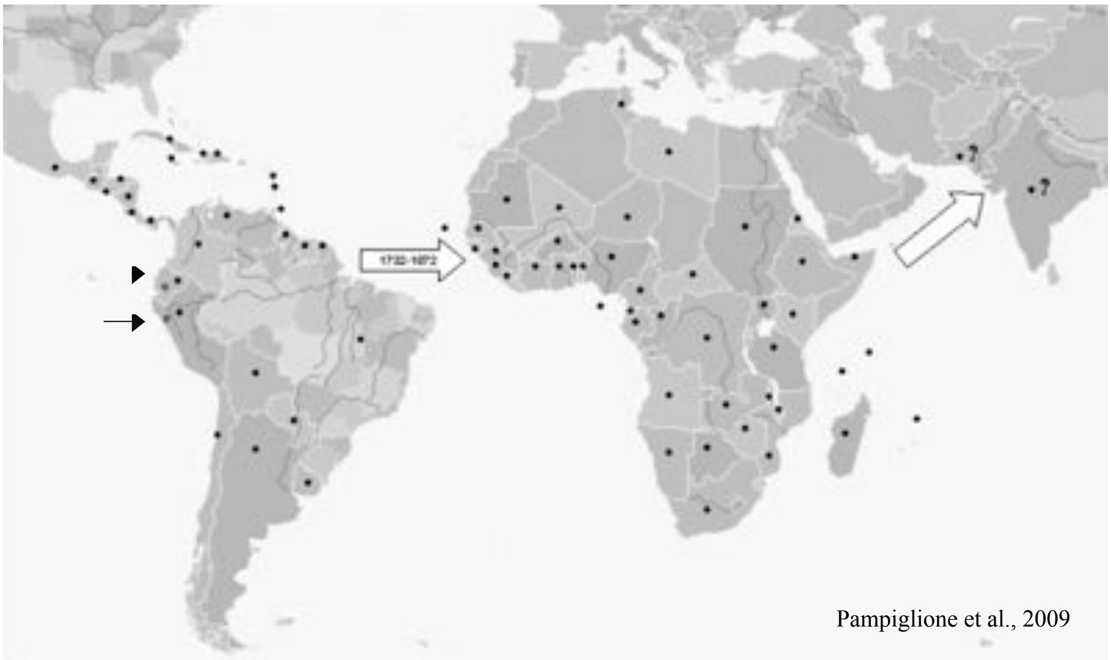


Figura 5: Distribuição global da *T. penetrans*(•); distribuição de casos não confirmados *T. penetrans*(•?); e a distribuição da *T. trimamillata*(○) (Equador e Peru; indicada também com seta preta). As setas brancas indicam a propagação transcontinental da *T. penetrans* (PAMPIGLIONE *et al.*, 2009).

No Brasil, estudos populacionais recentes demonstraram que a prevalência da tungíase pode atingir mais de 50% da população de favelas urbanas, vilas pesqueiras e comunidades rurais, e causa patologias graves, tais como, infecções secundárias, perda de dígitos e dificuldade de andar (WILCKE *et al.*, 2002; CARVALHO *et al.*, 2003; FELDMEIER *et al.*, 2003; MUEHLEN *et al.*, 2003;

ARIZA *et al.*, 2007; HEUKELBACH *et al.*, 2007). Há ainda relatos de sua ocorrência no país desde a região Norte entre os índios Yanomami de Roraima, até o Sul em populações de áreas periféricas no Rio Grande do Sul (MATIAS, 1989; EHRENBERG e AULT, 2005; HEUKELBACH, 2005; DAMAZIO e SILVA, 2009; LIMA *et al.*, 2009; SILVEIRA *et al.*, 2009).

Estudos realizados nos Camarões, Kenya, São Tomé & Príncipe, Madagascar e na Nigéria indicam que na África a situação socioeconômica e epidemiológica das áreas atingidas é comparável com a do Brasil (ADE-SERRANO e EJEZIE, 1981; EJEZIE, 1981; ARENE, 1984; NTE e EKE, 1995; PAMPIGLIONE *et al.*, 1998; UGBOMOIKO *et al.*, 2007a; UGBOMOIKO *et al.*, 2007b; RATOVONJATO *et al.*, 2008; UGBOMOIKO *et al.*, 2008a; COLLINS *et al.*, 2009). As prevalências variaram entre 30%, em escolares da Nigéria (ARENE, 1984) e 54% em comunidades dos Camarões (COLLINS *et al.*, 2009). Em Madagascar, o problema foi reconhecido como uma das prioridades de saúde pública e a situação epidemiológica da tungíase foi mapeada em todos os municípios do país. Prevalências acima de 40% foram identificadas em mais de 13% dos distritos (RATOVONJATO *et al.*, 2008). No Quênia, governo e ONGs vêm divulgando recentemente a doença como um problema de saúde que deve ser urgentemente enfrentado.

Dois casos autóctones foram descritos na Índia e na costa do sul da Itália, mas nesses países, a ectoparasitose nunca se tornou endêmica (SANE e SATOSKAR, 1985; VERALDI *et al.*, 2000).

1.1.4 – Tungíase: Doença Tropical Negligenciada

A tungíase pode ser considerada uma Doença Tropical Negligenciada: ocorre em áreas rurais e comunidades de baixos recursos sócio-econômicos; é promotora de pobreza e está associada a forte estigma; não é considerada como problema de saúde pública por profissionais de saúde e gestores; não tem medicamentos com comprovada eficácia disponíveis no mercado e não está incluída dentro da lista de notificação compulsória dos serviços de saúde (HEUKELBACH *et al.*, 2001; HEUKELBACH *et al.*, 2002a; HEUKELBACH, 2005; FELDMEIER e HEUKELBACH, 2009). Embora a tungíase cumpra esses critérios definidos por

EHRENBERG e AULT (2005) para doenças em populações marginalizadas, dentre as doenças parasitárias de pele somente a escabiose foi incluída na recente edição do *Communicable Disease Control Handbook* da Organização Mundial de Saúde (OMS) (FELDMEIER e HEUKELBACH, 2009).

Nos últimos anos, o número de estudos sobre o tema vem aumentando, mas dados sobre a real situação epidemiológica da tungíase ainda são escassos. A falta de conhecimento sistemático sobre as áreas de ocorrência e grau de morbidade da tungíase impede de mostrar, com dados confiáveis, o enorme impacto negativo que esta e outras ectoparasitoses têm atualmente nas condições de saúde e vida dos indivíduos afetados (FELDMEIER e HEUKELBACH, 2009).

1.1.5 – Aspectos clínicos

No homem, *T. penetrans* pode penetrar em qualquer parte do corpo: mãos, cotovelos, pescoço, nádegas e região genital (BEZERRA, 1994; VERALDI *et al.*, 1996; HEUKELBACH *et al.*, 2001; HEUKELBACH *et al.*, 2002b; HEUKELBACH *et al.*, 2004e) (Figura 6). Entretanto, a pulga penetra principalmente a epiderme dos pés (Figura 7). Nesta localização as partes mais afetadas são a região periungueal dos dedos, o calcâneo, como também a face lateral e a planta dos pés (ARIZA *et al.*, 2007; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b). Essa localização de predileção originou seu nome popular no Brasil: "bicho do pé" (CUNHA, 1914).

Existem relatos recentes de que outra espécie encontrada no Equador e no Peru, a *Tunga trimamillata*, causa tungíase no ser humano (FIORAVANTI *et al.*, 2003; PAMPIGLIONE *et al.*, 2009). Entretanto, essa espécie nunca foi assinalada no Brasil, e por isto sua importância na epidemiologia das comunidades brasileiras ainda é desconhecida (HEUKELBACH e CALHEIROS, 2009).

Figure 6: Múltiplas lesões nas mãos de tungíase em um menino de 5 anos (Feldmeier et al., 2004).

Figure 7: Pés de uma menina de 10 anos infestados pela *T. penetrans* (Heukelbach, 2005).

Por vários mecanismos, a pulga penetrada provoca alterações na epiderme hospedeiro. Essas são induzidas por uma resposta imunológica resultando em uma visível inflamação na epiderme (EISELE *et al.*, 2003; FELDMEIER *et al.*, 2003). Dentro de 24 horas, percebe-se uma reação inflamatória local e dois a três dias depois dor. Durante o processo de hipertrofia, o edema e o eritema que se desenvolvem ao redor da lesão ficam mais intensos (EISELE *et al.*, 2003). De forma quase inevitável, a superinfecção com bactérias patógenas ocorre pela própria penetração da pulga que ao quebrar o estrato córneo permite a entrada de bactérias na epiderme, fato incrementado pelo intenso prurido que provoca na pele. Como o último segmento abdominal deixa uma pequena abertura na epiderme, esta pode servir também como porta de entrada para micro-organismos patógenos (FELDMEIER *et al.*, 2002; FELDMEIER *et al.*, 2003). Durante o ato de coçar a área da lesão o indivíduo, também, promove a entrada de bactérias invasoras (FELDMEIER *et al.*, 2002).

O espectro das lesões vai de pápulas assintomáticas à prurido, dor, ulceração e infecção secundária. Tendo em vista que a tungíase é uma doença auto-limitada (EISELE *et al.*, 2003), o incômodo por prurido e dor, bem como outros sintomas clínicos e sinais de superinfecção bacteriana, usualmente, não causam patologia significativa quando a infestação limita-se a uma ou poucas pulgas penetradas, tal como ocorre com viajantes que retornam de áreas endêmicas (FRANCK *et al.*, 2003).

Nos indivíduos de áreas endêmicas, porém, as complicações graves e seqüelas são comuns (HEUKELBACH *et al.*, 2001; FELDMEIER *et al.*, 2002; FELDMEIER *et al.*, 2003). Nestas áreas cujas condições de higiene são precárias, a re-infestação é uma regra e novas lesões aparecem próximas às pulgas já penetradas nos indivíduos infestados (HEUKELBACH *et al.*, 2004c). Conseqüentemente, eles carregam muitas pulgas penetradas em diferentes estágios de desenvolvimento no hospedeiro (BEZERRA, 1994; MASHEK *et al.*, 1997; FELDMEIER *et al.*, 2003; MUEHLEN *et al.*, 2003; ARIZA *et al.*, 2007; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; UGBOMOIKO *et al.*, 2008a). Como os parasitos tendem a se acumular em certas localizações topográficas dos indivíduos, a patologia nestas é inevitavelmente grave. Adicionalmente, a gravidade da tungíase pode ser ainda mais agravada pela co-presença das lesões inadequadamente removidas.

Uma variedade de bactérias aeróbicas e anaeróbicas já foram isoladas de pulgas penetradas (HEUKELBACH *et al.*, 2001; FISCHER *et al.*, 2002; HEUKELBACH *et al.*, 2004a). Mais comumente a superinfecção é causada por *Staphylococcus aureus* e *Streptococci* (CHADEE, 1998; FELDMEIER *et al.*, 2002). As lesões superinfectadas levam à formação de pústulas, supuração e úlcera (HEUKELBACH *et al.*, 2001); e a lesão causada pela penetração da pulga pode servir como porta de entrada para *Clostridium tetani,* agente causador do tétano em indivíduos não-vacinados (OBENGUI, 1989; TONGE, 1989; LITVOC *et al.*, 1991; GRECO *et al.*, 2001; HEUKELBACH *et al.*, 2001; JOSEPH *et al.*, 2006). Foram descritas também as bactérias endossimbióticas *Wolbachia* em *T. penetrans* (HEUKELBACH *et al.*, 2004a). O papel destas bactérias como causadoras de patologia clínica (como acontece nas filarioses) não é conhecido, mas é possível que a inflamação grave observada após a penetração da pulga seja desencadeada por essas bactérias.

Como conseqüência da constante re-infestação e manipulação inapropriada das lesões nas áreas endêmicas, a tungíase está associada a patologias clínicas agudas e crônicas, tais como: intensa inflamação dos dedos, formação de úlceras e fissuras, abscesso e supuração, deformação e perda de dígitos (Figuras 8, 9, 10) (VALENÇA *et al.*, 1972; BEZERRA, 1994; HEUKELBACH *et al.*, 2001; FELDMEIER *et al.*, 2003; GONZÁLEZ *et al.*, 2003; ARIZA *et al.*, 2007; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; UGBOMOIKO *et al.*, 2008a). Gangrena, perda de unha, auto-amputação de dígitos, tétano e septicemia foram relatadas como sequelas e desfechos (MATIAS, 1989; MASHEK *et al.*, 1997; CHADEE, 1998; HEUKELBACH *et al.*, 2001); (OBENGUI, 1989; TONGE, 1989; LITVOC *et al.*, 1991; GRECO *et al.*, 2001; HEUKELBACH *et al.*, 2001; JOSEPH *et al.*, 2006). Recentemente, em estudo realizado no país mais pobre das Américas, Haiti, houve relato de óbitos em adultos extremamente infestados, provavelmente devido ao tétano e/ou a septicemia (JOSEPH *et al.*, 2006). Sintomas relatados pelos indivíduos, tais como prurido, dor e dificuldade de dormir e andar por causa das lesões, também são freqüentes entre os indivíduos infestados nas comunidades endêmicas (MUEHLEN *et al.*, 2003; UGBOMOIKO *et al.*, 2007b).

Os relatos de infestação maciça e patologia grave são preocupantes tendo em vista que tungíase é auto-limitada (EISELE *et al.*, 2003), que se agrava principalmente em decorrência das precárias condições de vida e circunstâncias sociais (MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a; PILGER *et al.*, 2008b).

Figura 8: Lesões em distintos estágios. Inflamação e deformação das unhas e dígitos (Heukelbach, 2005).

Figura 9: Presença de lesões manipuladas pelo paciente. Perda de unha em todos os dedos. Descamação e ulceração são presentes (Feldmeier et al., 2003).

Figura 10: Presença de lesões e perda de unha do 5º dígito do pé (Feldmeier et al., 2003).

1.1.6 – Epidemiologia da tungíase

Nas áreas endêmicas de baixos recursos sócio-econômicos da América Latina, Caribe e países da África, as prevalências da tungíase variaram entre 16% e 55% (ADE-SERRANO e EJEZIE, 1981; EJEZIE, 1981; ARENE, 1984; CHADEE, 1994; LINARDI, 1995; NTE e EKE, 1995; CHADEE, 1998; NJEUMI *et al.*, 2002; WILCKE *et al.*, 2002; CARVALHO *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009).

A incidência, prevalência e carga parasitária da tungíase mudam significativamente ao longo do ano, com as maiores taxas de ataque durante a estação seca, diminuindo consideravelmente na estação chuvosa (HEUKELBACH *et al.*, 2005). Por exemplo, ao longo de um ano, a prevalência em uma favela em Fortaleza (Ceará) variou entre 17% (estação de chuva) e 54% (estação seca), com uma clara relação com a estiagem (HEUKELBACH *et al.*, 2005). Essa característica variação sazonal é causada pela dinâmica da população de pulgas na comunidade, a qual estaria relacionada às variáveis climáticas. A alta umidade do solo poderia dificultar o desenvolvimento dos estágios imaturos da pulga que vive livremente no ambiente, e chuvas fortes podem varrer do solo ovos, larvas, pupas e estágios adultos da pulga (HEUKELBACH *et al.*, 2005).

A prevalência da tungíase mostra uma distribuição característica por idade. De modo geral, a prevalência é mais alta na faixa etária entre os menores de 15 anos, declinando nos adultos, e subindo novamente em indivíduos acima de 60 anos. Invariavelmente, nas diferentes áreas endêmicas, sejam elas na América Latina, Caribe e na África, e mesmo em distintas estações do ano, as crianças entre 5-14 anos são as que apresentam os mais elevadas prevalências (CHADEE, 1994; WILCKE *et al.*, 2002; CARVALHO *et al.*, 2003; GONZÁLEZ *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009). Dada a importância da prevalência da tungíase neste grupo etário, WILCKE *et al.* (2002) e HEUKELBACH *et al.* (2007) chegaram a afirmar que a tungíase é predominantemente um doença da infância. Por outro lado, o aumento da prevalência nos idosos pode diferir de uma comunidade para outra, e em alguns estudos esse segundo pico de prevalência não é tão evidente (CHADEE, 1998; CARVALHO *et al.*, 2003; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009). Embora os fatores que favoreçam essas altas prevalências nas crianças e nos idosos ainda não estejam claros, parece pouco provável estar associado à imunidade nestes grupos. As respostas a estas diferenças parecem estar mais associadas a aspectos comportamentais de exposição e prevenção (MUEHLEN *et al.*, 2003; UGBOMOIKO *et al.*, 2007a).

A distribuição da prevalência por sexo, por outro lado, não apresenta a mesma hegemonia entre os estudos como as elevadas prevalências entre os <15 anos de idade. O padrão de ocorrência da tungíase entre homens e mulheres difere de uma área endêmica para outra. Grande parte dos estudos, dentre os realizados em comunidades ou escolas em Camarões, Trinidad & Tobago e na própria Nigéria, mostraram um percentual maior de homens infestados (EJEZIE, 1981; ARENE, 1984; CHADEE, 1994; 1998; NJEUMI *et al.*, 2002; WILCKE *et al.*, 2002; GONZÁLEZ *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009). Da mesma forma, em favela urbana do Ceará em quatro estudos de prevalência realizados ao longo de um ano, a tungíase foi constantemente mais comum no sexo masculino (HEUKELBACH *et al.*, 2005). Em contraste, as mulheres de uma comunidade de baixos recursos no sul do Brasil foram significativamente mais infestadas por tunga do que os homens, assim como em comunidade de Trinidad (CHADEE, 1998; CARVALHO *et al.*, 2003). O maior percentual de mulheres infestadas também foi observado entre indivíduos com mais de cinco lesões de uma favela urbana, e também entre escolares de Santa Catarina (ARIZA *et al.*, 2007; DAMAZIO e SILVA, 2009). Acredita-se que as diferenças na prevalência por sexo, assim como por faixa etária, estão mais relacionadas às diferenças na exposição devido aos aspectos comportamentais e culturais do que as distintas suscetibilidades entre os homens e as mulheres (CHADEE, 1998; HEUKELBACH *et al.*, 2001; WILCKE *et al.*, 2002; MUEHLEN *et al.*, 2003; COLLINS *et al.*, 2009).

A carga parasitária total nas áreas endêmicas, em geral, é elevada, devido à constante re-infestação. É comum nestas áreas, os indivíduos terem até mais de 10 novas pulgas penetradas diariamente (HEUKELBACH *et al.*, 2004c). Esta situação faz com que os indivíduos tenham algumas dezenas de parasitos ou mesmo mais de uma centena deles penetrados (Figuras 11 e 12) (BEZERRA, 1994; FELDMEIER *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2004c; JOSEPH *et al.*, 2006; ARIZA *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; UGBOMOIKO *et al.*, 2008a; COLLINS *et al.*, 2009).

Figura 11: Planta dos pés de uma menina brasileira de sete anos. Lesões em todos os estágios de desenvolvimento em ambos os pés (Ariza et al., 2007).

Figura 12: Planta dos pés de um menino nigeriano de nove anos de idade. Múltiplas lesões em diferentes estágios de desenvolvimento.

Quanto maior o número de pessoas e animais infestados, maior a transmissão, pois um maior número de ovos da pulga *T. penetrans* é colocado no meio ambiente pelos hospedeiros que estão a todo o tempo se locomovendo na comunidade (HEUKELBACH e CALHEIROS, 2009). Essa transmissão é ainda mais intensificada quanto maior for a carga parasitária dos hospedeiros (FELDMEIER *et al.*, 2006b). Sendo assim, na manutenção desse círculo vicioso, estão presentes pessoas e animais infestados e condições ambientais favoráveis (como matéria orgânica e terreno arenoso) para o desenvolvimento dos estágios imaturos da pulga (HEUKELBACH e CALHEIROS, 2009).

Em geral, a infestação intensa e conseqüentemente a gravidade da tungíase estão associados a aspectos comportamentais bem como às precárias condições de vida das comunidades endêmicas (MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a; PILGER *et al.*, 2008b). MUEHLEN *et al.* (2006) mostraram que em uma comunidade pesqueira brasileira a ocorrência de tungíase geral como doença grave estavam associadas, de forma significativa e independente, às condições precárias habitação, presença de animais doméstico e baixa escolaridade (*odds ratios* ajustados variaram de 1,9 a 4,7). Em uma vila rural da Nigéria, os fatores de risco encontrados foram semelhantes aos do Brasil. Neste caso, o piso de barro ou areia na casa e presença de porcos, principalmente, foram fortemente associadas à tungíase (*odds ratios* ajustados de 8,3 e 18,0, respectivamente). Estimou-se nesse estudo, que a simples melhoria do piso da casa através de cimentação poderia reduzir a tungíase em 75% (UGBOMOIKO *et al.*, 2007a). Todos esses fatores estão inevitavelmente associados às inadequadas condições sanitárias, sócio-econômicas, ambientais e estruturais de pobreza nas quais vivem as comunidades afetadas.

Esses dados corroboram observações e estudos anteriores que afirmaram que baixa escolaridade e inadequadas condições de higiene eram fatores que contribuem para a disseminação do parasita no ambiente e que a tungíase tem maior impacto em populações sem acesso a assistência de saúde adequada (FELDMEIER *et al.*, 2003)Nestes contextos quanto mais inadequados tais fatores, maior a tendência que os indivíduos tenham carga parasitária mais elevada (FELDMEIER *et al.*, 2003; ARIZA *et al.*, 2007).

Estas comunidades contêm os elementos e fatores necessários para manutenção de altas cargas parasitárias (HEUKELBACH *et al.*, 2004b; MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a). Dado que a prevalência está associada à carga parasitária (HEUKELBACH *et al.*, 2005), e esta é diretamente responsável pelo grau de morbidade associado à tungíase (FELDMEIER *et al.*, 2004; KEHR *et al.*, 2007) assume-se que quanto mais elevada a carga parasitária de uma comunidade, maiores serão os graus de morbidade aguda e crônica (KEHR *et al.*, 2007), e conseqüentemente, as seqüelas debilitantes e desfigurantes nas comunidades endêmicas de baixos recursos.

1.1.7 – Reservatório Animal

Pulgas *T. penetrans* adultas vivem livre no ambiente, porém a pulga fêmea penetra na epiderme de um hospedeiro freqüentemente humanos e mamíferos domésticos (VERHULST, 1976; RIETSCHEL, 1989; LINARDI, 2001; CARVALHO *et al.*, 2003; HEUKELBACH *et al.*, 2004b). Entretanto, como *T. pentrans* é promiscua na escolha dos hospedeiros, ela também é encontrada infestando: porcos, gado, cabras, cavalos, ratos e animais selvagens (HESSE, 1899; SORIA e CAPRI, 1953; PAMPIGLIONE *et al.*, 1998; SILVA *et al.*, 2001; NJEUMI *et al.*, 2002; HEUKELBACH *et al.*, 2004b; ARIZA *et al.*, 2007; UGBOMOIKO *et al.*, 2008b). Embora qualquer mamífero – doméstico ou silvestre – possa servir de hospedeiro, os animais silvestres parecem ter pouca relevância na infestação por *T. penetrans* em humanos (HEUKELBACH *et al.*, 2004b).

Principalmente cães, gatos, porcos e ratos são importantes reservatórios na dinâmica de transmissão da tungíase, sugerindo que esta ectoparasitose pode ser considerada uma zoonose (PAMPIGLIONE *et al.*, 1998; NJEUMI *et al.*, 2002; CARVALHO *et al.*, 2003; HEUKELBACH *et al.*, 2004b; MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a; PILGER *et al.*, 2008b).

A clínica da tungíase nos animais é semelhante à patologia encontrada no ser humano, isto é, a maioria das lesões ocorre nas patas e os animais podem apresentar infestação grave que podem decorrer, por exemplo, que cães tenham dificuldade de andar e possam morrer, presumivelmente, devido à eventual superinfecção bacteriana e conseqüente septicemia (HEUKELBACH *et al.*, 2004b).

Três estudos recentes de fatores de risco disponíveis, dois do Brasil e um da Nigéria, mostraram que a presença de animais no peri- ou intra-domicilio é um fator importante para infestação humana (MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a; PILGER *et al.*, 2008b). O reservatório animal, no contexto brasileiro, é principalmente o cão e o gato, porém, apesar de muitas vezes esquecido, o rato também desempenha papel importante como reservatório da pulga em áreas urbanas. Em uma favela urbana em Fortaleza (Ceará), 67% dos cães, 50% dos gatos e 41% dos ratos apreendidos se encontravam infestados pela *T. penetrans* (HEUKELBACH *et al.*, 2004b). Em comunidade rural nigeriana, os mais importantes reservatórios foram porcos (55% infestados) e cães (46%) presentes no peri-domicílio e roedores silvestres (UGBOMOIKO *et al.*, 2008b). Os porcos tiveram carga parasitária mais alta e foram um dos mais importantes fatores de risco na comunidade (UGBOMOIKO *et al.*, 2007a). Estudo recente realizado em comunidade pesqueira no Brasil mostrou que cães (70% infestados) e gatos (50%) domésticos infestados foram, de forma significante e independente, um fator de risco para a tungíase com *odds ratio* ajustado de 1,7 (PILGER *et al.*, 2008b).

Em áreas onde os suínos se locomovem livremente nas comunidades, eles são importantes na manutenção das altas taxas de ataque. No Brasil, o porco se destacava na transmissão da tungíase no passado, principalmente em áreas rurais.

Com a redução da livre circulação de porcos nos últimos anos (como medida de reduzir a incidência da neurocisticercose), a importância desses animais como reservatório foi reduzida em comunidades brasileiras, diferentemente de algumas comunidades na África (HEUKELBACH e CALHEIROS, 2009).

Embora a real extensão do papel dos animais para a infestação da tungíase em diferentes cenários ainda permaneça incerta (PILGER *et al.*, 2008b), o caráter de zoonose conferido à tungíase faz o seu controle mais complexo do que outras ectoparasitoses, tais como, escabiose e pediculose, nas quais não há um reservatório animal (HEUKELBACH *et al.*, 2002a).

1.1.8 – Tratamento e Prevenção

O tratamento padrão da tungíase consiste na extração cirúrgica da pulga com uma agulha ou instrumento semelhante, em condições estéreis (HEUKELBACH *et al.*, 2001; HEUKELBACH, 2006). Quando necessário recomenda-se o uso de antibiótico tópico após a remoção da pulga. Para prevenir infecções bacterianas secundárias recomenda-se que as pulgas sejam removidas o mais precoce possível e por inteiro, e em boas condições de higiene (FELDMEIER *et al.*, 2002). A abertura na epiderme precisa ser alargada cuidadosamente com agulha, enquanto de maneira hábil a pulga hipertrofiada é retirada por inteiro. Depois da extração a ferida deve ser tratada com um antibiótico tópico de largo espectro. Como medida complementar do tratamento da tungíase, em indivíduos não imunizados contra tétano, a profilaxia especifica deve ser realizada (HEUKELBACH *et al.*, 2001; HEUKELBACH, 2006).

A extração das pulgas conforme preconizado requer habilidade manual e condições de higiene satisfatórias, os quais nem sempre são disponíveis nas áreas endêmicas. Quando as pulgas são retiradas com instrumento inapropriado e não-esterilizado, muito provavelmente ocorrerá superinfecção bacteriana. Por exemplo, em 16 pacientes gravemente infestados (>50 lesões), os autores afirmaram que a superinfecção foi também o resultado de inapropriada manipulação das lesões (FELDMEIER *et al.*, 2003). Neste sentido, a remoção das pulgas pode trazer mais prejuízos do que benefícios (FELDMEIER *et al.*, 2003).

Nos últimos anos, alguns produtos orais foram sugeridos para o tratamento. A ivermectina oral, por exemplo, um anti-parasitário de amplo espectro, tem sido reivindicada como tratamento eficaz da tungíase por alguns dermatologistas do nordeste do Brasil (SARACENO *et al.*, 1999; HEUKELBACH *et al.*, 2004d; GATTI *et al.*, 2008). Porém, em estudo duplo-cego randomizado a ivermectina oral em dose relativamente alta (duas doses de 300 µg/kg corpo peso) não mostrou eficácia quando comparado a placebo (HEUKELBACH *et al.*, 2004d). O tratamento com tiabendazol oral (50 e 25 mg/kg/dia) também já foi sugerido (VALENÇA *et al.*, 1972; CARDOSO, 1981), porém a efetividade deste medicamento permanece incerta, e o mesmo apresenta outras limitações devido aos seus efeitos colaterais (HEUKELBACH, 2006). Loções tópicas de ivermectina (0,8%), de metrifonate (0,2%) e de tiabendazol (5%) foram testadas, contudo mostraram pouca eficácia ao serem comparadas com loção tópica placebo e um grupo de controle sem tratamento (HEUKELBACH *et al.*, 2003b).

Estudos recentes com aplicação de um repelente natural composto por óleo de coco, jojoba (*Simmondsia chinensis*) e babosa (*Aloe vera*) mostraram regressão importante da patologia e da re-infestação em indivíduos gravemente infestados (SCHWALFENBERG *et al.*, 2004; FELDMEIER *et al.*, 2006a; KEHR *et al.*, 2007). Esse repelente é recomendado com sucesso contra picadas de insetos e carrapatos em países europeus (SCHWALFENBERG *et al.*, 2004). Sugere-se que o uso de repelente é a melhor opção para reduzir a morbidade associada à tungíase em indivíduos infestados quando comparado ao tratamento pós-infestação em áreas com taxas de ataque elevadas (HEUKELBACH, 2005).

Outros compostos advindos da medicina popular, tais como óleo de mamona e extrato de mandioca, são também utilizados para a prevenção da tungíase em comunidades do Brasil, porém sua eficácia ainda não foi comprovada em estudos científicos (HEUKELBACH, 2005).

Para prevenção individual, o uso regular de chinelos ou sandálias (BROOKER *et al.*, 2009) também é indicado, mas sua proteção contra a penetração das pulgas de areia é parcial, assim como o uso de sapatos fechados e de meias (HEUKELBACH, 2005; FELDMEIER *et al.*, 2006a; MUEHLEN *et al.*, 2006). Pulgas penetradas já foram identificadas em indivíduos adequadamente calçados em áreas endêmicas (ARIZA, dados não publicados). O uso de calçados apropriados pode diminuir a prevalência na comunidade, entretanto, dificuldades econômicas e particularidades culturais podem ser limitantes para essa prática.

1.1.9 – Controle

O controle da *T. penetrans* deverá abarcar não apenas o hospedeiro humano (como abordado no item anterior), mas incluir o controle do reservatório animal e socio-ambiental (intra e extra-domiciliar).

O caráter de zoonose conferido a tungíase torna seu controle complexo, uma vez que são requeridas intervenções em uma variedade de animais que servem como reservatórios (cães, gatos, porcos e ratos) (HEUKELBACH *et al.*, 2001; HEUKELBACH *et al.*, 2003a). Por outro lado, há que se considerar o ciclo de vida da pulga *T. penetrans* no qual estágios pré-adultos da pulga (ovos, larva e pupa) persistam no ambiente (HICK, 1930; CALHEIROS, 2007; WITT *et al.*, 2007; LINARDI *et al.* 2010). Estes aspectos tornam o controle da tungíase um desafio (HEUKELBACH *et al.*, 2002a), associados ainda com comportamento dos indivíduos, condições de pobreza e falta de tratamento adequado, entre outros fatores.

A redução do reservatório animal em uma comunidade reduzirá a taxa de ataque nos humanos (PILGER *et al.*, 2008b; PILGER *et al.*, 2008c). Entretanto, devido a questões culturais esta estratégia pode apresentar limitações. Desta forma, o tratamento dos animais domésticos infestados pode ser efetivo – embora caro. Por exemplo, a aplicação tópica de uma combinação de 10% imidaclorida e 50% permetrina (Advantix®) em cachorros apresentou eficácia terapêutica contra pulgas penetradas (KLIMPEL *et al.*, 2005). Outra estratégia para reduzir prevalências nos humanos, pode ser o confinamento dos porcos em comunidades nas quais aqueles circulam livremente (UGBOMOIKO *et al.*, 2007a; UGBOMOIKO *et al.*, 2008b).

Estratégias sócio-ambientais, como cimentação do chão de casas e pavimentação das ruas, também podem reduzir as taxas de ataque pois as pulgas, na fase fora dos hospedeiros, parecem desenvolver-se preferivelmente em terra arenosa e com sombra (CALHEIROS, 2007; NAGY *et al.*, 2007; WITT *et al.*, 2007; LINARDI *et al.* 2010).

Medidas de intervenção para controle da tungíase precisam ser planejadas por um grupo interdisciplinar de profissionais e em conjunto com as comunidades afetadas. Além disso, faz-se necessário políticas públicas que promovam mudanças sustentáveis de qualidade de vida e saúde as quais reduzirão a incidência e a carga negativa que este parasito provoca nas comunidades afetadas (HEUKELBACH *et al.*, 2002a; HEUKELBACH, 2006).

1.2 – MÉTODOS EPIDEMIOLOGICOS RÁPIDOS

Em cenários onde recursos financeiros, estruturais e humanos são insuficientes para obtenção de dados através de estudos epidemiológicos complexos, planejadores e gestores em saúde buscam alternativas custo-efetivas para a tomada de decisões adequadas e otimização dos recursos. Esses métodos estão sendo aplicados em diferentes áreas do conhecimento, tais como a epidemiologia (SMITH, 1989; ANKER, 1991), a antropologia e administração de serviços de saúde (ANKER, 1991; VLASSOFF e TANNER, 1992). Por meio de métodos epidemiológicos rápidos pode-se estimar a prevalência e gravidade de uma variedade de doenças, principalmente em países de poucos recursos (ANKER, 1991; VLASSOFF e TANNER, 1992; MACINTYRE, 1999; MACINTYRE *et al.*, 1999).

Especificamente no campo das doenças infecto-parasitárias, os métodos epidemiológicos rápidos têm sido aplicados na África para estimar a carga por doenças bacterianas e parasitárias em comunidades de alto risco. Em geral, esses métodos são baseados em sinais e sintomas da infecção por um determinado parasito. Por exemplo, a presença macroscópica de hematúria ou a presença de microhematuria utilizando *dip sticks* podem ser utilizadas como método rápido do diagnostico da esquistossomose urinaria (MOTT *et al.*, 1985; LENGELER *et al.*, 1991; WHO, 1995a; LENGELER *et al.*, 2002a; b; FRENCH *et al.*, 2007; UGBOMOIKO *et al.*, 2009). A identificação de nódulos palpáveis na pele é empregada como método rápido da oncocercose (WHO, 1993; NGOUMOU *et al.*, 1994; WHITWORTH e GEMADE, 1999; KIPP e BAMHUHIIGA, 2002), a presença de larvas nos olhos como método rápido para a loíase (TAKOUGANG *et al.*, 2002; ADEOYE *et al.*, 2008), e a identificação de elefantíase ou hidrocele como métodos rápidos da filariose linfática (GYAPONG *et al.*, 1996; GYAPONG *et al.*, 1998a; GYAPONG *et al.*, 1998b; WEERASOORIYA *et al.*, 2008).

A "rapidez" tem como um dos seus componentes a simplicidade e facilidade do exame diagnóstico frente aos métodos diagnósticos parasitológicos tradicionais (padrões-ouro). Nestes há necessidade de identificação da presença e do número de parasitos em amostras de material biológico, como sangue, fezes ou urina. Em geral, tais métodos quando utilizados em levantamentos epidemiológicos são complexos, de custo elevado e demorados, pois necessitam de recursos técnicos e humanos especializados (ANKER, 1991; VLASSOFF e TANNER, 1992;

MACINTYRE, 1999; BROOKER *et al.*, 2009). Por exemplo, nos levantamentos da esquistossomose urinária o diagnóstico clássico é feito através da detecção parasitológica de ovos na urina pelo método de filtração (BERGQUIST *et al.*, 2009; BROOKER *et al.*, 2009). Entretanto, nas áreas endêmicas os custos para aplicação de método diagnóstico complexo são altos e no sistema de saúde local faltam equipamentos, suprimentos e pessoal qualificado. Além disto, a capacidade técnica, para a condução de um levantamento de base populacional, é também limitada. Dado todo este contexto, não especifico apenas para a esquistossomose, mas para várias outras doenças tropicais, surge a necessidade das alternativas custo-efetivas, simples e rápidas (BROOKER *et al.*, 2009).

No caso da tungíase, o diagnóstico é clínico, feito por inspeção visual por meio da identificação da presença da *T. penetrans* na epiderme dos indivíduos, conforme método diagnóstico padrão ouro baseado na Classificação de Fortaleza (EISELE *et al.*, 2003). Para tanto, faz necessário o exame de todo o corpo dos indivíduos, registro de cada lesão por localização topográfica, estágio de desenvolvimento da pulga na epiderme, bem como das patologias associadas. Desta forma, esse método diagnóstico é extenso e demorado, tanto em sua coleta como de entrada e análise dos dados e divulgação dos resultados.

1.3 – JUSTIFICATIVA

A tungíase continua sendo uma doença de importância em saúde publica com prevalências altas em comunidades de alto risco no Brasil e na Nigéria. Entretanto, a situação epidemiológica ainda é desconhecida nessas áreas. Desta forma, métodos epidemiológicos rápidos precisam ser elaborados para, de forma confiável e dentro de curto espaço de tempo, fornecer um panorama da distribuição da tungíase.

Devido ao sucesso da aplicação de métodos epidemiológicos rápidos em outras doenças parasitárias negligenciadas é sensato supor que um método epidemiológico rápido para a tungíase possa contribuir para delimitação de áreas endêmicas e grau de gravidade, e assim possibilitar a implementação e avaliação de programas de controle em áreas onde não se tem informação e os recursos humanos e financeiros são escassos.

1.4 – HIPÓTESE

A presença de pelo menos uma lesão por *T. penetrans* em uma localização específica nos pés pode ser utilizada como indicador confiável para estimar de forma rápida a prevalência e a gravidade da tungíase em comunidades endêmicas brasileiras e nigerianas.

2 – OBJETIVOS

2.1 – OBJETIVO GERAL

Desenvolver um método epidemiológico rápido da tungíase em comunidades endêmicas com diferentes características demográficas, sócio-culturais e ambientais na Nigéria e no Brasil.

2.2 – OBJETIVOS ESPECÍFICOS

1. Determinar a prevalência, carga parasitária e aspectos clínicos da tungíase em duas comunidades pesqueiras da Nigéria;
2. Elaborar um método de avaliação rápida para estimar a prevalência e a gravidade da tungíase, com base em estudos populacionais realizados no Brasil e na Nigéria;
3. Aplicar o método epidemiológico rápido em distintas comunidades pesqueiras da Nigéria.

3 – MATERIAL E MÉTODOS

O presente trabalho divide-se em três partes distintas:

- Descrição da epidemiologia da tungíase em duas comunidades pesqueiras da Nigéria;
- Elaboração do método epidemiológico rápido da tungíase, baseado em 10 estudos transversais realizados em comunidades brasileiras (dados secundários) e nigerianas (dados primários);
- Aplicação do método em duas distintas comunidades pesqueiras na Nigéria.

Em primeiro momento, são descritas as áreas e populações de estudo do Brasil e da Nigéria, bem como o exame clínico padrão utilizado em todas os estudos transversais. Segundo, são descritos em separado os desenhos dos estudos e a análise de dados.

3.1 – ÁREAS E POPULAÇÕES DE ESTUDO

Os dados utilizados nesta tese foram provenientes de dez estudos transversais realizados em cinco comunidades, sendo três do Nordeste brasileiro e duas do Sudoeste da Nigéria (África ocidental). A coleta de dados desses estudos foi realizada no período entre 2001 e 2008.

As comunidades do Brasil foram (Figura 13):

- Balbino: vila pesqueira no município de Cascavel no estado do Ceará;
- Morro do Sandra's: favela urbana de Fortaleza (capital do Ceará);
- Feliz Deserto: município rural no estado de Alagoas.

Detalhes das características das três comunidades, populações, desenho de estudo e as respectivas prevalências foram previamente publicados por esse grupo de pesquisa (WILCKE *et al.*, 2002; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; ARIZA *et al.*, 2007; HEUKELBACH *et al.*, 2007).

Na Nigéria, os dados foram coletados em Yovoyan e Okunilage, duas pequenas vilas de pescadores de Badagry (estado de Lagos, Figura 13). A coleta de dados foi realizada pela própria doutoranda durante estágio de doutoramento no exterior financiado pela CAPES.

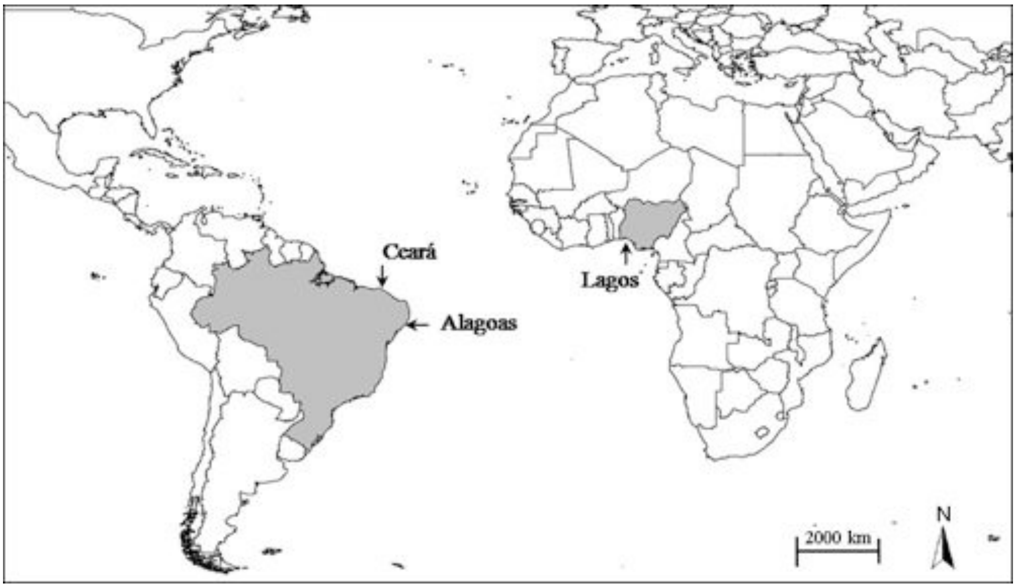


Figura 13: Localização dos estados de estudo no Brasil (Ceará e Alagoas) e na Nigéria (Lagos).

Tanto no Brasil como na Nigéria, as comunidades foram escolhidas por serem áreas típicas endêmicas e apresentarem distintas características sócio-culturais. Na Tabela 1 estão resumidas as principais características das comunidades.

Tabela 1: Características das cinco comunidades e dos 10 estudos transversais em áreas do Brasil e Nigéria, no período 2001 a 2008.

Comunidade	No. do estudo	Período da coleta de dados		População-alvo (indivíduos)	Principais características	
		Mês/Ano	Estação		Tipo de comunidade	Localização
Morro do Sandra's	1	03/2001	Chuvosa	1468	Favela urbana	Fortaleza (CE)
	2	06/2001	Chuvosa			
	3	09/2001	Seca			
Balbino	4	07/2001	Seca	605	Pesqueira	50 km ao leste de Fortaleza
	5	08/2001	Seca			
	6	04/2002	Chuvosa			
Feliz Deserto	7	06/2003	Chuvosa	1146	Rural	120 km ao sul de Maceió (AL)
	8	10/2003	Seca	1087		
Yovoyan	9	02/2008	Seca	220	Pesqueira	63 km à oeste de Lagos, capital do Estado
Okunilage	10	03/2008	Seca	147	Pesqueira	56 km à oeste de Lagos

3.1.1 – Comunidades brasileiras

O Morro do Sandra's (latitude: 3°43'46"S; longitude: 38°27'57"O) é uma micro-área da favela Vicente Pinzón situada nas dunas da Praia do Futuro, uma das praias urbanas de Fortaleza/CE (Figura 14). Foi formada há mais de 50 anos por pessoas vindas do interior do estado. No momento do estudo (2001), a favela possuía uma população em torno de 1500 habitantes. Embora mais de 95% das residências tivesse energia elétrica, apenas pouco mais de 60% tinha acesso a água encanada e as condições gerais de higiene, tais como coleta de lixo e rede de esgoto, eram precárias e insuficientes. Muitas casas eram construídas com material aproveitado e tinham piso de areia. Analfabetismo e desemprego eram altos na área, e a renda mensal familiar era inferior a um salário mínimo. Cachorro, gatos e ratos eram presentes na área. Crimes, uso drogas e prostituição eram comuns entre os habitantes (HEUKELBACH *et al.*, 2002b; WILCKE *et al.*, 2002). Do Morro do Sandra's foram utilizados dados coletados em três estudos transversais realizados na população. As coletas foram realizadas em 2001, nos meses de março, junho (período chuvoso) e Setembro (período seco) (Tabela 1).

Balbino (latitude: 4°04'30"S; longitude: 38°10'48"O) é uma tradicional vila de pescadores, localizada no município de Cascavel (CE), 50 km ao leste de Fortaleza (Figura 15). Estava composta, no momento da pesquisa, por aproximadamente 140 famílias totalizando uma população de 620 indivíduos. Era uma comunidade relativamente isolada cuja maioria dos moradores viviam na área desde o nascimento. Todas as residências tinham fornecimento de energia elétrica, porém sem abastecimento de água. Esta era coletada em poços (próprios ou públicos). O sistema de esgoto era inexistente na comunidade, e em torno de 60% das famílias depositava o lixo no terreno de casa (MUEHLEN *et al.*, 2003). Cerca de 90% das casas eram de tijolo e mais de 60% tinha o piso cimentado ou de cerâmica. Quase todas as casas possuíam pelo menos um animal doméstico (gato ou cachorro) (MUEHLEN *et al.*, 2003; MUEHLEN *et al.*, 2006). Desta comunidade foram utilizados três estudos transversais populacionais, o primeiro em julho de 2001, o segundo no mês seguinte e o último em abril de 2002 (estação chuvosa).

Feliz Deserto (latitude: 10°17'26"S; longitude: 36°18'44"O) uma comunidade rural situada a 120 km ao sul de Maceió no estado de Alagoas (AL), localizada próxima à costa e com população total composta por cerca de 3.850

habitantes (Figura 16). Os estudos de prevalência, porém, foram realizados apenas nas áreas consideradas como as de maior presença da doença, as quais totalizaram em torno de 1100 indivíduos. Nestas áreas do estudo, embora fossem considerada uma das mais precárias da comunidade, a maioria das famílias tinha abastecimento de água, energia elétrica e coleta de lixo diária. Além disto, quase todas (98,5%) as casas eram construídas de tijolo e em torno de 90% tinha piso de cimento (ou similar). A renda média familiar era em torno de 200 reais. Menos da metade das famílias (40%) tinham cão ou gato como animais domésticos (HEUKELBACH *et al.*, 2007). De Feliz Deserto, foram utilizados dois estudos transversais, com amostras representativas de aproximadamente 1.000 indivíduos, respectivamente. Os dados foram coletados, entre junho (estação chuvosa) e outubro de 2003 (estação seca).

Figura 14: Favela Morro do Sandra's, Fortaleza (CE)

Figura 15: Vila pesqueira de Balbino, Cascavel (CE)

Figura 16: Comunidade rural de Feliz Deserto (AL)

3.1.2 – Comunidades na Nigéria

As duas pequenas comunidades pesqueiras nigerianas, Yovoyan e Okunilage, localizam-se no município de Badagry (latitude: 6^{o}25’03”N; longitude: 2^{o}.53’03”L). Esta é uma cidade típica da costa Sudoeste da Nigéria (África Oeste) e é uma das áreas de governo local (*Local Government Area*: LGA) do estado de Lagos. Está situada entre a região metropolitana da cidade de Lagos (em torno de 60 km Leste) e a fronteira com a República de Benin (15 km a Oeste) (Figura 17).

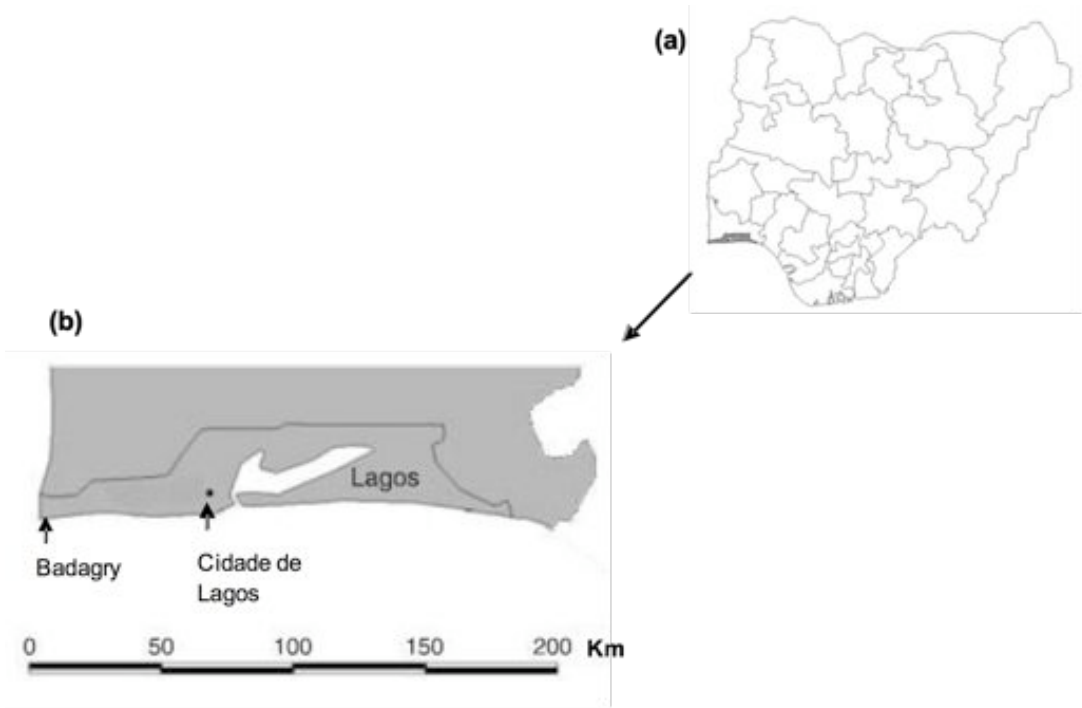


Figura 17: (a) Mapa da Nigéria com destaque para o estado de Lagos; (b) Mapa do estado de Lagos com destaque para as cidades de Lagos (capital do estado) e Badagry.

Badagry foi fundada no início do século XV em uma das lagoas próximas ao Golfo da Guiné. Devido a sua localização estratégica, teve importante papel na história de relações e contatos entre o Oeste da África e a Europa. Foi um dos principais portos na exportação de escravos e mercadorias para as Américas (Figura 18). A partir de 1840, com o fim do tráfico de escravos negros, tornou-se um importante local de missão cristã por parte dos colonizadores britânicos.

Atualmente, é a segunda maior cidade comercial do estado de Lagos. Seus principais produtos são relacionados principalmente às atividades de pesca e agricultura. A LGA de Badagry é formada por inúmeras localidades e uma população total em torno de 240.000 pessoas (Censo Nigéria, 2006) que pertencem principalmente aos grupos étnicos Yoruba e Ogu (Figura 19).

O clima em toda esta área é tropical com duas estações bem definidas: a estação seca de Novembro a Março; e a estação chuvosa de Abril a Outubro. Embora a temperatura varie pouco na região, as médias mais altas são em torno de 29°C em Fevereiro/Março e as mais baixas 25°C em julho/agosto. Chuvas intensas ocorrem entre maio/junho com média de 300 mm/mês.

A área costeira de Badagry é formada por diversas tradicionais e pequenas comunidades pesqueiras, entre essas estão: Yovoyan (Figura 20) e Okunilage (Figura 21). Embora estas comunidades tenham em comum a atividade pesqueira e condições precárias de vida, como inexistência de saneamento básico, abastecimento de água, energia elétrica, coleta de lixo pública e a maioria das casas era feita de produtos de palmeiras e com chão de areia, elas eram distintas quanto a aspectos sócio-culturais e organização da comunidade.

Yovoyan (latitude: 6°23'38"N; longitude: 2°52'09"L) é uma vila antiga, formada há mais de 60 anos por famílias de pescadores vindas de Ghana, as quais ainda hoje são a maioria dominante. Atualmente, vivem na comunidade aproximadamente 60 famílias (220 indivíduos), compostas principalmente por mulheres. Possuem hábitos, língua e dialetos próprios e, em certa medida, se mantém isolados do contato com Badagry e demais cidades. As casas eram construídas em terrenos cercados, e o lixo depositado em uma área, nos fundos da comunidade. As crianças estudavam na escola primária e uma creche da própria comunidade. Os dados foram coletados entre janeiro e fevereiro de 2008.

Okunilage (latitude: 6°23'44"N; longitude: 2°53'28"L) foi formada há apenas 15 anos. Seus habitantes são jovens pescadores vindos de Lagos ou outras pequenas cidades. A maioria pertencia aos grupos étnicos Ogu e Yoruba. Vivem na comunidade em torno de 45 famílias (aproximadamente 150 indivíduos), cujas casas eram localizadas uma ao lado das outras sem separação por cercas. A vida social era freqüente entre os moradores que compartilhavam momentos de trabalho e laser em conjunto. Era comum o lixo estar espalhado por toda comunidade, uma vez que não havia local específico para seu depósito. A população mantém contato constante com Badagry e outras cidades próximas, inclusive as crianças freqüentam escolas de Badagry. O estudo transversal desta foi realizado entre fevereiro e março de 2008.

Figura 18: A antiga rota dos escravos ao “Ponto de Não-Retorno” no município de Badagry (Nigéria, 2008).

Figura 19: Badagry nos dias de hoje (Nigéria, 2008).

Figura 20: Comunidade pesqueira de Yovoyan (Nigéria, 2008).

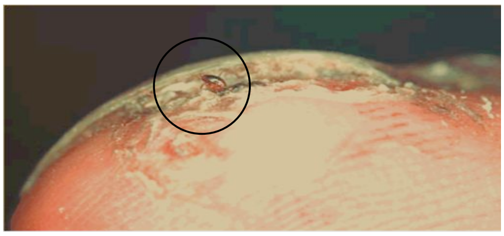
Figura 21: Comunidade pesqueira de Okunilage (Nigéria, 2008).

3.2 – EXAME CLÍNICO

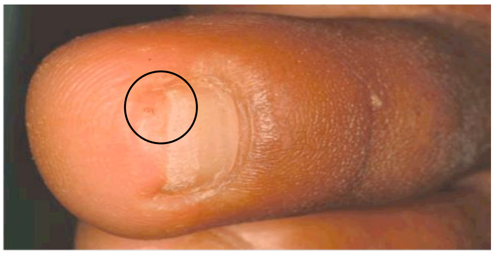
A tungíase foi diagnosticada de forma clínica a partir da presença de lesões de *T. penetrans*. O exame clínico foi realizado de forma padronizada nos dez estudos transversais.

O critério diagnóstico tungíase baseou-se na "Classificação de Fortaleza" (EISELE *et al.*, 2003), a qual define estágios de desenvolvimento da pulga fêmea adulta na epiderme do hospedeiro, sendo:

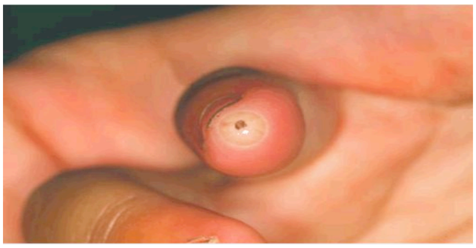
(a) presença da *T. penetrans* penetrando a pele (lesões vitais, estágio I);



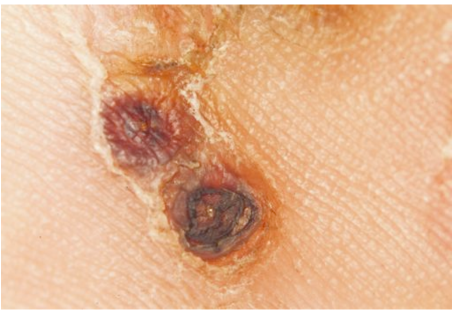
(b) presença de um pequeno ponto vermelho-pardo com diâmetro de um a dois milímetros associado á queixa de prurido (lesões vitais, estágio II);



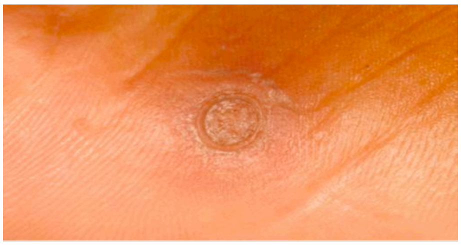
(c) presença de uma zona circular branca com diâmetro de três a dez milímetros com um pequeno ponto preto central (lesões vitais, estágio III);



(d) presença de uma casca preta plana e circular e por tecido necrosado (lesões avitais, estágio IV).



(e) presença de zona circular residual com sinais de descamação e reconstituição da epiderme (lesão avital, estágio V).



No diagnóstico, também foi incluída a presença de lesões devido à recente remoção, pelo indivíduo, da pulga ou parte dela (lesões manipuladas, Figura 22) (EISELE *et al.*, 2003). O tamanho das lesões manipuladas depende do estágio de desenvolvimento no qual pulga foi removida e dos cuidados na sua remoção. Em geral, estas lesões se caracterizam por úlceras ou sinas recentes de sangue, descamação de tecido ao seu redor e sinais inflamação.

Figura 22: Menina nigeriana de 12 anos com 3 lesões recentemente manipuladas no hálux e uma lesão manipulada mais antiga no terceiro dedo (Nigéria, 2008).

Tendo em vista que mais de 90% das lesões ocorrem nos pés (HEUKELBACH *et al.*, 2002b), somente foram consideradas lesões nesta área do corpo, dividido nas seguintes localizações topográficas: dedos, sola, canto lateral e calcanhar. Nos dedos, os registros ainda foram feitos por área periungueal (ao redor das unhas) e área não-periungueal (porção distal, posterior e entre dedos).

No exame clínico também foram identificadas os sinais de patologias agudas e crônicas associadas à tungíase, sendo elas: edema, eritema, pele brilhante, hipertrofia periungual, descamação, hiperceratose, fissura, ulcera, deformação de unha, perda de unha, abscesso/supuração (como sinal de superinfecção bacteriana), deformação de dígitos e lesões crônicas. Os indivíduos foram indagados sobre sintomas associados à infestação: prurido, dor espontânea, dor ao pressionar a lesão, distúrbio do sono associado ao prurido ou dor e dificuldade de andar.

Todos os membros das comunidades, independente da idade e sexo, foram elegíveis para o estudo. Para serem incluídos, os indivíduos deveriam ter passado pelo menos quatro noites da semana na área. Pessoas que se recusaram a participar do estudo e não concordaram em assinar o Termo de Consentimento Livre e Esclarecido (TCLE) não foram avaliados. Em caso de ausência de um dos membros da família no momento da avaliação clínica, o domicilio foi re-visitado em horário previamente combinado.

3.3 – ESTUDO TRANSVERSAL NA NIGÉRIA

3.3.1 – Desenho de estudo

Foi realizado estudo transversal nas duas comunidades da Nigéria. Em ocasião de visita domiciliar, os membros das comunidades foram inspecionados para a presença de lesões pela *T. penetrans*. Todas as lesões encontradas foram contadas e estagiadas. A presença de patologias agudas e crônicas associadas às lesões por tungíase também foi registrada utilizando ficha padrão pré-testada (Apêndice 1)

Tanto em Yovoyan como em Okunilage, a coleta de dados foi realizada pela própria doutoranda para eliminar viés inter-observador. Como nas comunidades havia indivíduos que não falavam a língua oficial do país (Inglês), mas apenas suas línguas nativas (Yoruba, Egu e outras) ou dialetos específicos, os dados foram coletados com suporte de uma assistente de campo local para as devidas traduções. Para evitar efeito de mudança de incidência durante o estudo, em cada comunidade, a coleta de dados não se estendeu mais do que um mês.

3.3.2 – Procedimentos

Prévio à coleta de dados, os lideres locais das comunidades foram visitados, e os objetivos do estudo explicados.

Os seguintes procedimentos foram realizados durante a visita domiciliar:

- Leitura do TCLE e obtenção de assinatura do indivíduo ou seu representante legal ;
- Exame clínico: exame detalhado das lesões por tungíase (Apêndice 1);
- Questionário: coleta de dados sócio-econômicos, comportamentais e ambientais familiares e individuais (Apêndice 2).

3.3.3 – Análise dos dados:

Os dados foram inseridos em bancos de dados no programa Epi Info (versão 6.04d, *Centers for Disease Control and Prevention*, Atlanta, Estados Unidos) e também foram verificados os erros de digitação neste programa. A seguir os dados foram exportados para o programa STATA versão 9 (*Stata Corporation,* College Station, Estados Unidos) para realização das análises estatísticas.

Razões de prevalência e intervalos de confiança de 95% foram calculados. Medianas e intervalos interquartis foram apresentados para indicar a dispersão do número de lesões por indivíduo, uma vez que este dado não apresentou distribuição normal. O teste exato de *Fisher* foi utilizado para comparar freqüências relativas. As medidas quantitativas foram comparadas pelo teste *Mann-Whitney* (medianas) e teste t (médias).

3.4 – ELABORAÇÃO E AVALIAÇÃO DO MÉTODO EPIDEMIOLÓGICO RÁPIDO DA TUNGÍASE

Os dez estudos transversais, embora realizados em comunidades e períodos distintos, tiveram desenho de estudo, exame clínico e critérios de inclusão da população de estudo semelhantes (vide descrição do exame clinico padrão – item 3.2). Essas condições permitiram a agregação de todos os dados coletados em um único banco de dados.

Dentre todas as localizações nos pés registradas no banco de dados, seis foram selecionadas e avaliadas como possível base de um método rápido epidemiológico. As localizações foram avaliadas considerando a presença ou ausência de lesões nas seguintes localizações:

- Pé direito (incluindo área periungueal dos dedos, planta do pé, calcanhar e porção lateral)
- Área periungueal do pé direito
- Área periungueal de qualquer um dos pés
- Hálux do pé direito
- Área periungueal do hálux do pé direito
- Área periungueal do hálux de qualquer um dos pés

A escolha da localização mais adequada para estimar de forma rápida a prevalência geral e gravidade em uma comunidade endêmica foi feita com base no coeficiente de determinação (R^2) e no valor *p* obtido por correlação. Além disso, foram considerados aspectos operacionais, como o tempo de exame em indivíduos não-infestados, a praticidade de exame, o incômodo ao indivíduo e a possibilidade de sua realização do método por um membro da comunidade.

3.4.1 – Análise dos dados

Definições:

- Prevalência geral verdadeira = [número de indivíduos com presença de tungíase em qualquer localização nos pés ÷ numero total de indivíduos examinados] x 100

- Prevalência grave verdadeira = [número de indivíduos com mais de 20 lesões tungíase em qualquer localização nos pés ÷ numero total de indivíduos examinados] x 100
- Prevalência em uma localização especifica no pé = [número de indivíduos com presença de tungíase na específica área topográfica do pé ÷ numero total de indivíduos examinados] x 100.
- Prevalência geral estimada: prevalência calculada a partir da regressão linear.
- Prevalência grave estimada: prevalência de indivíduos com mais de 20 lesões, calculada a partir da regressão linear.

Correlação e regressão linear:

As unidades de observação utilizadas nas regressões e correlações foram os dez estudos transversais. As correlações lineares foram realizadas para avaliar a associação entre prevalência geral verdadeira e as prevalências de cada uma das seis localizações selecionadas. Foram assim calculados a significância da correlação (valores *p*) e os coeficientes de determinação (R^2).

O coeficiente de determinação indica a fração da variável dependente (prevalência geral verdadeira) que é explicada pela variável independente (prevalência na localização específica) (CALLEGARI-JACQUES, 2004). Assim, um coeficiente de determinação de 1 significaria que a prevalência geral poderia ser prevista completamente pela prevalência na localização especifica.

Em seguida, para cada um dos estudos transversais, a prevalência geral foi estimada à base da equação da reta oriunda de regressão linear. Os erros absolutos (*prevalência estimada – prevalência verdadeira)* foram também calculados.

Para a localização escolhida como possível método epidemiológico rápido foi feita correlação e regressão linear com as prevalências graves. Da mesma forma, foram obtidos os valores de R^2 e valor de *p*, assim como estimadas prevalências graves e calculados os erros absolutos.

3.4.2 – Avaliação do Método Rápido nas Comunidades Nigerianas

O método rápido da tungíase elaborado foi aplicado nas comunidades nigerianas para avaliação de sua aplicabilidade em contexto distinto ao do Brasil.

Os indivíduos da comunidade de Yovoyan e Okunilage antes de serem examinados pelo exame clínico padrão foram inspecionados para identificação de lesões apenas na área periungueal de qualquer um dos pés (Apêndice 3). Foram, além disto, verificados o tempo de execução pelos dois métodos, o rápido e o tradicional. Para o cálculo do tempo por família pelo método tradicional, considerou-se: *[número médio de indivíduos infestadas por família x tempo médio do exame] + [numero médio de indivíduos não infestados por família x tempo para avaliação]*.

Os dados coletados por este método foram comparados com os do exame clínico, e a estimativa da prevalência geral foi calculada com base na equação de reta obtida com os 10 levantamentos epidemiológicos.

3.5 – CONSIDERAÇÕES ÉTICAS

Os estudos transversais nas cinco comunidades foram aprovados pelos respectivos Comitês de Ética de Pesquisa em Humanos, sendo o da Universidade Federal do Ceará, o da Escola de Ciências Médicas de Alagoas, Comitê de Ética *ad-hoc* do Município de Balbino, e da Universidade Federal de Ilorin na Nigéria. Na Nigéria, os chefes tradicionais de Badagry (*Ankar*) e de comunidades locais (*Baales*) também aprovaram o estudo (Anexo 1).

Nas comunidades, foram realizadas reuniões com os seus líderes e representantes nas quais foram explicados objetivos das pesquisas em detalhes. Os indivíduos selecionados para o estudo também receberam explicação sobre o estudo e termo de consentimento livre e esclarecido escrito (TCLE) foi obtido de indivíduos ou guardiões/responsáveis por menores de idades ou incapacitados. Na Nigéria, os TCLE foram fornecidos em inglês, e caso necessário, traduzido oralmente pela assistente de pesquisa nas línguas locais (Apêndice 4). No caso de pessoas analfabetas, a aprovação foi obtida através de impressões de dedo polegar.

Toda pesquisa deve ser conduzida com três princípios éticos básicos: respeito, beneficência e justiça (Resolução 196/96). O respeito pela indivíduo trata principalmente de sua autonomia em deliberar sobre suas escolhas pessoais. O benefício para o paciente refere-se à obrigação ética de maximizar benefícios e minimizar danos e prejuízos. Há ainda a justiça, que trata da obrigação ética de tratar cada pessoa com o que é moralmente certo e adequado.

Neste projeto se desconhece onde estes preceitos estejam quebrados: aos sujeitos foi garantido a livre participação na pesquisa e o direito de suspender sua participação em qualquer etapa da pesquisa; a identidade dos indivíduos foi preservada sem a identificação destes em publicações ou para terceiros; os indivíduos foram informados sobre medidas preventivas para evitar penetração das pulgas e remoção adequada das pulgas. Os indivíduos gravemente infestados foram orientados quanto a necessidade de vacina anti-tetânica. Não foram coletados material biológico de nenhuma espécie. Todos os dados coletado foram manuseados em sigilo. Os dados somente serão utilizados para fins dessa pesquisa.

Esse estudo teve como benefício público mostrar e alertar a importância desta ectoparasitose como um problema de saúde pública, e também de contribuir com gestores e planejadores de saúde para o desenvolvimento métodos permitam a delimitação de áreas endêmicas e seu nível de endemicidade e consequentemente o controle da tungíase em comunidades endêmicas.

4 – RESULTADOS

4.1 – EPIDEMIOLOGIA DA TUNGÍASE NAS COMUNIDADES DA NIGÉRIA

4.1.1 – Características das Populações de Estudo

Foram incluídos um total de 186 dos 220 indivíduos de Yovoyan e 116 dos 147 indivíduos de Okunilage (n=302). Esses indivíduos representaram aproximadamente 85% e 79% das suas respectivas populações-alvo. Em Yovoyan, 28 indivíduos não foram encontrados no domicilio e seis se recusaram em participar da pesquisa. Em Okunilage, 23 indivíduos estavam ausentes e houve oito recusas.

No geral, em ambas as comunidades mais mulheres foram examinadas (60% em Yovoyan e 53% em Okunilage) do que homens (40% e 47%, respectivamente). As comunidades foram semelhantes quanto às faixas etárias. Cerca de 50% dos indivíduos eram menores de 14 anos de idade, 30% adolescentes e jovens-adultos e 20% acima de 40 anos. Em Okunilage os indivíduos maiores de 60 anos foram menos representados do que em Yovoyan (Tabela 2).

Tabela 2: Distribuição por sexo e idade das populações de estudos nas duas comunidades nigerianas (Nigéria, 2008).

	Yovoyan		Okunilage		Total	
	N examinado (%)		N examinado (%)		N examinado (%)	
Sexo						
Homens	75	(40,3)	55	(47,4)	130	(43)
Mulheres	111	(59,7)	61	(52,6)	172	(57)
Grupos etários (anos)						
≤ 4	33	(17,7)	28	(24,1)	61	(20,2)
5 – 9	41	(22,0)	21	(18,1)	62	(20,5)
10 – 14	21	(11,3)	10	(8,6)	31	(10,3)
15 – 19	16	(8,6)	10	(8,6)	26	(8,6)
20 – 39	35	(18,8)	29	(25,0)	64	(21,2)
40 – 59	28	(15,1)	16	(13,8)	44	(14,6)
≥ 60	12	(6,5)	2	(1,7)	14	(4,6)
Total	186	(100)	116	(100)	302	(100)

Em torno de 60% da população era formada por estudantes (menores de 18 anos) e 16% era analfabeta. Entre os 129 adultos (acima de 18 anos) das duas comunidades, em torno de 35% eram analfabetos e 85% tinham algum tipo de ocupação laboral. A principal fonte de renda estava relacionada à atividade pesqueira, seja através da própria pesca, ou do preparo do peixe para comercialização, bem como sua venda em feiras populares ou na residência. Apenas uma minoria dos adultos nas comunidades tinha vínculo formal de trabalho (servidores públicos), sendo 7,6% (5/66) em Yovoyan e, 2,3% (1/43) em Okunilage (Tabela 3)

Tabela 3: Nível de escolaridade e ocupação profissional pelas comunidade nigerianas (Nigéria, 2008)

	Yovoyan		Okunilage		Total	
	N examinado	(%)	N examinado	(%)	N examinado	(%)
Escolaridade						
Estudante (≤18 anos)	106	(57,0)	66	(56,9)	172	(57)
Primeiro grau completo (ou mais)	49	(26,3)	32	(27,6)	81	(26,8)
Analfabeto/Primeiro grau incompleto	31	(16,7)	17	(14,7)	48	(15,9)
Ocupação						
Estudante (≤18 anos)	106	(57,0)	66	(56,9)	172	(57)
Trabalhador	66	(35,5)	43	(37,1)	109	(36,1)
Aposentados/Não trabalha	13	(7,0)	7	(6,0)	20	(6,6)
Tipo de ocupação*						
Comerciante	32	(48,5)	23	(53,5)	55	(50)
Pescador	13	(19,7)	15	(34,9)	28	(25,5)
Servidor público	5	(7,6)	1	(2,3)	6	(5,5)
Outros (lavrador, cabeleireiro, etc)	16	(24,2)	4	(9,3)	20	(18,2)

* Para aqueles que informaram serem trabalhadores (n=66, n=43 e n=109, respectivamente).

A composição das famílias examinadas foi semelhante nas duas comunidades, com mediana de cinco pessoas por família (amplitude: 1 a 10). Por outro lado, o tempo em que as famílias habitavam nas comunidades foi bastante distinto: em Yovoyan já viviam em média 30 anos (tempo mínimo dois anos e máximo 65), e em Okunilage a média foi de 7,5 anos (mínimo um ano e máximo 15 anos).

As duas comunidades eram também similares quanto à precária infra-estrutura pública: ruas de areia, não havia energia elétrica ou fornecimento de água tratada e encanada. Assim como não havia rede de esgoto ou coleta de lixo. Apesar destas semelhanças, as comunidades diferiram quanto à estrutura da casa e presença de animais. As principais características de moradia estão descritas na Tabela 4.

Em Yovoyan, aproximadamente 30% dos indivíduos moravam em casa de concreto ou com telhado "chapa ondulada" e quase 80% deles tinham piso de cimento na casa. Todas as casas eram dentro de terrenos cercados. A maioria dos indivíduos depositava o lixo em uma área em comum na comunidade. Por outro lado, em Okunilage os habitantes viviam em casas construídas com produtos derivados de palmeiras e 94% o piso da casa era de areia. O lixo em geral era depositado próximo a casa. Fossas também eram inexistentes nas casas, assim os indivíduos urinavam e se banhavam algum local reservado próximo a casa, e defecavam no ambiente externo a casa.

Tabela 4: Condições de moradia nas duas comunidades nigerianas (Nigéria, 2008)

	Yovoyan	Okunilage	Total
	N examinado (%)	N examinado (%)	N examinado (%)
Tipo de casa			
Produto de palmeiras	125 (67,2)	116 (100,0)	241 (79,8)
Concreto	51 (27,4)	– –	51 (16,9)
Outros	10 (5,4)	– –	10 (3,3)
Tipo de piso			
Concreto	145 (78,0)	7 (6,0)	152 (50,3)
Areia	36 (19,3)	65 (56,0)	101 (33,4)
Areia com saco/carpete	5 (2,7)	44 (38,0)	49 (16,4)
Tipo de telhado			
Folhas de palmeira	114 (61,3)	116 (100,0)	230 (76,2)
"Chapa ondulada"	62 (33,3)	– –	62 (20,5)
"Chapa ondulada" e folhas de palmeira	10 (5,4)	– –	10 (3,3)
Banheiro/Fossa			
Não	175 (94,1)	113 (97,4)	288 (95,4)
Sim	11 (5,9)	3 (2,6)	14 (4,6)

A presença de animais domésticos – gatos, cachorro, cabra – foi maior na comunidade de Yovoyan (78%) do que em Okunilage (62%). Por outro lado, a presença de ratos foi maior nesta última comunidade (87%) (Tabela 5).

Tabela 5: Presença de animais e roedores por comunidade nigerianas (Nigéria, 2008)

	Yovoyan	Okunilage	Total
	N examinado (%)	N examinado (%)	N examinado (%)
Presença de animais na família			
Cachorro/Gato/Cabra	117 (62,9)	39 (33,6)	156 (51,7)
Outros animais (galinha, pato etc)	28 (15,1)	23 (19,8)	51 (16,9)
Não	41 (22,0)	54 (46,6)	95 (31,5)
Presença de ratos			
Sim	119 (68,4)	101 (93,5)	220 (78)
Não	55 (31,6)	7 (6,5)	62 (22)

4.1.2 – Prevalência de tungíase

A prevalência geral da tungíase nas duas comunidades foi 47,0% (142/302; IC 95%: 41,4% - 52,7%). Em Yovoyan foi 51,5% e em Okunilage 40,5% (p=0,08). A prevalência de infestação grave (>20 lesões) foi de 10,2% e 5,2%, respectivamente (p=0,14; Tabela 6).

Os homens foram mais infestados por tungíase tanto em Yovoyan (58,7%) como em Okunilage (41,8%), porém em nenhuma delas houve uma diferença significante entre os sexos (p=0,1 e p=0,9, respectivamente).

As prevalências por grupos etários também apresentaram padrão semelhante. Em ambos os estudos, as crianças foram mais afetadas por tungíase do que os indivíduos maiores de 15 anos, sendo que em Yovoyan a diferença entre os grupos ocorreu de forma mais acentuada e significante (68,4% vs 33%, p<0,0001) do que em Okunilage (47,5% vs 33,3%, p=0,134).

Tabela 6: Prevalência nas duas comunidades de estudo e total, estratificado por sexo, grupo etário e gravidade (Nigéria, 2008).

	Yovoyan			Okunilage			p valor*	Total		
Prevalência	N positivo	%	IC 95%	N positivo	%	IC 95%		N positivo	%	IC 95%
Sexo										
Mulher	51/111	46,0	(36,5 − 55,4)	24/61	39,3	(26,7 − 52,0)	0,426	75/172	43,6	(36,1 – 51,1)
Homem	44/75	58,7	(47,3 − 70,1)	23/55	41,8	(28,4 − 55,3)	0,076	67/130	51,5	(42,8 − 60,2)
Grupos etários (anos)										
≤ 4	19/33	57,6	(39, 8 − 75,4)	10/28	35,7	(16,8 − 54,6)	0,124	29/61	47,5	(36,6 – 60,4)
5 – 9	32/41	78,1	(64,8 − 91,3)	12/21	57,1	(34,1 − 80,2)	0,138	44/62	71	(59,4 – 82,6)
10 – 14	14/21	66,7	(44,7 − 88,7)	6/10	60,0	(23,1 − 96,9)	1,0	20/31	64,5	(46,7 – 82,4)
15 – 19	5/16	31,3	(5,7 − 56,8)	4/10	40,0	(3,1 − 76,9)	0,692	9/26	34,6	(15,0 – 54,2)
20 – 39	16/35	45,7	(28,4 − 63,1)	8/29	27,6	(10,3 − 44,9)	0,195	24/64	37,5	(25,3 – 49,7)
40 – 59	6/28	21,4	(5,2 − 37,6)	7/16	43,8	(16,5 − 71,5)	0,172	13/44	29,6	(15,5 – 43,6)
≥ 60	3/12	25,0	(0 − 53,7)	0/2	−	−	1,0	3/14	21,4	(0 – 46,0)
Infestação										
grave	19/186	10,2	(6,3 − 15,5)	6/116	5,2	(1,9 − 10,9)	0,138	25/302	8,3	(5,4 – 12,0)
Geral	95/186	51,1	(43,8 − 58,3)	47/116	40,5	(31,5 − 49,6)	0,08	142/302	47	(41,4 – 52,7)

* Comparando as duas comunidades

Em geral, a distribuição da prevalência por faixa etária seguiu um padrão característico, com um pico na infância, e descida na adolescência (Figura 23). Não houve diferença significante nas faixas etárias entre as comunidades.

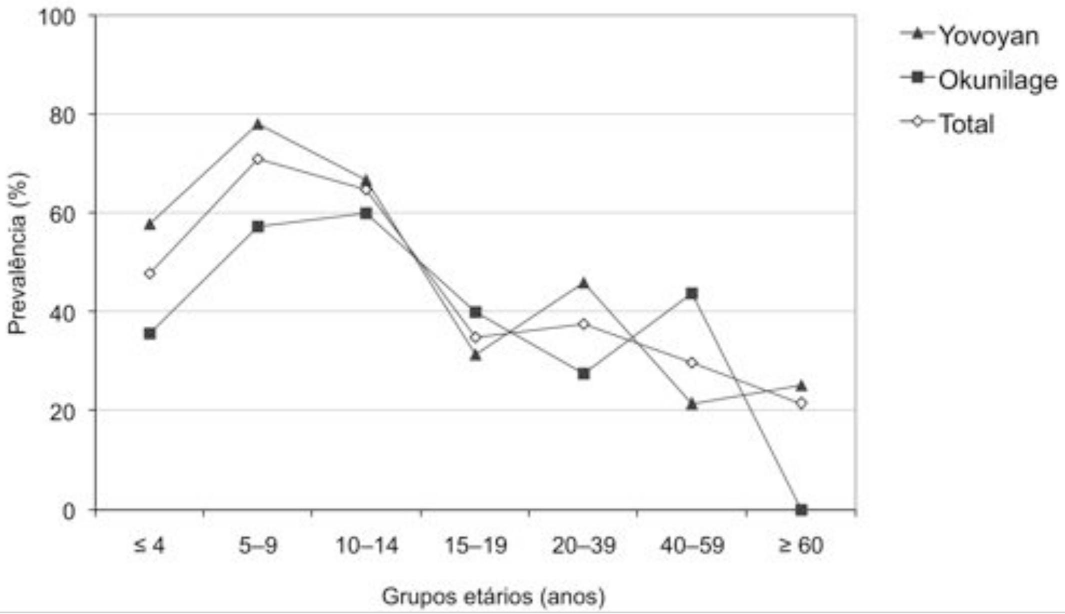


Figura 23: Prevalência por grupos etários estratificado por comunidade (Nigéria, 2008)

4.1.3 – Gravidade de infestação

Ao todo foram contadas 1.615 lesões nas 142 pessoas afetadas por tungíase, sendo: 1.251 lesões nos 95 indivíduos infestados em Yovoyan e 364 nos 47 indivíduos de Okunilage.

A mediana do número de lesões nas duas comunidades foi 5 (Intervalo Interquartil: 2 – 13). Entre as duas comunidades, as medianas foram significantemente distintas: 6 lesões em Yovoyan e 3 lesões em Okunilage (p=0,02). Tal como a mediana, as médias de lesões foram diferentes entre as áreas: 13,1 (dp=16,9) lesões em Yovoyan e 7,7 (dp=9,7) em Okunilage. O número máximo foi 75 lesões em uma menina de 11 anos na comunidade de Yovoyan. Em Okunilage, esse número foi 40 lesões em um menino de 7 anos.

Entre homens e mulheres de ambos os estudos, não houve diferença significante (p=0,46) entre a gravidade de infestação (medianas de 6 e 5 lesões) Em ambos os estudos, as crianças na faixa etária entre cinco e 14 anos (Tabela 7) foram responsáveis por mais de 50% do total de lesões na comunidade (788/1251; 63%, Yovoyan; 198/364, 54,4%, Okunilage).

Tabela 7: Carga parasitaria por comunidade e total, estratificado por sexo e grupos etários (Nigéria, 2008).

	Yovoyan			Okunilage				Total		
	N lesões	Mediana (IIQ)*	máx.	N lesões	Mediana (IIQ)	máx.	*p* valor	N lesões	Mediana (IIQ)	máx.
Sexo										
Mulheres	579	5,0 (2-10)	75	167	3 (2-10)	24	0,086	746	5 (2-10)	75
Homens	672	7,5 (2,5-22)	72	197	3 (2-12)	40	0,109	869	6 (2-15)	72
Grupos etários (anos)										
≤ 4	154	5 (2-12)	33	65	3,5 (2-8)	24	0,532	219	5 (2-10)	33
5 – 9	440	7,5 (2,5-16,5)	72	118	6,5 (2-12,5)	40	0,57	558	7,5 (2-15)	72
10 – 14	348	9,5 (4-44)	75	80	5 (3-31)	35	0,264	428	8,5 (3-3,5)	75
15 – 19	77	10 (5-26)	33	42	6,5 (2,5-18,5)	27	0,459	119	10 (3-26)	33
20 – 39	148	5 (2,5-10)	34	47	3,5 (1,5-10)	16	0,371	195	5 (2-10)	34
40 – 59	77	4,5 (1-15)	51	12	2 (1-2)	3	0,16	89	2 (1-3)	51
≥ 60	7	2 (2-3)	3	-	- -	-	-	7	2 (2-3)	3
Total	1251	6 (2-15)	75	364	3 (2-11)	40	0,02	1615	5 (2-13)	75

* Intervalo interquartil

Dos 142 indivíduos infestados nas comunidades, 51% (73) apresentaram infestações leves (≤5 lesões). Destes, 45,3% (43/95) em Yovoyan e 63,8% (30/47) em Okunilage. O percentual de indivíduos com infestação grave (>20 lesões) foi elevado em ambas as comunidades, em torno de 18%, tendo sido, porém, mais acentuado em Yovoyan (20%; 19/95) do que em Okunilage (12,8; 6/47). Apesar das diferenças nos níveis de infestação (Figura 24), não houve uma diferença significante entre as comunidades (leve, p=0,05; moderado, p=0,18; grave, p=0,35; respectivamente).

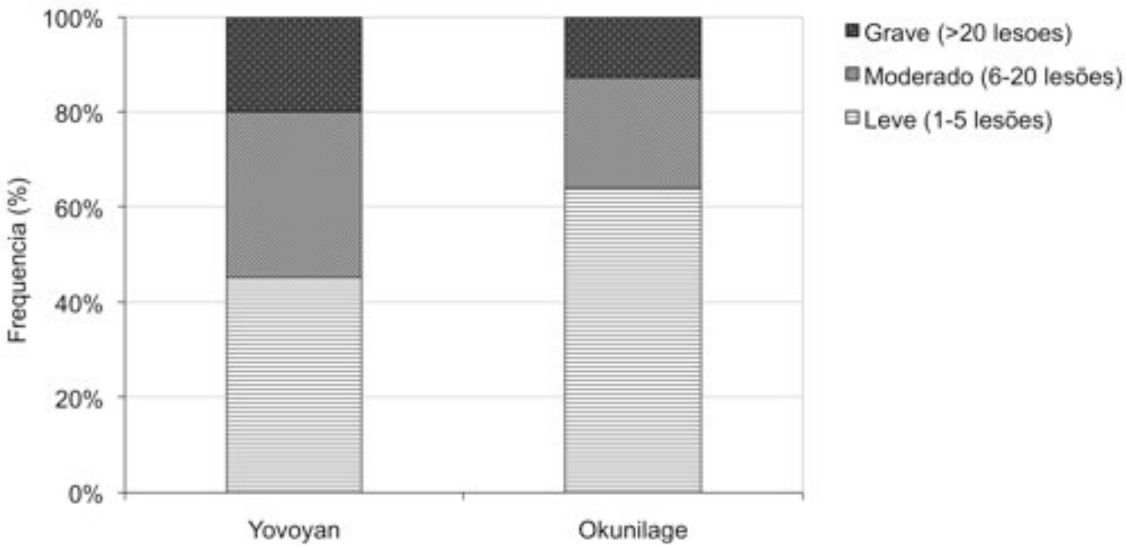


Figura 24: Freqüência relativa dos níveis de infestação por comunidade (leve: 1-5 lesões; moderado 6–20 lesões; grave >20 lesões; Nigéria, 2008).

Nas duas comunidades, aproximadamente 80% das lesões eram manipuladas (76% em Yovoyan e 90% em Okunilage, p<0,0001) e 16% vitais (18% e 9,9%, respectivamente, p<0,0001). Lesões avitais foram minoria (5,6%) em Yovoyan, e ausentes em Okunilage.

As medianas das lesões vitais (3 lesões) e manipuladas (6) por indivíduo infestado foram mais elevadas em Yovoyan do que em Okunilage (1 e 3, respectivamente) e a diferença foi significante (p=0,03) entre elas (Figura 25).

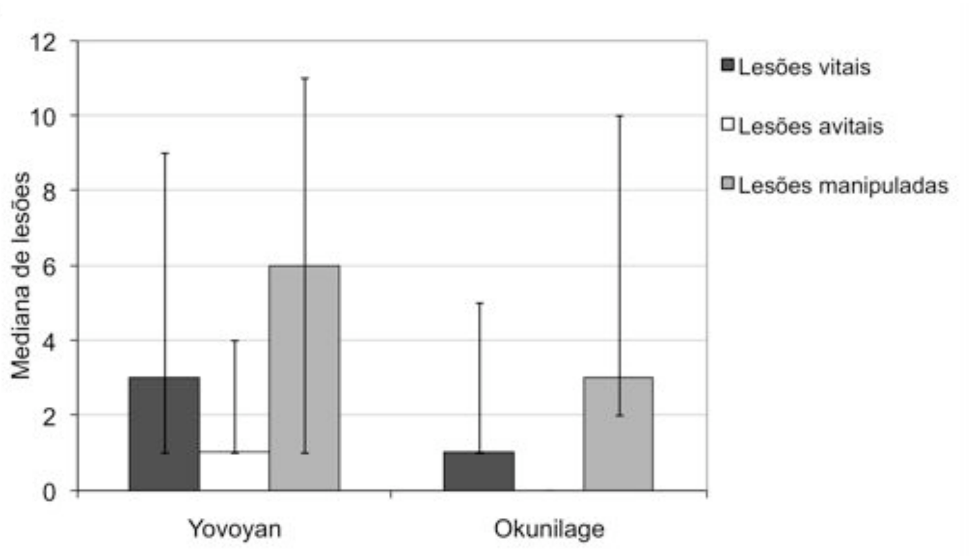


Figura 25: Medianas e intervalos interquartis das lesões vitais, avitais e manipuladas por indivíduos afetados nas comunidades (Nigéria. 2008).

Em torno de 80% dos indivíduos tinham lesões localizadas em áreas periungueais (88% em Yovoyan e 75% em Okunilage; p=0,06), e 70% nos dedos (excluindo a área periungueal), sendo que este percentual foi significativamente (p=0,02) mais elevado em Yovoyan (80%) do que em Okunilage (60%) (Tabela 8). A mediana de lesões na área periungueal foi 3 e 2 (p=0,02); e nos dedos 3 e 2,5 (p=0,03), Yovoyan e Okunilage, respectivamente.

Tabela 8: Distribuição topográfica das lesões nos pés dos indivíduos infestados (Nigéria, 2008)

	Yovoyan		Okunilage		Total	
	Número de lesões (%)*	% de indivíduos infestados	Número de lesões (%)*	% de indivíduos infestados	Número de lesões (%)*	% de indivíduos infestados
Periungual	572 (45,7)	87,4	150 (41,2)	74,5	722 (44,7)	83,1
Dedos†	427 (34,1)	79,0	131 (36,0)	59,6	558 (34,6)	72,5
Sola	166 (13,3)	42,1	70 (19,2)	31,9	236 (14,6)	38,7
Canto lateral	42 (3,4)	13,7	9 (2,5)	8,5	51 (3,2)	12
Calcanhar	44 (3,5)	6,3	4 (1,1)	4,3	48 (3)	5,6
Total	1251 (100)	100	364 (100)	100	1615 (100)	100

*Lesões ocorreram em mais de uma área topográfica.

† Excluindo a área periungueal

4.1.4 – Sinais e sintomas associados à tungíase

Os sinais mais associados à tungíase, após descamação da pele, foram edema e eritema (em torno de 50% cada) (Tabela 9). Em torno de 10% dos indivíduos de Yovoyan e 5% em Okunilage, tinham infecção bacteriana secundária (definida pela presença de abscesso e/ou supuração). Entre as patologias crônicas, a mais freqüente (acima de 45%) foi deformação de unha em ambas as comunidades. Em Yovoyan 17% dos indivíduos apresentaram deformação de dedos e seis perderam pelo menos um das unhas dos dedos dos pés (Tabela 9). Sintomas como prurido, dor, distúrbio do sono devido a dor/prurido por tungíase foram mais freqüentes em Yovoyan e, nesta comunidade, cinco indivíduos apresentaram dificuldade de andar (Tabela 10).

Tabela 9: Sinais e sintomas agudos e crônicos associados à tungíase nos indivíduos infestados por comunidade e total (Yovoyan: n=95; Okunilage: n=47; Nigéria 2008).

Sinais	Yovoyan		Okunilage		Total	
	n	(%)	n	(%)	n	(%)
Agudos						
Descamação da pele	95	(100,0)	43	(91,5)	138	(97,5)
Eritema	46	(48,4)	25	(53,2)	71	(50)
Edema	48	(50,5)	19	(40,4)	67	(47,2)
Úlcera	28	(29,5)	16	(34,0)	44	(31)
Fissura	24	(25,3)	9	(19,2)	33	(23,2)
Abscesso/Supuração	9	(9,5)	2	(4,3)	11	(7,7)
Pele brilhante	10	(10,5)	-	-	10	(7,0)
Crônicos						
Lesões crônicas	59	(62,1)	23	(48,9)	81	(57,7)
Deformação da unha	56	(59,0)	21	(44,7)	77	(54,2)
Hiperqueratose	28	(29,5)	10	(21,3)	38	(26,8)
Hipertrofia periungueal	21	(22,1)	8	(17,0)	9	(20,4)
Deformação de dedo	17	(17,9)	1	(2,1)	18	(12,7)
Perda de unha	6	(6,3)	-	-	6	(4,2)

Tabela 10: Sintomas associados à tungíase relatados pelos indivíduos infestados por comunidade e total (Yovoyan: n=95; Okunilage: n=47; Nigéria, 2008).

Sintomas relatados	Yovoyan		Okunilage		Total	
	N examinado (%)		N examinado (%)		N examinado (%)	
Prurido	51	(56,7)	19	(40,4)	70	(49,3)
Dor espontânea	48	(53,3)	15	(31,9)	63	(44,4)
Acorda à noite por dor/prurido	45	(50,0)	12	(25,5)	57	(40,1)
Dor à pressão	37	(41,1)	16	(34,0)	53	(37,3)
Dificuldade de andar	5	(5,6)	0	(0,0)	5	(3,5)

4.2 – MÉTODO EPIDEMIOLÓGICO RÁPIDO DA TUNGÍASE

4.2.1 – Características das Populações de Estudo e a Prevalência nas Comunidades

Ao todo, nos 10 estudos transversais foram incluídos 7.121 indivíduos, os quais corresponderam entre 58% e 91% das suas respectivas populações-alvos (Tabela 11). Em cada estudo, as populações examinadas eram compostas por homens e mulheres em proporções semelhantes (em média, 45% e 55%, respectivamente), e as medianas de idade variaram entre 14 e 20 anos.

As prevalências gerais e de tungíase grave (>20 lesões) variaram consideravelmente entre as comunidades, bem como dentro de uma mesma comunidade (Tabela 11). A prevalência variou de 21% (estudo 7; estação chuvosa) a 54% (estudo 3; estação seca). As prevalências gerais mais elevadas (acima de 50%) ocorreram durante a estação seca (estudos 3, 4, 5 e 9; Tabela 2), assim como as mais elevadas das prevalências graves (maiores de 4%; estudos 3, 4, 5, 9 e 10). A comunidade rural de Feliz Deserto, foi a que apresentou as mais baixas prevalências (estudo 7 e 8), quando comparada as demais. Independente disto, sua prevalência mais elevada ocorreu também durante estação seca (estudo 8) como nas demais comunidades.

Tabela 11: População examinada, prevalências geral e grave (>20 lesões) da tungíase, e razão de prevalência homem/mulher por estudo transversal (Brasil e Nigéria, 2001 a 2008).

Comunidade	Estudo	População		Prevalência geral		Prevalência grave		Razão prevalência homem/mulher
		Examinado n	% população-alvo	%	(IC 95%)	%	(IC 95%)	
Morro do	1	1185	(80,7)	33,6	(30,9–36,3)	2,2	(1,4–3,2)	1,7
Sandra's (MS)	2	1192	(81,2)	23,7	(21,3–26,2)	1,3	(0,8–2,2)	1,6
	3	849	(57,8)	54,4	(51,1–57,8)	4,7	(3,4–6,4)	1,3
Balbino (B)	4	548	(90,6)	51,3	(47,1–55,5)	6,0	(4,2 – 8,4)	1,1
	5	505	(83,5)	52,1	(47,7–56,5)	6,5	(4,5–9,1)	1,0
	6	535	(88,4)	31,2	(27,3–35,2)	2,8	(1,6–4,6)	1,3
Feliz Deserto	7	1015	(88,6)	21,1	(18,6–23,6)	0,1	(0,0–0,5)	1,2
(FD)	8	990	(91,1)	28,9	(26,1–31,7)	0,8	(0,3–1,6)	1,2
Yovoyan (Y)	9	186	(71,5)	51,1	(43,8–58,3)	10,2	(6,26-15,5)	1,3
Okunilage (O)	10	116	(72,5)	41,8	(28,4–55,3)	5,2	(1,9-10,9)	1,1

A Figura 26 apresenta as prevalências gerais e o percentual correspondente à prevalência grave. As comunidades que apresentaram as prevalências mais elevadas foram as que também as apresentaram mais altas prevalências graves. Tal relação pode ser ainda mais destacada ao se observar a variação das prevalências dentro da mesma comunidade nos períodos distintos, assim como ocorrido com as comunidades brasileiras.

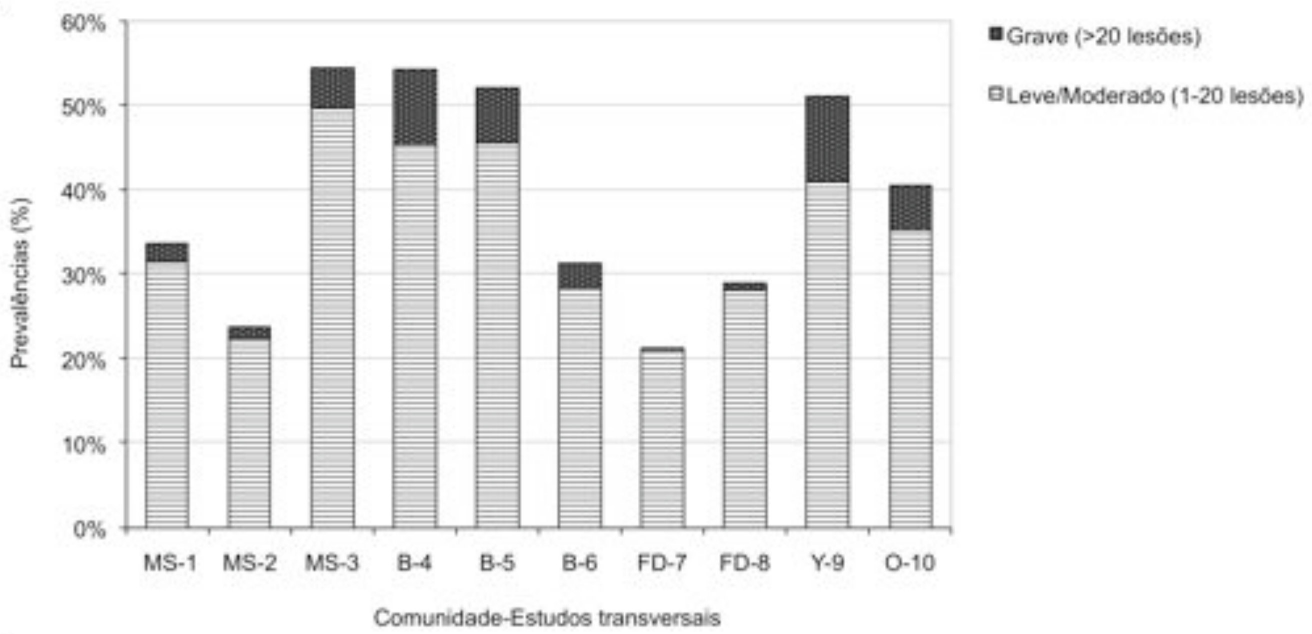


Figura 26: Prevalência de tungíase estratificada por gravidade da infestação e por estudo (Brasil e Nigéria, 2001 a 2008).

Em todos os estudos, os homens foram mais infestados por *T. penetrans* (prevalências entre 22,9% e 63,5%) do que as mulheres (18,5% a 51,8%), com razões de prevalência homem/mulher variando entre 1,0 e 1,7 (Tabela 11). Entretanto, a diferença entre os sexos foi significante somente nos estudos na comunidade Morro do Sandra's (estudos 1, 2 e 3).

Na maioria dos estudos a prevalência foi mais elevada em crianças, decrescendo em ≥15 anos, porém com aumento nos adultos e idosos (≥40 anos). Essa distribuição da prevalência por faixa etária foi mais acentuada nos estudos com as mais altas prevalências gerais. A comunidade de Yovoyan, porém, destacou-se do padrão dos demais estudos. Tal comunidade apresentou elevada prevalência da faixa etária 20 a 39 anos. Okunilage também apresentou uma diferença no padrão devido a um discreto aumento na prevalência da faixa etária 10 a 14 anos quando comparado a faixa 5 a 9 anos (Figura 27).

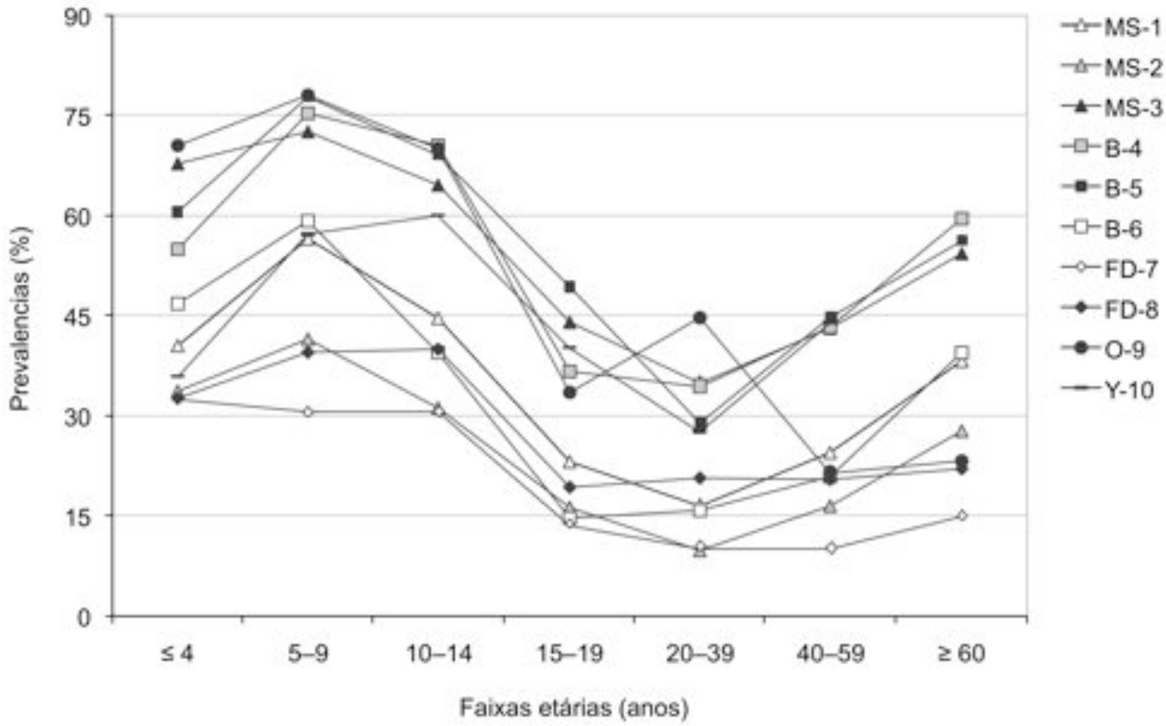


Figura 27: Prevalência por grupos etários e por comunidade-estudo transversal (Brasil e Nigéria, 2001 a 2008)

No total foram contadas 17.450 lesões nos 2.496 indivíduos infestados. A mediana do número de lesões (2 a 3) foi baixa em todos os estudos, uma vez que o número de lesões por individuo não apresenta uma distribuição normal (Tabela 12). As médias, por outro lado, foram elevadas variando de 3 (estudo 7) a 13 lesões por indivíduo (estudo 9). O número máximo de lesões teve também uma grande amplitude entre os estudos, de 42 a aproximadamente 200 lesões (estudos 7 e 5, respectivamente). (Tabela 12).

Tabela 12: Número de indivíduos infestados e carga parasitária, estratificado por estudo (Brasil e Nigéria, 2001 a 2008).

Comunidade	Estudo	Indivíduos infestados	Número de lesões		
		N	Total	Mediana (IIQ*)	Máximo
Morro do	1	398	3121	3 (1–9)	158
Sandra's	2	283	1395	2 (1–5)	50
	3	462	3405	3 (1–8)	115
Balbino	4	281	2493	2 (1–6)	145
	5	263	2486	3 (1–8)	199
	6	167	1263	3 (1–8)	78
Feliz Deserto	7	214	632	2 (1–3)	42
	8	286	1040	2 (1–4)	45
Yovoyan	9	95	1251	6 (2–15)	75
Okunilage	10	47	364	3 (2–11)	40

* Intervalo Interquartil

4.2.2 – Elaboração do Método Epidemiológico Rápido da Tungíase

Na Tabela 13 estão apresentadas as prevalências geral e específica por localização para cada estudo. Os coeficientes de determinação foram altos e variaram entre 70% e 96% e todos os valores p foram significantes. Nas Figuras 28 a 33 estão apresentadas as regressões lineares com suas respectivas retas estimadas, os coeficientes de determinação (R^2) e valores de p. A prevalência na área periungueal de qualquer um dos pés apresentou o mais alto coeficiente, seguido pela prevalência no pé direito (95%; Figuras 30 e 28, respectivamente).

Tabela 13: Verdadeiras prevalências gerais e específicas por localização nos pés por comunidade e estudo (Brasil e Nigéria, 2001 a 2008)

Prevalência		Geral (%)	Pé direito		Pé esquerdo ou direito	Hálux direito		Hálux pé esquerdo ou direito
Comunidade	Estudo		Todo (%)	Periungueal (%)	Periungueal (%)	Todo (%)	Periungueal (%)	Periungueal (%)
Morro do	1	33,6	25,5	21,4	28,8	12,2	11,5	17,0
Sandra's	2	23,7	16,9	13,7	18,8	6,6	5,7	8,7
	3	54,4	43,2	33,2	44,3	17,9	17,2	26,4
Balbino	4	51,3	38,7	28,6	37,8	17,2	16,1	23,0
	5	52,1	39,4	31,9	42,0	20,0	18,0	25,3
	6	31,2	25,8	16,6	21,1	10,5	8,8	12,5
Feliz	7	21,1	13,5	8,7	15,0	3,9	2,8	6,2
Deserto	8	28,9	18,2	12,3	20,8	7,9	4,6	9,9
Yovoyan	9	51,1	46,8	35,5	44,1	32,8	23,1	30,7
Okunilage	10	40,5	30,2	20,7	30,2	14,7	12,9	20,7

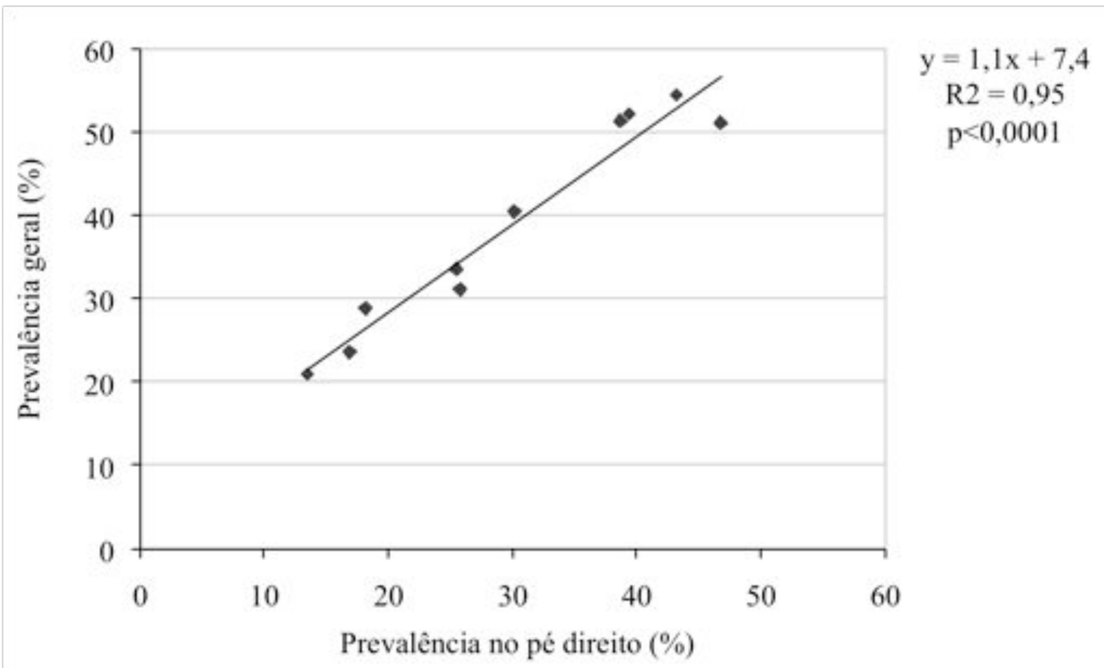


Figura 28: Gráfico de dispersão e regressão linear entre prevalência de tungíase no pé direito e a prevalência geral (Brasil e Nigéria, 2001 a 2008).

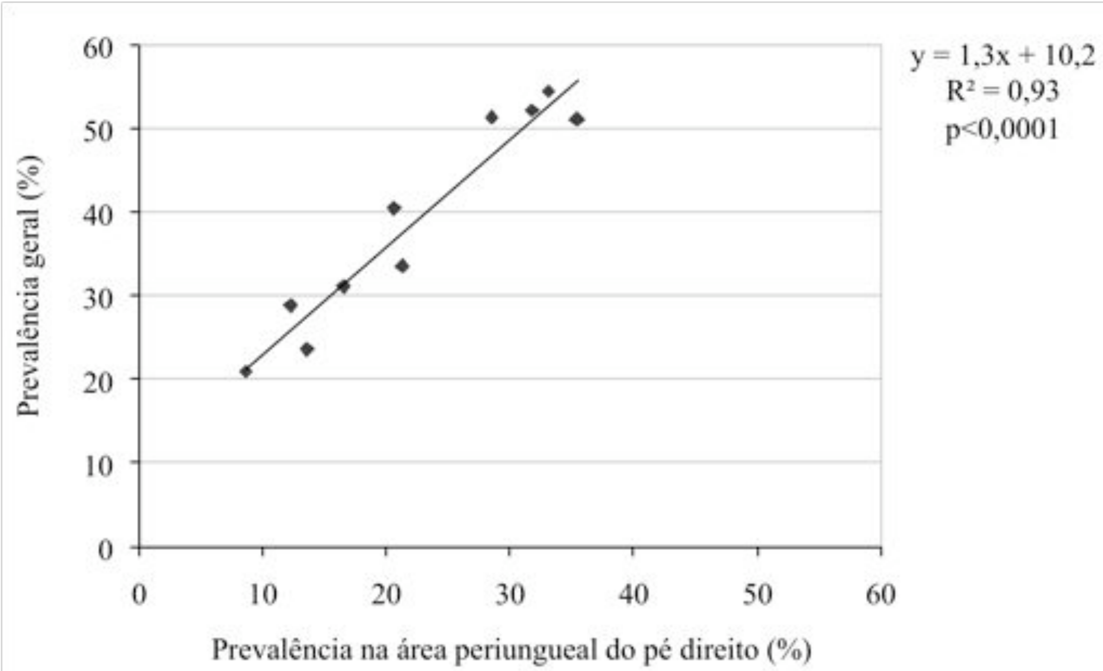


Figura 29: Gráfico de dispersão e regressão linear entre prevalência de tungíase na área periungueal do pé direito e a prevalência geral (Brasil e Nigéria, 2001 a 2008).

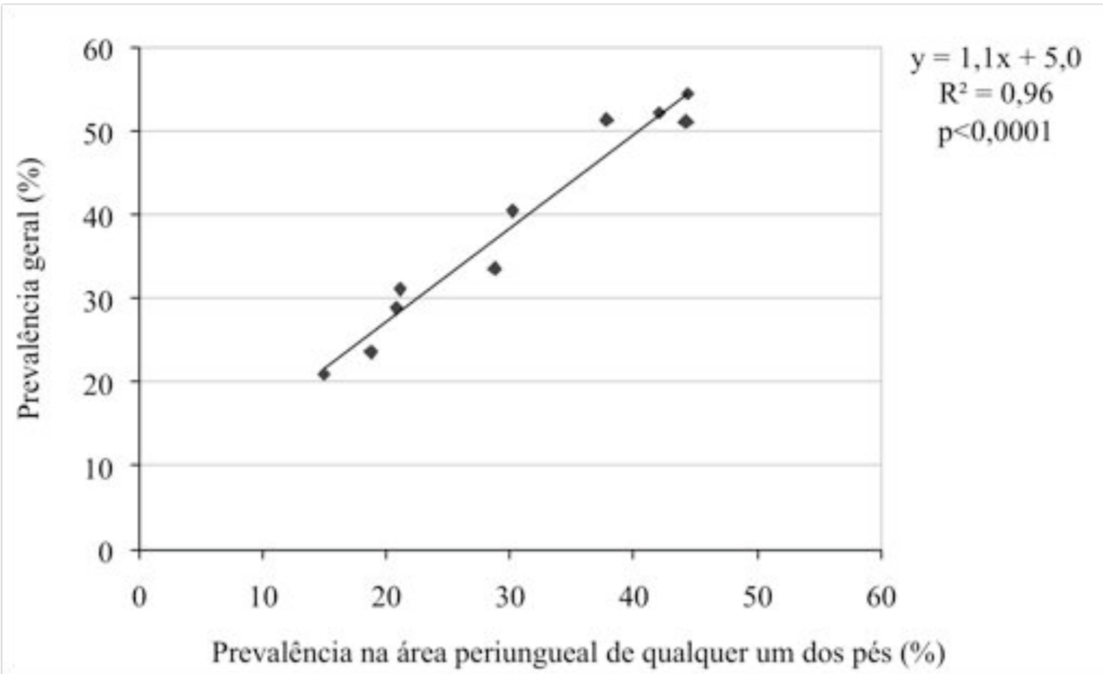


Figura 30: Gráfico de dispersão e regressão linear entre prevalência de tungíase na área periungueal de qualquer um dos pés e a prevalência geral (Brasil e Nigéria, 2001 a 2008).

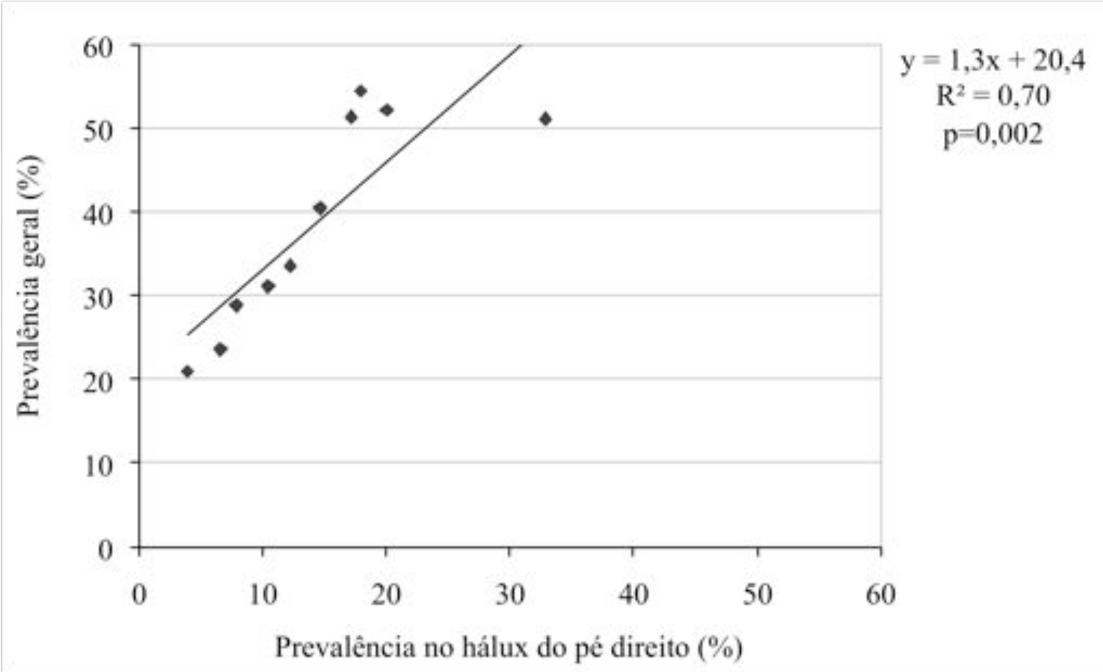


Figura 31: Gráfico de dispersão e regressão linear entre prevalência de tungíase no hálux do pé direito e a prevalência geral (Brasil e Nigéria, 2001 a 2008).

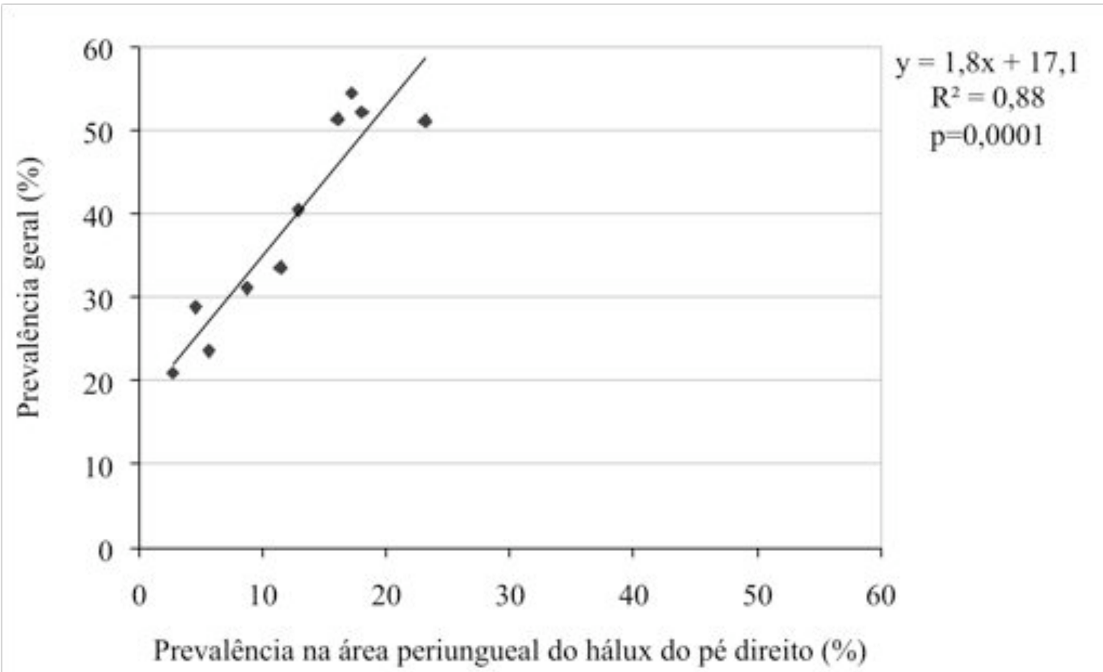


Figura 32: Gráfico de dispersão e regressão linear entre prevalência de tungíase na área periungueal do hálux do pé direito e a prevalência geral (Brasil e Nigéria, 2001 a 2008).

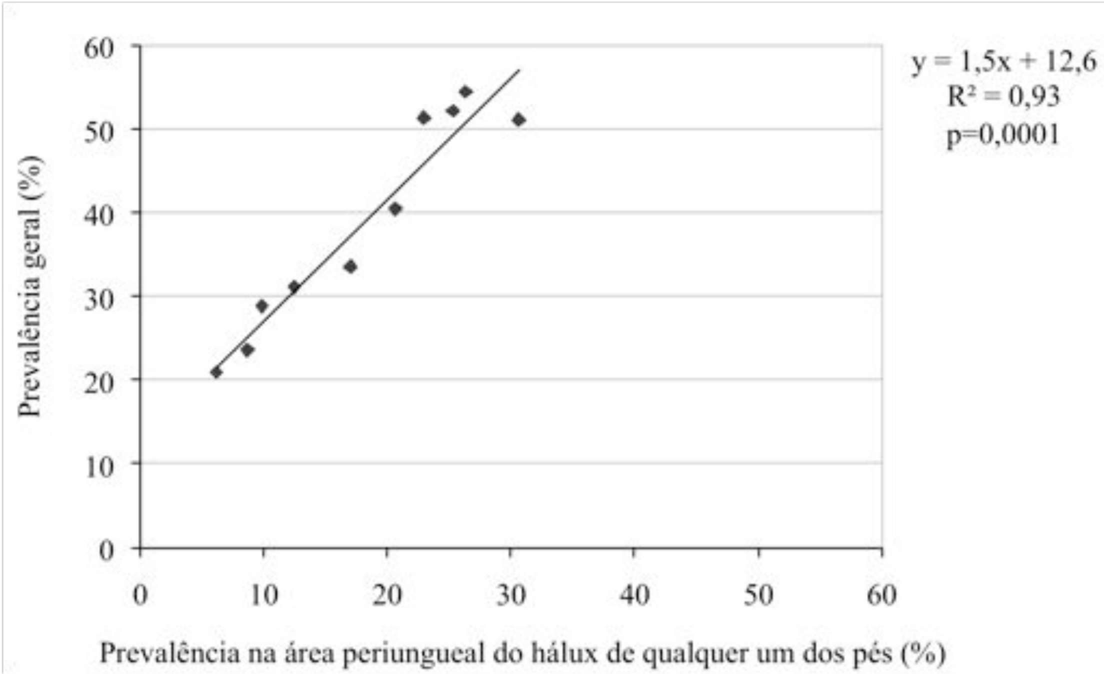


Figura 33: Gráfico de dispersão e regressão linear entre prevalência de tungíase na área periungueal do hálux de qualquer um dos pés e a prevalência geral (Brasil e Nigéria, 2001 a 2008).

Apesar das fortes e significantes correlações em todas as localizações, foram identificadas diferenças quanto à praticidade e ao tempo de aplicação entre elas. Em geral, as localizações em áreas periungueais foram consideradas as mais práticas e rápidas (Tabela 14), tendo em vista que apenas a porção distal ao redor das unhas foi examinada. Neste caso, sem a necessidade de sentar e/ou retirar os chinelos, como ocorre nas outras localizações. Conseqüentemente, se gastou menos tempo de exame nas áreas periungueais do que nas demais localizações.

Considerando seu elevado coeficiente de determinação (R^2= 96%, *p* valor <0,001), sua praticidade e rapidez, a identificação de lesões apenas na área periungueal de ambos os pés apresentou-se como o mais promissor método epidemiológico rápido da prevalência da tungíase em comunidades endêmicas. A Tabela 14 sumariza as seis áreas topográficas dos pés e suas principais características.

Tabela 14: Coeficiente de determinação, características operacionais e percentual de indivíduos infestados pelos seis potenciais métodos rápidos para tungíase em comunidades do Brasil e Nigéria (2001 a 2008).

	Pé esquerdo ou direito periungueal	Pé direito periungueal	Hálux esquerdo ou direito periungueal	Hálux direito periungueal	Hálux direito todo	Pé direito todo
Coeficiente de determinação (R^2)	0,96	0,93	0,93	0,88	0,70	0,95
Somente avaliação do lado dorsal*	+	+	+	+	–	–
Individuo com sandália/chinelo pode ser examinado*	+	+	+	+	–	–
Simplicidade de aplicação do método por um examinador*	+	+	+	+	–	–
Tempo do exame†	+	+	+	+	++	+++

* + Sim; – Não

† Tempo: + pouco; ++ médio; +++ muito

Na avaliação da associação das prevalências do método rápido com as prevalências graves (>20 lesões) dos oito estudos, o coeficiente de determinação também foi forte e significante (R^2=76%; p9<0,001; Figura 34). Entretanto, a variação dos dados foi maior.

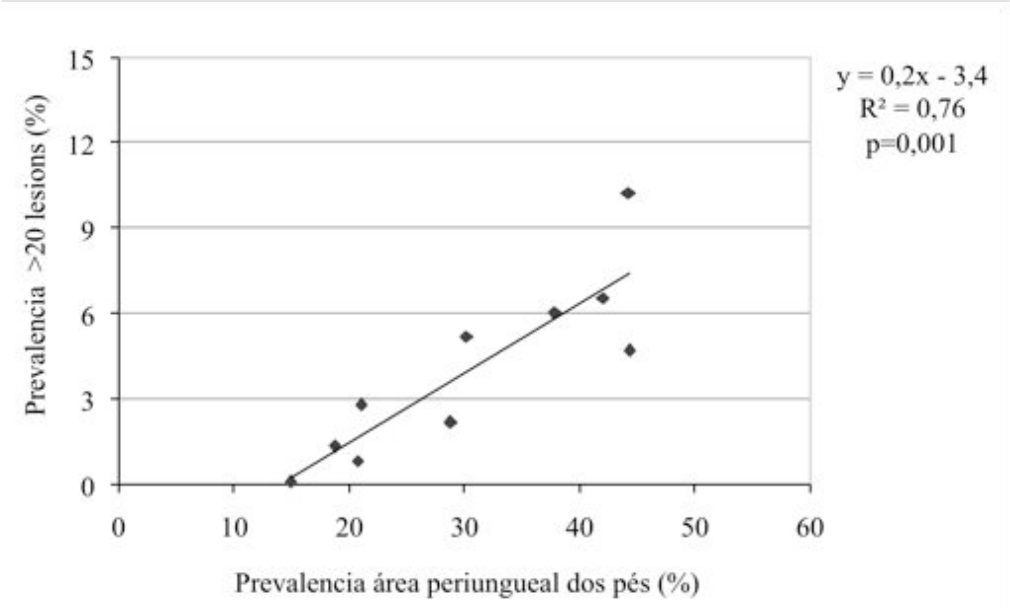


Figura 34: Gráfico de dispersão e regressão linear entre prevalência de tungíase na área periungueal de qualquer um dos pés e a prevalência grave (> 20 lesões; Brasil e Nigéria, 2001 a 2008).

Para verificação da validade interna da localização escolhida como método rápido, foram estimadas as prevalências gerais para as 10 comunidades a partir da equação de reta *Y= 1,12 x (X) + 5,0.* As prevalências gerais estimadas a partir da prevalência periungueal dos pés foram comparadas com as verdadeiras prevalências, cujos erros absolutos variaram entre -4,0% a +3,6% (Tabela 15). A média do erro absoluto foi 1,9%.

As prevalências graves foram também estimadas a partir da área periungueal pela equação de reta, *Y= 0,24 x (X) - 3,4*, obtida pela regressão linear. Neste caso, aos serem comparadas com as verdadeiras prevalências graves, os erros absolutos variaram de -3,1% a + 2,5%, sendo a média 1,0%.

Tabela 15: Prevalências da área periungueal dos pés, prevalências estimadas, prevalências verdadeiras e erros absolutos por estudo transversal (Brasil e Nigéria, 2001 a 2008)

Comunidade	Estudo	Prevalência Método Rápido*	Prevalência geral Estimada†	Prevalência geral Verdadeira	Prevalência geral Erro absoluto‡	Prevalência grave Estimada§	Prevalência grave Verdadeira	Prevalência grave Erro absoluto‡
Morro do	1	28,8	36,7	33,6	3,1	2,4	2,2	0,2
Sandra's	2	18,8	25,7	23,7	2,0	0,4	1,3	-0,9
	3	44,3	53,7	54,4	-0,7	5,5	4,7	0,8
Balbino	4	37,8	46,6	51,3	-4,7	4,2	6,0	-1,8
	5	42,0	51,2	52,1	-0,9	5,0	6,5	-1,5
	6	21,1	28,2	31,2	-3,0	0,8	2,8	-2
Feliz	7	15,0	21,5	21,1	0,4	-0,4	0,1	-0,5
Deserto	8	20,8	27,9	28,9	-1,0	0,8	0,8	0
Yovoyan	9	44,1	53,5	51,1	2,4	5,4	10,2	-4,8
Okunilage	10	30,2	38,2	40,5	-2,3	2,6	5,2	-2,6

* Prevalência na área periungueal da qualquer um dos pés

† Equação de reta *Y= 1,1 x (X) + 5,0,* onde X é a prevalência na área periungueal da qualquer um dos pés e Y é a prevalência estimada

‡ Erro absoluto = *prevalência estimada – prevalência verdadeira*

§ Equação de reta *Y= 0,2 x (X) - 3,4,* onde X é a prevalência na área periungueal da qualquer um dos pés e Y é a prevalência estimada.

4.2.3 – Avaliação do Método Epidemiológico Rápido nas Comunidades da Nigéria

A prevalência obtida pela inspeção visual correspondente ao método epidemiológico rápido (exame da área periungueal de qualquer um dos pés) foi 44,6% (83/186; IC 95%: 37,4–51,8) em Yovoyan e 30,2% (35/116; IC 95%: 21,7–28,7) em Okunilage. Estas prevalências foram semelhantes às encontradas na mesma localização pelo exame clínico padrão. Entretanto, dos 83 indivíduos positivos pelo método epidemiológico rápido em Yovoyan 81 (97,6%) apresentaram lesões também na área periungueal de qualquer um dos pés, de acordo com o método clínico padrão. Na comunidade Okunilage, esse percentual de concordância foi de 94,3% (33/35).

O tempo médio gasto, por família, para a inspeção da área periungueal pelo método rápido foi semelhante em ambas as comunidades: 3,2 minutos em Yovoyan (50 famílias) e 3,6 minutos (36) em Okunilage. A amplitude de tempo por família variou de no mínimo 1 minuto (em cada comunidade) até 8 minutos, no máximo, em Yovoyan e 13 minutos em Okunilage. As famílias inspecionadas em 1 minuto eram compostas por até duas pessoas, e as inspecionadas em mais tempo formadas, em média, por oito pessoas.

Pelo exame clínico padrão a média de tempo gasto por indivíduo infestado foi 4,7 minutos em Yovoyan e 3,5 minutos em Okunilage. Em ambas as comunidades o tempo mínimo foi de 1 minuto por indivíduo variando até tempo máximo de 19 minutos em Yovoyan (em um menino de seis anos com 72 lesões) e 10 minutos em Okunilage (em um menino de sete anos com 40 lesões por *T. penetrans).* Este exame por indivíduo infestado já foi bastante superior ao tempo de inspeção pelo método rápido. Se consideramos o tempo por família, esse tempo mantém-se elevado quando comparado ao método rápido. Na comunidade Yovoyan o tempo por família incluído tempo de inspeção dos indivíduos não infestados e infestado foi estimado em 13,5 minutos e em Okunilage de 10 minutos.

As prevalências gerais estimadas a partir da prevalência do método rápido em Yovoyan foi 55,0% e em Okunilage 38,8%. Os erros absolutos destas prevalências em relação à verdadeira prevalência foram +3,9 e -1,7. As estimativas das prevalências graves a partir do método foram 7,3% (erro absoluto= -2,9%%) e 3,8% (erro absoluto= -1,3%), respectivamente (Tabela 16).

Tabela 16: Prevalências gerais e graves estimadas pela equação da reta por comunidade

	Yovoyan	Okunilage	Equação da reta
Prevalência pelo método rápido (X)	44,6%	30,2%	
Prevalência geral (%)			
Estimada (Y)	55,0%	38,8%	
Verdadeira	51,1%	40,5%	*Y= 1,12 x (X) + 5,0*
Erro absoluto	3,9%	-1,7%	
Prevalência grave (>20 lesões)			
Estimada (Y)	7,3%	3,8%	
Verdadeira	10,2%	5,2%	*Y= 0,24 x (X) - 3,4*
Erro absoluto	-2,9%	-1,3%	

5 – DISCUSSÃO

5.1 – EPIDEMIOLOGIA DA TUNGÍASE NA NIGÉRIA

As prevalências encontradas em Yovoyan (51,1%) e em Okunilage (40,5%) foram tão elevadas quanto as identificadas em outros estudos populacionais no Brasil e na África. Por exemplo, em áreas endêmicas pesqueiras e costeiras no Brasil, as prevalências variaram entre 51,3% e 54,8% (CARVALHO *et al.*, 2003; MUEHLEN *et al.*, 2003). Especificamente na África, não há estudos exclusivos em regiões litorâneas, mas em uma vila rural também na Nigéria próxima às áreas deste estudo. A prevalência encontrada foi de 42,5% (UGBOMOIKO *et al.*, 2007b). Em Camarões, foram reportadas prevalências de 53% em um conjunto de comunidades, e 49% em escolares (NJEUMI *et al.*, 2002; COLLINS *et al.*, 2009). Para o mesmo período sazonal (estação seca), em uma favela urbana no nordeste do Brasil foi identificado um pico de prevalência de 54,4% tão elevado quanto em Yovoyan (HEUKELBACH *et al.*, 2005).

Embora seja reconhecida a sazonalidade da tungíase (HEUKELBACH *et al.*, 2005), nas duas comunidades a coleta foi feita apenas no período da seca. Na época das chuvas havia dificuldade de acesso às comunidades. Além disto, de acordo com informantes-chaves, a tungíase não ocorre durante o período de muita chuva, típicos desta região.

As altas prevalências de tungíase encontradas em Yovoyan e Okunilage podem ser explicadas, principalmente, pelas inadequadas condições sócio-econômicas, sanitárias e estruturais de pobreza em que vivem as comunidades afetadas, as quais a incluem entre as doenças tropicais de pele negligenciadas (HEUKELBACH *et al.*, 2001; HEUKELBACH *et al.*, 2002a; FELDMEIER e HEUKELBACH, 2009). Nas comunidades de Yovoyan e Okunilage não havia abastecimento de água, fornecimento de energia elétrica, sistema de esgoto e coleta pública de lixo. Serviços de saúde eram inexistentes. A maioria dos indivíduos adultos das comunidades era analfabeta e aqueles que tinham escolaridade apresentavam dificuldade em ler e escrever o próprio nome; e os adultos economicamente ativos não tinham vínculo formal de trabalho. As moradias eram precárias. Além disso, reservatórios animais (como cães, gatos e ratos) eram abundantes.

Tais características identificadas nas áreas de estudo corroboram observações e estudos anteriores, os quais afirmam que a tungíase tem maior impacto em populações sem acesso a assistência de saúde (FELDMEIER *et al.*, 2003). Em estudo no Brasil os principais fatores de risco associados a tungíase geral e grave estavam associadas às condições precárias da habitação (incluído ausência de piso de areia dentro das habitações), presença de cães e gatos domésticos e baixa escolaridade (MUEHLEN *et al.*, 2006). Em uma vila rural da Nigéria, piso de barro ou areia em casa, e a presença de porcos foram fortemente associadas à tungíase (UGBOMOIKO *et al.*, 2007a).

Independente das possíveis características sócio-ambientais e culturais que podem ter influenciado a ligeira diferença entre as prevalências (bem como cargas parasitárias e gravidade) de Yovoyan e Okunilage, estas apresentaram condições típica de áreas endêmicas de alta prevalência.

Nestes cenários, conforme esperado, os grupos etários mais afetados por tungíase nas duas comunidades foram crianças menores de <15 anos. Este achado confirma outros estudos publicados de diferentes comunidades na América Latina, Caribe e África em distintas épocas climáticas (ADE-SERRANO e EJEZIE, 1981; CHADEE, 1994; NTE e EKE, 1995; WILCKE *et al.*, 2002; CARVALHO *et al.*, 2003; GONZÁLEZ *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009).

Elevadas prevalências nas crianças podem ser explicadas principalmente pelo maior exposição e circulação deste grupo na área endêmica sem medidas protetoras adequadas, como uso de sandálias e chinelos (MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a), ou sem a devida remoção das pulgas em estágios iniciais.

Em geral, a prevalência por grupos etários se caracterizou por uma curva S, na qual um segundo pico da prevalência ocorreu entre nos indivíduos mais velhos. No caso da comunidade de Okunilage, sua curva foi mais acentuada do que a de Yovoyan e se assemelhou as identificados em outras comunidades do Brasil, Nigéria e Trinidad (CHADEE, 1994; WILCKE *et al.*, 2002; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; UGBOMOIKO *et al.*, 2007b). Apesar de um aumento de prevalência nos adultos entre 40-59 anos em Okunilage, a confirmação sobre um segundo pico de prevalência nos idosos foi prejudicada em virtude do baixo número de indivíduos examinados nessa faixa etária (decorrente da própria formação recente da comunidade por jovens pescadores). Por outro lado, em Yovoyan mesmo que tenha havido um discreto aumento da prevalência na faixa etária acima de 60 anos este foi ainda menos marcante do que em Okunilage. Outros estudos no sudeste e nordeste do Brasil e em comunidades de Camarões também não confirmaram o aumento de prevalência nos mais velhos (CHADEE, 1998; CARVALHO *et al.*, 2003; HEUKELBACH *et al.*, 2007; COLLINS *et al.*, 2009).

Mesmo que a prevalência nos idosos não tenha sido tão claramente evidenciado, nem Yovoyan e nem Okunilage, este achado parece ter pouca associação com desenvolvimento de imunidade no decorrer dos anos de vida. O aumento da prevalência não pode ser explicado por aquisição de imunidade, mas seus verdadeiros determinantes devem ser avaliados por meio de estudos de fatores de risco (MUEHLEN *et al.*, 2003). Refutam, inclusive, a hipótese defendida por alguns pesquisadores (ADE-SERRANO e EJEZIE, 1981; CHADEE, 1994; WILCKE *et al.*, 2002), de que a queratinização da pele ao longo da infância e adolescência poderia impedir progressivamente a entrada das pulgas. Algo improvável de acontecer, na opinião dos autores, uma vez que foram observadas pulgas em áreas dos pés intensamente queratinizadas. Além disto, a hipótese da queratinização seria insuficiente para explicar que em algumas comunidades foram observadas altas prevalências e cargas parasitárias em indivíduos acima de 60 anos (MUEHLEN *et al.*, 2003).

A prevalência por idade de Yovoyan na faixa de 20-39 anos apresentou um aumento em relação à faixa anterior. De modo geral, esta é a faixa que apresenta uma das menores prevalências, assim como ocorreu em Okunilage e também verificado em diferentes comunidades do nordeste do Brasil e dos Camarões (WILCKE *et al.*, 2002; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; COLLINS *et al.*, 2009). Um aumento discreto, entretanto, foi visto no município de Feliz Deserto (AL) (HEUKELBACH *et al.*, 2007). Foi apenas no estudo de CHADEE (1994), realizado em comunidade pesqueira de Trinidad, que a prevalência dos adultos entre 25 e 35 anos foi mais acentuada. Esta faixa etária era representada por pescadores que freqüentemente estavam descalços, cujo comportamento justificaria a alta prevalência neste grupo e nas crianças. Tal afirmação parece não ser suficiente para explicar a diferença nesta faixa entre as duas comunidades, uma vez em ambas tal faixa era composta por pescadores e/ou pessoas envolvidas com esta atividade e cujo comportamento do uso de chinelos/sandálias era semelhante: circulavam na comunidade de chinelos, apenas quando sentados tiram os sapatos. No caso, uma diferença entre as comunidades é que em Yovoyan os adultos permaneciam mais tempo na comunidade e descalços em ambientes propício à infestação, o local de preparar o pescado para venda por exemplo. Este poderia apresentar condições propícias para o desenvolvimento das larvas, isto é, uma área sombria, úmida, com matéria orgânica disponível.

Para um melhor entendimento do padrão das curvas de prevalência por idade nas comunidades, estudos mais específicos deverão ser conduzidos, incluindo estudos sobre comportamento e exposição, bem como a influência do processo de queratinização da epiderme com a idade. Mesmo que esta ainda seja uma questão em aberto quanto aos fatores que explicam as diferenças entre os grupos etários (KEHR *et al.*, 2007), os dados deste estudo mostraram que, de fato, a tungíase nestas comunidades era uma doença fortemente associada à infância (WILCKE *et al.*, 2002).

Quanto a prevalência por sexo nem Yovoyan e ou Okunilage apresentaram um padrão tão claramente definido como por grupos etários. Embora nas duas comunidades a prevalência de tungíase tenha sido ligeiramente maior no sexo masculino, não houve uma diferença significativa em relação a prevalência nas mulheres. Tal comportamento também foi encontrado em comunidades rurais da Nigéria e do Brasil, e em comunidade pesqueira no estado do Ceará (MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b). Um dos únicos estudos cuja prevalência foi maior entre as mulheres, foi em comunidade pesqueira em Trinidad (CHADEE, 1998).

Alguns autores como MUEHLEN *et al.*, 2003 consideram que o tema sobre a prevalência por sexo também ainda um assunto para debate na compreensão da epidemiologia da tungíase. Por exemplo, especulam que as diferenças entre os sexos nas comunidades, tal como dos grupos etários, estejam pouco relacionadas a suscetibilidade biológica (UGBOMOIKO *et al.*, 2007a). Para esses autores, os aspectos sócio-culturais que conduzem o comportamento humano, mais uma vez, parecem explicar melhor tais diferenças, uma vez que vão se refletir em diferenças na exposição e hábitos de saúde/higiene.

No caso das comunidades de Yovoyan e Okunilage, à semelhante dos estudos de WILCKE *et al*. (2002) e MUEHLEN *et al*. (2003), as mulheres tiveram prevalências mais baixa de lesões vitais (estágios iniciais da penetração da pulga), assim como de lesões manipuladas (lesões decorrentes da remoção da pulga) (WILCKE *et al.*, 2002; MUEHLEN *et al.*, 2003). De acordo com os autores, isto indicaria que as meninas e mulheres teriam menor prevalência de tungíase, principalmente por se exporem menos do que os homens ao circularem menos pela área endêmica, e não porque elas tiravam as pulgas embutidas de maneira mais cuidadosa que os homens.

Entretanto, no caso destas duas comunidades nigerianas não se pode excluir por completo um maior cuidado das mulheres quanto a remoção das pulgas penetradas quando comparadas aos homens, uma vez que estas parecem estar mais tempo na área endêmica, mesmo que circulando menos que os homens. Nestas comunidades e em áreas do Brasil, o hábito de cuidados higiênicos/estéticos em limpar e pintar as unhas dos pés, pode ser um fator para a remoção das pulgas nos pés em estágios iniciais (ARIZA, dados não publicados). Tal hábito poderia favorecer com que as mulheres observassem mais rapidamente lesões novas. Conseqüentemente seriam retiradas tão inicialmente que nenhuma cicatriz na pele fosse vista, e não provocariam inflamação aguda por remoção indevida em estágios de desenvolvimento mais avançados da pulga (FELDMEIER *et al.*, 2004).

Embora não se possa afirmar o real impacto das diferenças de exposição na área e de hábitos de higiene na prevalência da tungíase entre homens e mulheres nas comunidades deste estudo, possivelmente, as diferenças por sexo em geral estão mais relacionadas aos aspectos comportamentais e culturais (CHADEE, 1998; HEUKELBACH *et al.*, 2001; WILCKE *et al.*, 2002; MUEHLEN *et al.*, 2003; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009). Além disto, como em Yovoyan e Okunilage as diferenças por sexo não foram significativas, isto poderia indicar que independente das diferenças comportamentais por sexo que podem ter induzido a uma pequena diferença entre eles, homens e mulheres foram em certa medida igualmente afetados pela *T. penetrans* nas duas áreas endêmicas.

Nas áreas de estudo, a distribuição topográfica das lesões por *T. penetrans* nos pés foi semelhante a outros estudos previamente publicados (HEUKELBACH *et al.*, 2002b; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b): aproximadamente 75% de indivíduos infestados apresentaram lesões na área periungueal. Este dado confirma a afirmativa feita por MUEHLEN *et al*. de que a área periungueal nos pés é a área de predileção das pulgas *T. penetrans* quando comparada a outras áreas anatômicas no próprio pé.

As cargas parasitárias por indivíduos das comunidade de Yovoyan e Okunilage foram elevadas e significativamente diferentes (médias = 13,1 e 7,7; medianas = 6 e 3; respectivamente). Dentre os estudos epidemiológicos até então realizados, as médias das cargas parasitárias foram diferentes entre as distintas áreas endêmicas do Brasil, Caribe e África, variando entre 3,0 e 12,3 lesões por indivíduo infestado (CHADEE, 1994; 1998; WILCKE *et al.*, 2002; CARVALHO *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2005; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009).

Em geral, as cargas parasitárias parecem estar associadas com suas prevalências de forma positiva, conforme observado em estudo longitudinal na favela urbana de Fortaleza (HEUKELBACH *et al.*, 2005), no qual as cargas mais elevadas foram identificadas nos períodos de elevadas prevalências também. Embora esta associação seja mais claramente vista dentro de uma mesma comunidade, em Yovoyan e Okunilaje foi possível observar que aquela, com a mais alta prevalência, a que também apresentou a carga parasitária mais elevada.

A carga parasitária em Yovoyan chama a atenção por ter apresentado a mais alta carga até então identificada em uma área endêmica. Esta foi semelhante apenas à outra área endêmica também na Nigéria (Erekiti). Nesta comunidade rural localizada há 40 km de Yovoyan, a média de lesões por indivíduo infestado foi 12,3, mediana de 6 lesões e número máximo de lesões relativamente baixo (75) (prevalência 42,5%) (UGBOMOIKO *et al.*, 2007b). Yovoyan apresentou mediana elevada (6 lesões) e o número máximo foi relativamente baixo quando comparado com outras comunidades cujas prevalências eram semelhantes. Por exemplo, na comunidade pesqueira do Ceará (prevalência: 51,3%; carga parasitária média: 9 lesões), o número máximo de lesões foi 145 (MUEHLEN *et al.*, 2003); na favela urbana de Fortaleza (prevalência: 54,8%; carga parasitária média: 7,4 lesões), foi 115 (HEUKELBACH *et al.*, 2005), e nas comunidades de Camarões (prevalência: 53%; carga parasitária média: 5,1 lesões), 102 (COLLINS *et al.*, 2009). No Brasil tinham poucas pessoas com cargas altas que estavam em risco, enquanto na Nigéria a distribuição era mais uniforme.

Diferentemente de Yovoyan, Okunilage apresentou um padrão médio de carga parasitária semelhante às demais comunidades com cargas elevadas independente da prevalência, tais como: na favela urbana em Fortaleza (CE), média de 7,4 durante estação chuvosa e 7,8, na estação seca (prevalências, 54,8 e 33,6%)

(HEUKELBACH *et al.*, 2005), nas comunidades de Trinidad, 7,7 e 8,0 lesões (prevalência 31,4 e 20%) (CHADEE, 1994; 1998), e na comunidade pesqueira do Ceará, média de 8,9, durante a seca (prevalência 51,3%) (MUEHLEN *et al.*, 2003). A mediana (2 a 3 lesões) das lesões em Okunilage também ficou na faixa observada tanto nas áreas anteriormente referidas. Entretanto, Okunilage se distinguiu daquelas comunidades de elevada carga, quanto ao seu número máximo de lesões (40). Este foi relativamente baixo e mais próximo ao das comunidades com prevalências e médias de cargas parasitárias mais baixas, como na comunidade rural de Alagoas (prevalências 29,5% e 21,6%; cargas parasitárias médias: 3,7 e 3 lesões), números máximos 40 e 42 (HEUKELBACH *et al.*, 2007); e na favela urbana de Fortaleza em períodos de chuva (prevalências 16,8%; e 23,8% cargas parasitárias médias: 2 lesões, cada), sendo os números máximos 38 e 50) (HEUKELBACH *et al.*, 2005).

Se por um lado as cargas parasitárias por indivíduos foram distintas entre Yovoyan e Okunilage, por outro elas foram semelhantes quanto a desproporcional distribuição por faixas de infestação, isto é: uma minoria (20% e 13%, respectivamente) de indivíduos infestados apresentou um número elevado de lesões (> 30) enquanto a maior parte (45% e 64%) tinha entre uma e cinco lesões. Padrão similar foi encontrado na maioria dos estudos, nos quais cerca de 45% a 85% tinham até cinco lesões, e entre 1% e 10% tinham mais de 30 lesões (CHADEE, 1994; CARVALHO *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007a; COLLINS *et al.*, 2009).

Os indivíduos gravemente infestados foram poucos, mas contribuíram em excesso para a eliminação de ovos no solo pelas pulgas penetradas, sendo assim responsáveis pela manutenção da transmissão da tungíase nas comunidades (HEUKELBACH *et al.*, 2007). No caso de Yovoyan, somente 19 (10%) indivíduos foram responsáveis por quase 65% do total de lesões entre os infestados, e em Okunilage apenas seis (5%) indivíduos continham aproximadamente 50% das lesões.

Este mesmo padrão foi confirmado por uma comunidade pesqueira do Ceará, na qual 8% dos indivíduos apresentaram 55% da carga parasitária comunitária (MUEHLEN *et al.*, 2003), assim como na comunidade Alagoas (HEUKELBACH *et al.*, 2007). A agregação de poucos indivíduos responsáveis por um grande número parasitos não é restrita a tungíase, mas é similar a distribuição da intensidade de infestação de doenças helmínticas, como esquistossomose, e o qual tem sido visto como aspecto chave para o controle destas doenças (WOOLHOUSE *et al.*, 1997). Na tungíase, a desproporcional da carga parasitária terá conseqüências no controle da tungíase tanto no nível comunitário como no individual (HEUKELBACH *et al.*, 2007). As ações iniciais do controle comunitário, nestas e outras comunidades, deverão ser focalizadas nos indivíduos mais afetados e de mais alto risco e suas famílias para a interrupção da cadeia de transmissão, e no nível individual para tratamento destes indivíduos mais afetados para a redução do grau de morbidade (HEUKELBACH *et al.*, 2007), dado que a elevadas cargas parasitárias estão associadas a morbidades mais graves (FELDMEIER *et al.*, 2003).

Em Yovoyan em torno de 50% dos indivíduos infestados por *T. penetrans* queixaram-se de dor, tinham edema, eritema, prurido e reportaram acordar à noite devido ao incômodo provocado pelas lesões; enquanto que em Okunilage, eritema foi o sinal mais recorrente (53%), as demais ficaram em torno de 25% (acordar à noite) a 40% (prurido e edema). A gravidade mais acentuada em Yovoyan pode ser ainda observada por outros sinais e sintomas como: presença de pele brilhante (11%), abscesso (9%), além de seqüelas como deformação de dígito (18%), perda de unha (6%) e dificuldade de andar (6%). Em Okunilage, abscessos foram identificados em somente dois indivíduos (4%). Úlceras e fissuras foram semelhantes nas duas comunidades (em torno de 30% e 20%, respectivamente em cada). A presença de lesões crônicas e deformação de unha indicam que a tungíase não é um problema atual, mas que vêm atingindo os indivíduos destas comunidades ao longo dos anos.

Alguns estudos populacionais e relatos de casos de países endêmicos mostraram o amplo espectro de patologias relacionadas à tungíase. Por exemplo, dados de Erekiti, mostraram que eritema estava presente em 44% de indivíduos infestados, dificuldade de andar em 32%, deformação de unhas de dedo do pé em 27%, e perda de unhas de dedo do pé em 16%; foram achadas fissuras em 11% de casos (UGBOMOIKO *et al.*, 2007b). Em pacientes identificados em uma unidade básica de saúde na cidade de Fortaleza, todos os casos tinham prurido e 77% dor; eritema foi observado em 64%, edema em 27%, superinfecção em 29%, úlceras em 23%, fissuras em 12%, e dificuldade que entra 45% dos casos (FELDMEIER *et al.*, 2004). Estudo recente no Haiti descreveu as terríveis condições de comunidades afetadas por *T. penetrans,* nas quais casos de óbitos foram associados a infestações graves por *T. penetrans*, possivelmente em decorrência de septicemia e tétano (JOSEPH *et al.*, 2006). Em Yovoyan e Okunilage, embora os indivíduos infestados tivessem sinais de superinfecção bacteriana, esta não resultou em seqüelas como gangrena ou auto-amputação de dígitos. Entretanto, mesmo sem relatos sobre a ocorrência de tétano e suas conseqüências associados à tungíase nestas comunidades, eles devem ser considerados como possíveis desfechos nas duas áreas de estudo, uma vez que esses são esperados em locais de baixa ou nenhuma cobertura vacinal (OBENGUI, 1989; JOSEPH *et al.*, 2006).

A gravidade da tungíase em áreas endêmicas, como Yovoyan e Okunilage, fica ainda mais evidente quando se comparam com casos de tungíase em viajantes. Por exemplo, foram reportados casos de 14 americanos retornando de áreas tropicais que apresentaram uma ou duas lesões e que exceto prurido e dor espontânea, nenhuma outra patologia clínica foi observada (SANUSI *et al.*, 1989). FRANCK *et al.* (2003) afirmaram que os sintomas clínicos e sinais de superinfecção bacteriana de 83 viajantes procedentes de áreas endêmicas eram os mesmos que os dos indivíduos de áreas endêmicas, porém as complicações foram menos freqüentes nos viajantes. As diferenças entre essas duas populações decorreram provavelmente porque os viajantes, em geral, têm lesões únicas e as pulgas penetradas, geralmente, são extraídas em estágios iniciais antes de desenvolver superinfecção bacteriana grave.

Em Yovoyan e Okunilage, os indivíduos apresentavam um quadro diferente dos viajantes: viviam nas precárias áreas endêmicas, tinham médias de lesões por indivíduo infestado elevadas e agregação de lesões na área periungueal. Mesmo que não se considere o elevado número lesões manipuladas/removidas (10 e 7 em Yovoyan e Okunilage, respectivamente), as quais são bastante associadas a superinfecção bacteriana (FELDMEIER *et al.*, 2004), o número de lesões seguindo o seu ciclo natural de desenvolvimento nos indivíduos já seria suficiente para gerar quadros de patologia grave nos indivíduos destas comunidades, sendo: 6 lesões vitais e 3 avitais por indivíduo infestado em Yovoyan e 4 lesões vitais em Okunilage (nenhum indivíduo tinha lesões avitais).

Chama a atenção a inexistência de lesões avitais em Okunilage. Em certa medida isto pode indicar uma taxa de ataque menor, facilitando assim a remoção das pulgas e em estágios inicial e em geral levando a um quadro de menor carga parasitária (HEUKELBACH *et al.*, 2001; HEUKELBACH, 2006). Este quadro poderia explicar a menor gravidade do quadro patológico encontrado nesta comunidade. Por outro, lado em Yovoyan, o mesmo não ocorreu, indicando a situação já apontada por outros autores, os quais afirmam que em áreas de alto ataque (HEUKELBACH *et al.*, 2004c), a carga parasitária elevada dificulta a remoção das pulgas em estágios iniciais, e sua remoção gera mais prejuízos do que benefícios (FELDMEIER *et al.*, 2003).

Independente das diferenças observadas entre Yovoyan e em Okunilage os resultados das patologias em ambas foram alarmantes dado que a tungíase é uma doença auto-limitada (EISELE *et al.*, 2003). Porém, assim como mostraram os dados destas duas comunidades e outros estudos, nas áreas endêmicas as complicações graves e seqüelas são, de forma assustadora, comuns (HEUKELBACH *et al.*, 2001; FELDMEIER *et al.*, 2002; FELDMEIER *et al.*, 2003). A gravidade da tungíase está como visto nesta e em outras comunidades inevitavelmente associada com as precárias condições de vida nas comunidades endêmicas (MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a; PILGER *et al.*, 2008b), as quais contêm os elementos e riscos necessários para manutenção de altas cargas parasitárias (HEUKELBACH *et al.*, 2004b; MUEHLEN *et al.*, 2006; UGBOMOIKO *et al.*, 2007a), gerando desfechos e seqüelas potencialmente evitáveis conforme os observados em Yovoyan e Okunilage.

5.2 – MÉTODO EPIDEMIOLÓGICO RÁPIDO DA TUNGÍASE

A inexistência de métodos que permitam uma avaliação epidemiológica rápida da tungíase em nível comunitário pode estar contribuindo para o desconhecimento ainda maior da sua distribuição, prevalência e gravidade na maioria das áreas endêmicas. Como conseqüências, a tungíase não é reconhecida como um problema de saúde pública nas áreas afetadas e recebe pouca atenção por parte de planejadores locais de saúde, bem como de agências internacionais de saúde (FELDMEIER e HEUKELBACH, 2009). Pode-se supor ainda que, tal contexto pode contribuir para a ausência de intervenções efetivas e sustentáveis e de programas de controle nas áreas atingidas.

Situação semelhante ocorreu com outras doenças parasitárias negligenciadas, como a filariose linfática. Os métodos epidemiológicos rápidos para a filariose linfática, apareceram nos anos 1990 tendo como objetivo a delimitação de áreas endêmicas através de dados válidos e sistemáticos que possibilitassem pleitear sua entrada na agenda de prioridades para um programa de controle junto aos governos locais e agências internacionais de saúde (GYAPONG *et al.*, 1996; GYAPONG *et al.*, 1998b). O método em si consistia na identificação de indivíduos com elefantíase ou hidrocele (GYAPONG *et al.*, 1996; GYAPONG *et al.*, 1998a; GYAPONG *et al.*, 1998b; WEERASOORIYA *et al.*, 2008). Como resultado da rápida delimitação de áreas atingidas pela filariose linfática, atualmente na África o programa de controle da filariose linfática, o *Global Programme to Eliminate Lymphatic Filariasis*, direcionado pela OMS, já tem 10 anos de implementação. Durante este período 35 países completaram seus mapeamentos epidemiológicos, outros estão em processo ou fase de finalização. Em 2005, quinze dos 35 países conduziram tratamentos em massa (WHO, 2008).

Os métodos epidemiológicos rápidos da esquistossomose urinária, oncocercose e tracoma, por outro lado, já nasceram dentro dos programas de intervenção estruturados *a priori*. A identificação rápida de populações/áreas de alto risco para essas doenças tinha como foco o tratamento em massa conforme orientado pelos programas de controle de doenças negligenciadas iniciados pela Organização Mundial de Saúde (OMS) para países na África e Ásia, sendo: *Schistosomiasis Control Initiative*, *African Programme for Onchocerciasis Control* e *Alliance for the Global Elimination of Trachoma by 2020* (REMME, 1995; WHO, 1995b; NEGREL *et al.*, 2001; WHO, 2002; 2006). No caso da tungíase, não há ainda nem programas de controle, nem se conhece de forma válida a maioria das áreas atingidas, desta forma, a tungíase continua sendo uma doença altamente negligenciada.

Independente dos objetivos iniciais que demandaram a criação dos métodos rápidos acima, o que estava na base de todos eles era a simplicidade e facilidade do exame diagnóstico frente aos métodos parasitológicos tradicionais (padrões-ouro) para uma resposta rápida e válida sobre a situação epidemiológica das áreas endêmicas. Sendo, assim, a presença macroscópica de hematúria era utilizada para estimar a prevalência da esquistossomose urinária (MOTT *et al.*, 1985; LENGELER *et al.*, 1991; GROUP, 1995; LENGELER *et al.*, 2002a; b), a identificação de nódulos palpáveis na pele para a oncocercose (REA) (WHO, 1993; NGOUMOU *et al.*, 1994; WHITWORTH e GEMADE, 1999; KIPP e BAMHUHIIGA, 2002), a presença de larvas nos olhos para loíase (TAKOUGANG *et al.*, 2002; ADEOYE *et al.*, 2008). Esses métodos foram baseados na presença de condições ou características clínicas associadas às respectivas doenças nas comunidades. A presença destas, similar a avaliação rápida da tungíase, é usada como indicador indireto da prevalência da infecção e sua intensidade no nível comunitário.

O método rápido da tungíase não se orientou em sinais indiretos para indicação da infestação, mas manteve a identificação da presença do próprio parasita, isto é: a presença de *T. penetrans* na epiderme dos indivíduos. Tal identificação manteve-se também baseada no critério diagnóstico definido pela Classificação de Fortaleza (EISELE *et al.*, 2003). A facilidade e rapidez do método rápido da tungíase estão baseadas na simplificação do método padrão, ao restringir a inspeção clínica à identificação de uma única lesão e em apenas uma localização nos pés.

A partir da prevalência específica da lesão na área periungueal foi feita regressão linear e calculada a equação da reta para estimar a prevalência geral da tungíase. A utilização da própria doença para estimar a presença de tungíase na comunidade pode explicar os altos e significantes coeficientes de determinação de todas seis localizações testadas como métodos rápidos, quando comparadas com as prevalências gerais.

Outra característica do método rápido da tungíase é sua possibilidade de ser utilizado na população geral ou em um grupo específico, como as crianças. Em geral nos métodos rápidos, a definição de um grupo em detrimento de todos os indivíduos não está relacionada diretamente ao tamanho amostral, mas sinaliza para uma diminuição da quantidade de pessoas a serem examinadas em comparação a quantidade necessária em levantamentos epidemiológicos padrão (MACINTYRE, 1999). Na esquistossomose urinária, por exemplo, a identificação da presença macroscópica de hematúria é feita em crianças em idade escolar, pois em geral, quando a doença existe na comunidade, as crianças são as que apresentam as mais elevadas razões de infecção. Elas são utilizadas como sentinelas da doença no nível comunitário – o que também poderá ser feito na tungíase. Desta forma, o percentual de crianças infectadas fornecerá uma boa aproximação da prevalência geral na comunidade (WHO, 1995b; BROOKER *et al.*, 2009). Na oncocercose, a palpação de nódulos na pele é feita preferencialmente em homens com idade acima de 20 anos, pois são o grupo de maior risco para infecção e porque aceitam melhor serem examinados por palpação do que mulheres (WHO, 1993).

Na tungíase, optou-se inicialmente que o método seria aplicado na população geral, uma vez que o método já seria em si rápido, de fácil realização, aceito pelos membros da comunidade, e que não haveria dificuldade de se examinar todos os indivíduos. Entretanto, estudo piloto em comunidade semi-rural na Nigéria indicou que o método rápido da tungíase em escolares pode ser uma alternativa ainda mais simples para estimar a prevalência na comunidade, bem como para identificar possíveis áreas de maior risco (ARIZA *et al*., em elaboração 1).

Na Nigéria, por exemplo, há falta de serviços e profissionais de saúde que possam funcionar como informantes chaves para identificar as áreas ou populações em risco, além disto, muitas comunidades são de difícil acesso (como Yovoyan) e associado a isto, há que se considerar que em geral a população de crianças e adultos economicamente ativos reduzida durante a semana (horário escolar de 07:30 às 14:30). Dada estas situações, as escolas apresentam-se como uma alternativa para aplicação do método epidemiológico rápido da tungíase nos escolares. Entretanto, este aspecto deverá ser verificado em cada área endêmica, uma vez que deverá ser avaliada a representatividade deste grupo etário nas escolas. Na Nigéria, o método poderia ser aplicado nas comunidade de Badagry, tendo em vista que a maior parte das crianças freqüentava as escolas tanto pelo caráter compulsório, mas também pelo valor social que a educação tem no país. Esta situação leva a crer que, em tese, os escolares são uma população representativa destes grupos etários das comunidades que são procedentes. Além disto, os professores são cooperativos e conhecem as comunidades, e por isto podem funcionar como informantes chaves, além de cooperar na coleta de dados. Em termos da epidemiologia da doença, conforme anteriormente mencionado, a tungíase atinge principalmente as crianças, assim a presença de lesões nestas seria um indicador da sua presença na população geral.

A avaliação de crianças escolares já têm se mostrado como alternativa custo-efetiva no controle de verminoses intestinais e da esquistossomose. A identificação de quais escolas e comunidades que requerem tratamento para estas infecções é uma parte essencial dos programas de controle, e uma questão chave para mapeamentos epidemiológicos (BROOKER *et al.*, 2009). Tal estratégia (e seu sucesso) indica que assim a aplicação todo método rápido da tungíase em escolares pode ser uma excelente estratégia alternativa em comunidades do Brasil e da África (ARIZA *et al*., em elaboração 2).

Em geral, na elaboração de um método rápido dois aspectos também são considerados: o incômodo do exame para os indivíduos e a facilidade do exame por uma pessoa da comunidade ou paramédico. No caso da tungíase, a área periungueal em qualquer localização dos pés, mostraram se as mais fáceis de serem utilizadas.

Com esta área definida, basta inspecionar somente a parte posterior dos dedos (ao redor das unhas) para identificar ou não a presença de lesões por *T. penetrans*. Conseqüentemente, em termos de facilidade do exame, o indivíduo pode ser examinado em pé e sem ter que de retirar sandália/chinelo ou mesmo levantar os pés. Para os indivíduos, então, o método reduz o incomodo de ser examinado.

Poucos estudos de método rápido mencionam o incômodo do exame padrão aos indivíduos. Os existentes são os da à filariose linfática. Nesta doença, além do exame ser invasivo (coleta da amostras de sangue nos indivíduos), a coleta deve ser feita à noite pois na maioria das áreas endêmicas a microfilaremia exibe periodicidade noturna (entre 22:00 e 02:00). Tal especificidade, torna o método padrão da filariose linfática um incômodo para os indivíduos que se traduz em inúmeras recusas de participação e na dificuldade da logística para o trabalho em campo (GYAPONG *et al.*, 1996; GYAPONG *et al.*, 1998a; GYAPONG *et al.*, 1998b; SRIVIDYA *et al.*, 2000).

Acredita-se que a realização do método epidemiológico rápido da tungíase por um membro da comunidade treinado (como agentes de saúde ou algum outro representante) seja viável em áreas endêmicas, tendo em vista a facilidade do diagnóstico da tungíase (HEUKELBACH, 2005). Além disto, nas áreas endêmicas os indivíduos infestados ou não têm facilidade de diagnosticar a doença, assim como ocorre na pediculose, por exemplo. Nesta, especificamente o auto-diagnóstico de pediculose ativa mostrou melhor acurácia quando comparado a inspeção visual por um investigador (PILGER *et al.*, 2008a). Na esquistossomose urinária um método rápido de se identificar hematúria é através de *dip sticks* cuja realização pode ser feita por professores treinados (meio dia de treinamento). Os resultados dos testes de acurácia foram promissores, os quais variaram de moderado e elevado (N'GORAN *et al.*, 1998; MAFE *et al.*, 2000; FRENCH *et al.*, 2007; UGBOMOIKO *et al.*, 2009). Isto indica que os professores com treinamento e supervisão podem realizar procedimentos simples e rápidos (FRENCH *et al.*, 2007; BROOKER *et al.*, 2009). No método rápido da tungíase a precisão e validade da aplicação por membros da comunidade treinados deverá ainda ser avaliada em estudos futuros.

Tanto a escolha da localização para exame como também a equação de reta obtida para estimar as prevalências gerais e graves foram elaboradas com base em distintas comunidades e levantamentos. As seis comunidades apresentaram consideráveis diferenças nas prevalências e número de lesões por *T. penetrans*. Essas diferenças foram conseqüência tanto das distintas características sócio-demográficas e ambientais que as distinguem, assim como da variação sazonal típica da tungíase. Mesmo na Nigéria onde os dados não foram coletados no período da chuva esta situação foi conseqüência de uma sazonalidade bem demarcada da doença na área. Em geral, observou-se que quanto mais precárias as condições de vida, como no Morro do Sandra's, mais altas as prevalências, inclusive no período de chuvas(HEUKELBACH *et al.*, 2005). Por outro lado, Feliz Deserto cujas condições eram relativamente melhores quando comparadas as outras comunidades (HEUKELBACH *et al.*, 2007), apresentou prevalência elevada no período seco, porém esta prevalência ainda assim ficou até mesmo abaixo da prevalência do período chuvoso do Morro do Sandra's.

Independente da variação da prevalência entre comunidades e estações, das diferenças geográficas e culturais e do tamanho da comunidade, o coeficiente de determinação (R^2) do método rápido da tungíase foi alto e os erros absolutos das prevalências estimadas foram baixos. Estes resultados associados à diversidade das comunidades fortalecem a confiança da aplicabilidade do método de avaliação rápido em outras comunidades na America Latina, Caribe e países da África. Porém, deve-se estar atento o método precisará ser validado dentro dos contextos ecológicos, epidemiológicos, geográficos e sócio-culturais nos quais for aplicado.

Frente à falta de informações, seguras e disponíveis, sobre a ocorrência global e distribuição de doenças parasitárias de pele em áreas endêmicas (FELDMEIER e HEUKELBACH, 2009), o método rápido da tungíase, ao gerar dados confiáveis em um curto espaço de tempo, auxiliará a cobrir essa lacuna. Este método deverá, então, contribuir para seu reconhecimento como um importante problema de saúde pública nas áreas afetadas e também para ser utilizado para o planejamento, execução e monitoramento de programas de controle.

5.3 – VIÉSES E LIMITAÇÕES DOS ESTUDOS

No estudo das comunidades nigerianas, as populações de estudo, embora representativas, foram pequenas em decorrência de suas próprias composições. Buscou-se reduzir o viés de não-participação através de reuniões com os líderes comunitários prévias à coleta de dados. Durante o trabalho de campo, as visitas domiciliares foram realizadas nos dias e horários de maior presença da população, incluindo fins de semana. Em caso de ausência de um dos membros da família, mais uma visita era realizada em horário previamente marcado. Algumas perdas também ocorreram em virtude de recusas de algumas famílias.

Exclui-se viés inter-observador no exame clínico e no método epidemiológico rápido para tungíase, tendo em vista que somente a própria doutoranda realizou tais procedimentos nas duas comunidades. Por outro lado, a realização dos dois exames pela mesma investigadora deixa margens para o viés do observador. Tentou-se minimizar este através da aplicação do método epidemiológico rápido primeiro, e em todos os membros da família e, somente a seguir a realização do exame clínico.

O viés inter-observadores, considerando os estudos do Brasil e os da Nigéria, foi reduzido através do treinamento da doutoranda na mesma área endêmica que os demais, pela mesma equipe e utilizando o mesmo critério diagnóstico de tungíase, Classificação de Fortaleza (EISELE *et al.*, 2003). A doutoranda realizou pré-teste no Brasil e na Nigéria, com monitoramento nas duas áreas.

Na avaliação dos 10 levantamentos não se pode descartar que viés inter-observador tenha influenciado nos resultados, uma vez que os dados foram coletados por diferentes investigadores e as coletas foram feitas com diferença de tempo entre eles. Considera-se, entretanto, que tal viés tenha sido reduzido, pois os investigadores fazem parte do mesmo grupo de pesquisa, foram treinados na mesma área endêmica no Brasil e pela mesma equipe de *experts.* Além disto, todos foram supervisionados durante as coletas de dados pela mesma equipe.

Lesões em localizações ectópicas (i.e. não localizadas nos pés) podem acontecer em qualquer parte de corpo, incluindo: mãos, cotovelos, pulsos, genitálias, costas, pálpebras, pavilhão auricular, entre outras (GOLDMAN, 1976; MATIAS, 1987; CARDOSO, 1990; HEUKELBACH *et al.*, 2002b; HEUKELBACH *et al.*, 2004e; KAIMBO *et al.*, 2007). Estudos em áreas endêmicas mostraram que menos de 10% dos indivíduos apresentavam lesões nestas localizações, concomitantemente com as dos pés, e foram identificadas nos indivíduos com cargas parasitárias mais elevadas (CHADEE, 1998; HEUKELBACH *et al.*, 2002b; WILCKE *et al.*, 2002; CARVALHO *et al.*, 2003; MUEHLEN *et al.*, 2003; HEUKELBACH *et al.*, 2007; UGBOMOIKO *et al.*, 2007b; COLLINS *et al.*, 2009). Em geral, essas lesões ectópicas foram mais associadas às crianças do que aos adultos (HEUKELBACH *et al.*, 2002b). MUEHLEN *et al.* (2003) descreveram diferentes freqüências de lesões nas mãos entre faixas etárias, às quais variavam de 3% em adultos para 23% em crianças pequenas.

Em Yovoyan no máximo três crianças tinham lesões apenas nas mãos e nenhuma em Okunilage. Tendo em vista esta restrição, na análise dos 10 bancos de dados para a elaboração do método rápido da tungíase foram consideradas, então, apenas as localizações nos pés. Acredita-se, que a restrição do exame não subestimou nem a prevalência geral nem a carga parasitária, seja das comunidades nigerianas como na elaboração do método, o que pode ser comprovado na análise dos 10 bancos de dados. Dentre esses, apenas em Feliz Deserto, dos seus 2005 indivíduos examinados somente 11 (0,5%) tinham lesões ectópicas, e não tinham lesão nos pés.

6 – CONCLUSÕES

Epidemiologia da tungíase na Nigéria:

- A tungíase na comunidades pesqueiras apresenta prevalência elevada, similar a outras áreas endêmicas no Brasil.

- O grupo mais vulnerável naquelas comunidades foram crianças menores de 15 anos, tendo em vista a elevada prevalência e carga parasitária.

Método epidemiológico rápido:

- A identificação de *T. penetrans* na área periungueal dos pés pode ser usado como método rápido e confiável de avaliação epidemiológica da tungíase em distintos cenários epidemiológicos e sócio-culturais.

- A simplicidade, rapidez, praticidade e exeqüibilidade deste método viabiliza a sua aplicação em cenários com escassos recursos humanos qualificados.

- A aplicação do método auxiliará tanto na delimitação de áreas endêmicas e monitoramento da dinâmica da doença, bem como no planejamento de medidas que visem à redução da tungíase em áreas endêmicas.

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8 – APÊNDICES

APENDICE 1

UNILORIN (Ilorin/Nigeria) and Federal University of Ceará (Brazil)

"Prevalence and severity of the tungiasis in endemic communities of the Nigeria."

TUNGIASIS' CLINICAL EXAM FORM/Short (RAMT 2)

Data {data} ____/____/____ FAMILY'S NUMBER/ INDIVIDUAL'S {FAMNUM} ____ /[IDNUM] ____

Start (hour): ______________

Name {nomind}: ____ Age:_____

LEFT FOOT

SITE	STAGES (n)				PATHOLOGIES ("X")													
TOES	VITAL	AVITAL	MANIPULETED	Cluster ("X")	Oedema	Erythema	Shinning skin	hypertrophic nail rim	Descamation of skin	Hyperkeratosis	Fissure	Ulcer	Deformation of nail	Loss of nail	Abscess / Suppuration	Deformation of toe	Chronic lesion *(punched out)*	Obs:
1																		
1 Per																		
2																		
2 Per																		
3																		
3 Per																		
4																		
4 Per																		
5																		
5 Per																		
SOLE																		
LAT. RIM																		
HEEL																		
Oth1:																		
Oth2:																		
Oth3:																		

(continuação)

RIGHT FOOT

SITE	STAGES (n)				PATHOLOGIES ("X")													
TOES	VITAL	AVITAL	MANIPULETED	Cluster ("X")	Oedema	Erythema	Shinning skin	Hypertrophic nail rim	Descamation of skin	Hyperkeratosis	Fissure	Ulcer	Deformation of nail	Loss of nail	Abscess / Suppuration	Deformation of toe	Chronic lesion *(punched out)*	Obs:
1																		
1 Per																		
2																		
2 Per																		
3																		
3 Per																		
4																		
4 Per																		
5																		
5 Per																		
SOLE																		
HEEL																		
LAT. RIM:																		
Oth1:																		
Oth2:																		

OTHER PATHOLOGIES: (0) No (1) Yes	**PICTURES :** ( ) No ( ) Yes
ITCHING .... {itchy}: ____ (0/1)	Left foot ( ) No ( ) Yes
SPONTANEOUS PAIN .... {painper}: ____ (0/1)	Right foot ( ) No ( ) Yes
PAIN UPON PRESSURE .... {painpres}: ____ (0/1)	Both feet ( ) No ( ) Yes
PAIN WHILE WALKING .... {painwak}: ____ (0/1)	
DIFFICULTY OF WALKING .... {difwalk}: ____ (0/1)	
SLEEP DISTURBANCE DUE TO ITCHING/PAIN .... {slepdis}: ____ (0/1)	

End (hour) : ______________

APENDICE 2

UNILORIN (Ilorin/Nigeria) and Federal University of Ceará (Brazil)

"Prevalence and severity of the tungiasis in endemic communities of the Nigeria"

FAMILY and INDIVIDUAL RISK FACTORS

(Form RAMT-3)

Data [datarf] ____/____/____ FAMILY NUMBER [FAMNUM] _____

I. FAMILIAR RISK FACTORS

[names]	**Name of responsible**	____________			
[livesit]	**How long live in the community:** __________				
[relig]	**Familiar religion**	(1) Christian	(2) Muslin	(3) Traditional relig.	(3) Oth________
[houstp]	**House structure**	(1) Concrete block	(2) Palm products	(3) Adobe	(4) Oth________
[floortp]	**House floor**	(1) Concrete	(2) Sand	(3) Carpet/Concrete	(4) Carpet/Sand
		(5) Clay	(6) Tile	(7) Oth________	
[rooftp]	**House roof**	(1) Zinc	(2) Leaves (Coc/Pal)	(3) Slate	(4) Oth________
[streetp]	**Type of street**	(1) Asphalt	(2) Sand	(3) Clay	(4) Oth________
[energhs]	**House light**	(1) Electricity	(2) Kerosene lamb	(3) Native oil lamb	(4) Oth________
[waterhs]	**Source of water supply**	(1) Tap water/Tank	(2) Well	(3) River	(4) Oth________
[toilet]	**House toilet system**	(1) Toilet /WC	(2) Pit	(3) Bush	(4) Oth________
[trash]	**Waste products** (place to put)	(1) Yard	(2) Backyard	(3) Outside (public)	(4) Oth________
[burn]	**Burn the waste**	(1) No	(1) Yes		
[veran]	**Veranda/frontage in d house**	(0) No	(1) Yes		
[verantp]	**If YES: Type floor**	(1) Cement	(2) Sand	(3) Clay	(4) Oth________
[yard]	**Yard in the house?**	(0) No	(1) Yes		
[yardtp]	**If YES: Type floor**	(1) Cement	(2) Sand	(3) Clay	(4) Oth________
[backy]	**Backyard in the house?**	(0) No	(1) Yes		
[backytp]	**If YES: Type floor**	(1) Cement	(2) Sand	(3) Clay	(4) Oth________
[dog]	**Have dog?**	(0) No	(1) Yes; **How many?**	(1) (2) (3) (4) (5)	(≥6) Oth_______
[cat]	**Have cat?**	(0) No	(1) Yes; **How many?**	(1) (2) (3) (4) (5)	(≥6) Oth_______
[pig]	**Have pig?**	(0) No	(1) Yes; **How many?**	(1) (2) (3) (4) (5)	(≥6) Oth_______
[pigfree]	**If YES, how do they live?**	(0) Pigsty	(1) Free		
[animal]	**Other animals**	(0) No	(1) Yes		
[animoth]	**If YES, what are?**	(1) Goat	(2) Cow	(3) Chicken	(4) Oth________
[mouse]	**Presence of rats comp/house**	(0) No	(1) Yes		
[room]	**Number of rooms:**	__________			

2. INDIVIDUAL RISK FACTORS FAMILY NUMBER {FAMNUM} _____

IDNUM:	________	Name: ______________________		(1) Resp	(2) Onw person
{marital}	**Marital status?**	(1) Single	(2) Married	(3) Separ/Divorced	(4) Widow(er)
{occup}	**Main occupation?**	(1) Farmer	(2) Fisherman/wm	(3) Trade/town	(4) Trade/hous/com
		(5) Made mat/house	(6) Civil Servant	(7) Retired	(8) Student
		(9) Part-time studies	(10) No work	(11) No school	(12) Oth_________
{leveduc}	**Level of education?**	(0) Illiterate/No form	(1) Nursery	(2) Prim Comp	(3) Prim Not-compl
		(4) Sec Comp	(5) Sec Not-compl	(6) Tech/University	(7) Oth_________
{sleep}	**Do you sleep in (…) ?**	(0) Mattress/bed	(1) Mattress/floor	(2) Mat/floor	(3) Oth_________ (Traditional bed)
{barefins}	***Put on <u>inside</u> your room** *(bed/sit)*?	(0) Slippers	(1) Barefoot		(2) Oth_________
{barefout}	***Put on <u>outside</u> your room** *(bed/sit)*?	(0) Slippers	(1) Barefoot		(2) Oth_________
{rest}	***Where do you spend your time?***	(1) Veranda/Frontage	(2) Yard	(3) Backyard	(4) Oth_________
{causetg}	**For you, what is most important cause of jigger?**	(1) Pig	(2) Sand	(3) Dog	(4) Oth_________
{takeoftg}	**What do you do when you have a jigger?**	(0) Nothing	(1) Remove/YES	(9) Never had	(2) Oth_________
{remov}	**If Remove YES, how is it?**	(0) Needle	(1) Stick	(2) Blade	(3) Oth_________
{prod}	**Use some products?**	(0) No	(1) Kerosine	(2) "Flict"	(3) Oth _________

(*In the community) **OBS.:**

APÊNDICE 3

UNILORIN (Ilorin/Nigeria) and Federal University of Ceará (Brazil)

"Prevalence and severity of the tungiasis in endemic communities of the Nigeria"

RAM FORM (RAMT 1)

Data {dataram} ____/____/____

FAMILY NUMBER {famnum} _______

Start (hour) {horbeg}: ____________________

Name of the responsible {namres}:_____________________________________ Address {End}:__________________________________ Site {site}: _________

How many people live in the house? {peohous} _______

*To record **everybody** who lives in the house:*

Individual number {idnum}	**Name of the individual** {nomind}	**Sex** {sex}	**Age** {age}	Ask: ***Do you have jigger?*** {pergtung}	*Who answered?* {whoans} (marcar X)	Exam: ***Are there any jigger around the toes' nail?*** {ramtung}
1				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
2				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
3				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
4				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
5				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
6				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
7				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
8				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
9				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
10				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
11				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
12				( ) No ( ) Yes ( ) Doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal

End (Hour) {horend}:____________

APÊNDICE 4

FAMNUM:______

UNIVERSITY OF ILORIN/DEPARTMENT OF ZOOLOGY

INFORMED CONSENT FROM RESEARCH PARTICIPANTS:

"Assessment of prevalence and the severity of the tungiase in endemic areas in Nigeria"

Sir/Madam,

We are conducting a study to assess the number of people with "jigger" and the severity of this disease in your community. We also want to identify the factors that cause jigger, to plan successful interventions in the future. This research is important as it will help that less people have "jigger" in your community and in other Nigerian communities with similar problems.

It will be necessary to examine your skin to know if you have (or have not) jiggers, and, if present, how many. The study will be conducted during a period of about four weeks in the community, and you will be visited twice: the first time to be examined clinically, and the other time to respond to a questionnaire.

The following considerations are important:

1. Your participation in the study is on a voluntary basis and you have the right not to participate without any disadvantage for you or your family;
2. There are no risks or dangers for your health, as there will be only a visual exam of your skin, without any invasive procedures (such as cuts, skin scratching etc);
3. Your data will be kept strictly confidential, and your identification (name, age, address) will be maintained in secret;
4. You will be able to desist from participation at any moment, without any disadvantage;
5. You will be able, at any moment, to have access to the results and any other information about the study;
6. You should sign the informed consent form only after the objectives of the study have been explained to you properly, and after you have understood the procedures.
7. By signing this document you agree to participate in the study.

At any moment, you can contact the principal investigator:

Dr. Uade Samuel Ugbomoiko,

University of Ilorin/Department of Zoology – address of Unilorin and phone number

Badagry, ____________________________.

IDNUM: _____

____

Complete name of study subject

____

Signature of study subject
(or of legal guardian in the case of minors)

____

Dr. Uade Samuel Ugobomoiko
University Ilorin, Principal investigator

9 - ANEXOS

9.1 AUTORIZACAO DO *BAALES* DAS COMUNIDADE

GBEREFU SEA BEACH COMMUNITY

Badagry, Lagos State, Nigeria

Assessment of prevalence and the severity of the tungíase in endemic areas in Nigeria

DECLARATION

I, **Chief Numeton – Baale of Gberefu Sea Beach**, as Member of Badagry Local Government and Baale of Gberefu, hereby declare that we agree with the aims and objective of the study, "**Assessment of prevalence and severity of tungiasis in endemic areas in Nigeria**". The study is coordinated by **Dr. U.S. Ugbomoiko**, senior lecturer at the University of Ilorin, Nigeria. The aims and objectives of the study have been explained to us, and we are fully aware of it procedures. We also agree that in our community there are many children and adults living with jigger fleas. Thus, the study will be of great benefit for the community as a whole, as well as the individual participants.

Badagary, ______________________________.

2008/04/06

Chief Numeton BAALE OF GBEREFU.

Member Badagry Local Government

Baale of Gberefu Sea Beach Community

Badagry, Lagos State, Nigeria.

9.2 – ARTIGOS PUBLICADOS: TUNGIASE

VOLUME 15 NO 7 PP 856–864 JULY 2010

A simple method for rapid community assessment of tungiasis

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Summary

OBJECTIVE To evaluate a rapid assessment method to estimate the overall prevalence of tungiasis and severity of disease in endemic communities.

METHODS We analysed data from 10 population-based surveys on tungiasis, performed in five endemic communities in Brazil and Nigeria between 2001 and 2008. To assess the association between occurrence of tungiasis on six defined topographic areas of the feet and the true prevalence/prevalence of severe disease, linear regression analyses were performed. Estimated prevalences were calculated for each of the 10 surveys and compared to true prevalences. We then selected the most useful topographic localization to define a rapid assessment method, based on the strength of association and operational aspects.

RESULTS In total, 7121 individuals of the five communities were examined. Prevalence of tungiasis varied between 21.1% and 54.4%. The presence of periungual lesions on the toes was identified as the most useful rapid assessment to estimate the prevalence of tungiasis (absolute errors: −4% to +3.6%; R^2 = 96%; P < 0.0001). Prevalence of severe tungiasis (>20 lesions) was also estimated by the method (absolute errors: −3.1% to +2.5%; R^2 = 76%; P = 0.001).

CONCLUSION Prevalence of tungiasis and prevalence of severe disease can be reliably estimated in communities with distinct cultural and geographical characteristics, by applying a simple and rapid epidemiological method. This approach will help to detect high-risk communities and to monitor control measures aimed at the reduction of tungiasis.

keywords tungiasis, *Tunga penetrans*, Rapid Assessment Method, Brazil, Africa

Introduction

Tungiasis is a tropical parasitic skin disease caused by penetration of the jigger flea *Tunga penetrans* (Linnaeus 1758) into the skin of human or animal hosts (Heukelbach 2005). Hundreds of parasites may accumulate in heavily infested individuals (Feldmeier *et al.* 2003; Joseph *et al.* 2006; Ugbomoiko *et al.* 2007). The disease is a self-limited infestation (Eisele *et al.* 2003; Feldmeier & Heukelbach 2009), but complications such as bacterial super-infection and debilitating sequels are often seen in endemic areas (Bezerra 1994; Heukelbach *et al.* 2001; Feldmeier *et al.* 2002, 2003; Joseph *et al.* 2006; Ariza *et al.* 2007; Ugbomoiko *et al.* 2008). Septicaemia and tetanus are life-threatening complications of tungiasis (Tonge 1989; Litvoc *et al.* 1991; Greco *et al.* 2001; Feldmeier *et al.* 2002; Joseph *et al.* 2006).

Typically, the disease occurs in poor communities in Latin America, the Caribbean and sub–Saharan Africa (Heukelbach *et al.* 2001; Heukelbach 2005). In recent cross-sectional studies from endemic areas in Brazil, Cameroon, Madagascar, Nigeria and Trinidad & Tobago, point prevalences ranged between 16% and 54% (Chadee 1998; Njeumi *et al.* 2002; Wilcke *et al.* 2002; Carvalho *et al.* 2003; Muehlen *et al.* 2003; Joseph *et al.* 2006; Ugbomoiko *et al.* 2007; Ratovonjato *et al.* 2008). However, prevalence and distribution of the disease are not documented in most endemic areas.

In settings where financial and human resources are scarce, policy makers need cost-effective and simple methods to estimate prevalence and severity of disease in affected populations (Anker 1991; Vlassoff & Tanner 1992; Macintyre 1999; Macintyre *et al.* 1999). As a consequence, rapid assessment methods have been developed for a variety parasitic diseases and health conditions, mainly in low-income countries (Anker 1991; Vlassoff & Tanner 1992; Macintyre 1999; Macintyre *et al.* 1999). For example, the macroscopic presence of haematuria (Lengeler *et al.* 1991, 2002a,b; Red Urine Study Group 1995), the identification of palpable nodules in the skin (Ngoumou *et al.* 1994; Whitworth & Gemade 1999; Kipp & Bamhuhiiga 2002) and the presence of elephantiasis and hydrocele (Gyapong *et al.* 1996, 1998a,b; Weerasooriya *et al.* 2008) have been used to estimate the prevalence of urinary schistosomiasis, onchocerciasis and lymphatic filariasis, respectively. Rapid assessment methods are commonly used to plan and monitor mass interventions, but also to detect parasitized individuals. Control of tungiasis at the community level has rarely been attempted (Heukelbach *et al.* 2001; Pilger *et al.* 2008), and rapid assessments methods are not available.

Because in endemic areas 95–98% of sand flea lesions are restricted to the feet (Heukelbach *et al.* 2002, 2007a; Ugbomoiko *et al.* 2007), we assessed different topographic areas of the feet to be used as a rapid method for the presence of sand fleas. An area was identified that would give a reliable proxy to estimate prevalence of tungiasis. The occurrence of tungiasis on periungual sites of the toes was the most reliable and practical approach to estimate overall prevalence and severity of disease.

Materials and methods

Study areas

We included data from 10 cross-sectional population-based surveys conducted in five communities between 2001 and 2008. Three communities are located in Northeast Brazil, two in Southwest Nigeria. The communities studied in Brazil were Balbino, a fishing village in Ceará State (Northeast Brazil); Morro do Sandras, an urban slum in the city of Fortaleza (capital of Ceará State); and Feliz Deserto, a rural community in Alagoas State. In Nigeria, data were collected in Yovoyan and Okunilaje, two small fishing villages in Lagos State (Southwest Nigeria, Figure 1).

All five communities were characterized by low socio-economic status, but showed distinct cultural and geographical characteristics. The study areas had in common that streets were not paved, and families were extremely poor (mean monthly family income equivalent to € 45.00). Illiteracy rates ranged between 15% and 30%. Whereas in Brazil, more than 90% of households had electric power supply, no access to electricity existed in the Nigerian communities. In Nigeria, the vast majority of houses were built of palm stems; and in Brazil, most houses were made of bricks or adobe. The main characteristics of the communities and their populations are depicted in Table 1.

As tungiasis is known to show a particular seasonal variation (Heukelbach *et al.* 2005), data were collected in different periods of the year (dry and rainy season). In Nigeria, surveys were conducted during dry season only, as in the rainy season isolated communities are not accessible. In addition, according to key informants, tungiasis virtually does not occur in these communities during the heavy rain falls typical of this region in Nigeria.

Detailed prevalence data on the Brazilian communities have been published previously (Wilcke *et al.* 2002; Muehlen *et al.* 2003; Heukelbach *et al.* 2005, 2007a). Clinical examinations were performed by investigators trained in an endemic area in Brazil and monitored by the same team leader. Field investigators were monitored

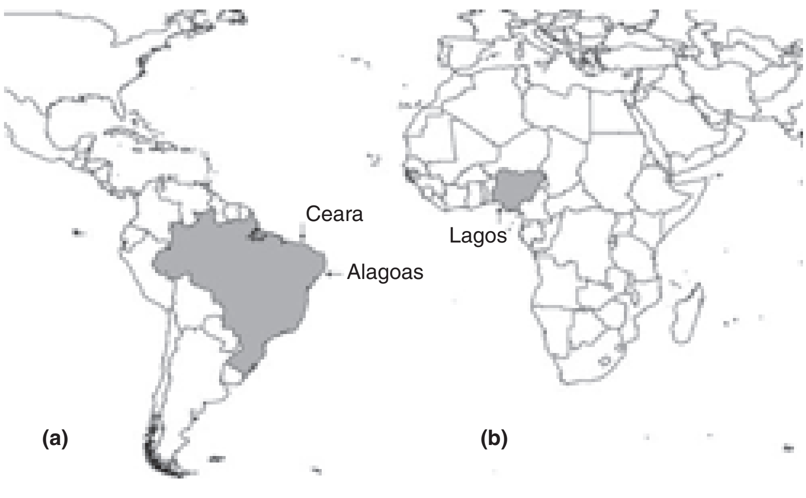

Figure 1 Location of study areas (a) in Brazil (Ceará and Alagoas State) and (b) Nigeria (Lagos State).

Table 1 Characteristics of communities and surveys

Community	Country	Survey No.	Date of survey		Target population	Main characteristics	
			Month/year	Season		Type of community	Localization
Balbino	Brazil	1	07/2001	Dry (beginning)	605 individuals	Fishing village	60 km south of Fortaleza, capital of Ceará State (northeast Brazil)
		2	08/2001	Dry (end)			
		3	04/2002	Rainy			
Morro do Sandra's	Brazil	4	03/2001	Rainy (beginning)	1468 individuals	Urban slum	Fortaleza, capital of Ceará State (northeast Brazil)
		5	06/2001	Rainy (end)			
		6	09/2001	Dry			
Feliz Deserto	Brazil	7	06–07/2003	Rainy	1146 individuals	Rural community	120 km south of Maceió, capital of Alagoas State (northeast Brazil)
		8	10–11/2003	Dry	1087 individuals		
Yovoyan	Nigeria	9	02/2008	Dry	260 individuals	Fishing village	63 km east of Lagos, capital of Lagos State (south Nigeria).
Okunilaje	Nigeria	10	03/2008	Dry	160 individuals	Fishing village	56 km east of Lagos (south Nigeria).

regularly, and cross-checks were performed to reduce observer bias.

Study design

In all surveys, data were collected according to identical procedures. The body of study participants was examined clinically for the presence of tungiasis, excluding the genital areas. In the first surveys conducted in Brazil, <1% of individuals had lesions at ectopic sites but not on the feet. Thus, we considered this small error acceptable and, for the sake of logistic simplicity, did not assess ectopic lesions in subsequent surveys.

Diagnosis of tungiasis was made clinically, and disease was staged according to the Fortaleza Classification (Eisele *et al.* 2003): presence of a red-brown itching spot with a diameter of 1–2 mm; presence of a yellow-white watch glass-like patch with a diameter of 3–10 mm with a central dark spot; or a brown-black crust with or without surrounding necrosis. Sand flea lesions with evidence of manipulation with needles or thorns by the patient or a caretaker were also documented. The exact location, stage and number of lesions were documented.

Data entry and statistical analysis

Data were recorded on pre-tested standardized forms, entered into separate databases using Epi Info software package (version 6.04d; Centers for Disease Control and Prevention, Atlanta, GA, USA) and checked for entry errors. Then, data of all surveys were merged into a single dataset and transferred to Stata® software package (version 9.0; Stata Corporation, College Station, USA) for statistical analysis. As the number of lesions per individual was not normally distributed, medians and interquartile ranges are given to indicate average and dispersion of data. Fisher's exact test was applied to compare relative frequencies.

Six topographic areas were defined and analysed as possible approaches for the estimation of prevalence of tungiasis: (i) right foot (including toes, interdigital areas, heels, lateral rim, sole); (ii) periungual area of right foot; (iii) periungual area of any foot (right or left); (iv) first right toe; (v) periungual area of first right toe; (vi) periungual area of any first toe (right or left). Periungual areas were defined as the locations around toe nails (Figure 2). True prevalence of tungiasis was based on the number of individuals with tungiasis on the feet in a community.

To assess the association between occurrence of tungiasis at one of the six topographic areas and the true prevalence or prevalence of severe disease, correlations and linear regression analysis were performed. Based on the linear regression equations, prevalences were estimated for each of the 10 surveys, and the absolute errors (*estimated prevalence–real prevalence*) were calculated. The same procedure was performed to estimate the prevalence of severe tungiasis (defined as the presence of >20 lesions in an individual).

We then selected the most useful localization to define a rapid assessment method based on the strength of

Figure 2 Right foot of a patient with approximately 100 sand flea lesions with several periungual lesions. Periungual site is exemplified by circles around the toe nail.

association (R^2) and operational aspects, such as time needed to perform an examination, simplicity and disturbance to the individuals. R^2 indicates the per cent of variation of one variable that can be explained by linear relationship with another variable.

Ethical aspects

Studies were approved by the respective Ethical Review Boards (Ethical Review Board of the Federal University of Ceará, Ethical Committee of the School of Medical Sciences of Alagoas, Brazil; *ad hoc* Ethical Committee of Cascavel Municipality, and Ethical Committee of the University of Ilorin, Nigeria). Meetings with community health workers and village representatives were held prior to the studies, in which objectives were explained in detail. Informed written consent was obtained from individuals or their caretakers. In case of illiteracy, the informed consent form was read out by one of the investigators, and approval was obtained by thumb prints. In Nigeria, the traditional chiefs of Badagry (*Ankra*) and of local communities (*Baales*) also approved the study.

Results

General characteristics

In total, 7121 individuals were included in the 10 surveys. This corresponded to 57.8–91.1% of the respective target populations (Table 2). Median age of the populations ranged between 13.5 and 20 years.

Prevalence and severity of tungiasis varied considerably between and within communities (Table 2), with point

Table 2 Characteristics of study populations and infestation status in 10 population-based surveys

	Brazil								Nigeria	
Survey No.	1	2	3	4	5	6	7	8	9	10
Individuals examined/total population (% of target population)	548/605 (90.6%)	505/605 (83.5%)	535/605 (88.4%)	1185/1468 (80.7%)	1192/1468 (81.2%)	849/1468 (57.8%)	1015/1146 (88.6%)	990/1087 (91.1%)	186/260 (71.5%)	116/160 (72.5%)
Prevalence of tungiasis (95% CI)	51.3% (47.1–55.5)	52.1% (47.7–56.5)	31.2% (27.3–35.2)	33.6% (30.9–36.3)	23.7% (21.3–26.2)	54.4% (51.1–57.8)	21.1% (18.6–23.6)	28.9% (26.1–31.7)	51.1% (43.8–58.3)	41.8% (28.4–55.3)
Male/female prevalence ratio	1.1	1.0	1.3	1.7	1.6	1.3	1.2	1.2	1.3	1.1
Number of lesions:										
Median (IQR†)	2 (1–6)	3 (1–8)	3 (1–8)	3 (1–9)	2 (1–5)	3 (1–8)	2 (1–3)	2 (1–4)	6 (2–15)	3 (2–11)
Maximum	145	199	78	158	50	115	42	45	75	40
Prevalence of severe tungiasis‡ (95% CI)	6.0% (4.2–8.4)	6.5% (4.5–9.1)	2.8% (1.6–4.6)	2.2% (1.4–3.2)	1.3% (0.8–2.2)	4.7% (3.4–6.4)	0.1% (0.0–0.5)	0.8% (0.3–1.6)	10.2% (6.3–15.5)	5.2% (1.9–10.9)

†Interquartile range.
‡>20 lesions.

prevalences from 21.1% (214/1015; survey 7 – Brazilian rural community, rainy season) to 54.4% (462/849; survey 6 – Brazilian urban slum, dry season). In general, highest prevalences of tungiasis and of severe disease were found in the dry season (surveys 1, 2, 6, 9, 10). The highest prevalence (10.2%; 19/186) of severe disease (>20 lesions) was found in one of the fishing communities in Nigeria (survey 9). The maximal number of lesions per individual ranged between 40 and 199 (Table 2).

In most surveys, men were more frequently infested (prevalence 22.9%; 105/459–63.5%; 235/370) than women (18.5%; 119/644–51.8%; 143/276) with a male/female prevalence ratio between 1.7 and 1.0 (Table 2). However, the difference was only statistically significant in the urban slum in Brazil ($P < 0.0001$).

Rapid assessment of prevalence in the communities

The six topographic areas considered as putative sites for rapid assessment and their characteristics are summarized in Table 3. Considering a high R^2 value, time and simplicity of the procedure, we identified the periungual areas of the toes as the most promising site. In fact, the estimated prevalence based on this localization very reliably predicted the overall true prevalence of tungiasis (R^2 = 96%; $P < 0.0001$; Figure 3a).

After estimating the prevalence of tungiasis (expressed as *[estimated prevalence] = 1.12 × [prevalence on periungual sites] + 5.0*), absolute errors ranged between −4% (survey 1) and +3.6% (survey 4; Table 4). The mean absolute error was 1.9%.

Presence of embedded sand fleas at the periungual areas of the feet also reliably estimated prevalence of severe disease using the equation (R^2 = 76%; $P = 0.001$; Figure 3b). Absolute errors of estimated prevalence of severe disease, when compared to true prevalence of severe disease, ranged between −3.1% (survey 9; Nigeria) and +2.5% (survey 6, Brazil; Table 4). The mean absolute error was 0.9.

Discussion

Similar to other parasitic skin diseases, tungiasis is underestimated and can be considered a Neglected Tropical

Table 3 Comparison of possible topographic areas used for rapid estimation of prevalence of tungiasis

Topographical area	Time needed to examine one person†	Comments	Strength of association (R^2)
Periungual areas of feet	+	Individual can be examined with minor disturbance; sandals or thongs can be kept. Diagnosis easily made by lay personnel	96%
Right foot	+++	Individual has to take off thongs and needs to stand up to show heel and plantar side of foot. Areas between and beneath toes are difficult to access, and toes need to be spread. Requires more skills of investigators, increased risk of investigator bias.	95%
Periungual areas of right foot	+	Individuals can be examined with minor disturbance without taking off thongs/sandals.	93%
Periungual area of any 1st toe	+	Individual can be examined with minor disturbance without taking off thongs/sandals. Increased risk for errors at data collection.	93%
Periungual area of right 1st toe	+	Individual can be examined with minor disturbance without taking off thongs/sandals.	88%
Right 1st toe	++	Individual has to take off thong and needs to stand up to show plantar side of toe. Area between toes I and II is difficult to access, and toes need to be spread. Increased disturbance. Requires more skills of investigators, increased risk of investigator bias.	70%

†Relative values (+, ++, +++) are given, as the time to examine one person varies considerably within and between communities (according to presence and number of lesions, age of individual, socio-cultural setting and experience of investigator).

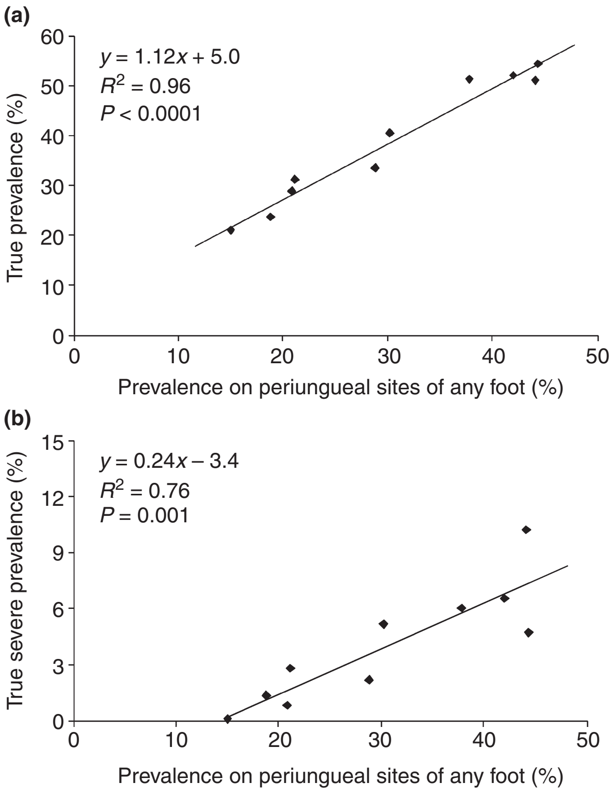

Figure 3 Linear regression analysis for estimating prevalence of tungiasis (a) and of severe tungiasis (>20 lesions; b).

Disease (Heukelbach *et al.* 2001; Franck *et al.* 2003; Heukelbach & Feldmeier 2004; Heukelbach & Ugbomoiko 2007b; Feldmeier & Heukelbach 2009). It occurs in many resource-poor communities in endemic countries and causes considerable morbidity and loss of quality of life, widely unnoticed by policy makers, the pharmaceutical industry and health professionals (Feldmeier *et al.* 2003; Heukelbach 2005; Joseph *et al.* 2006; Heukelbach & Ugbomoiko 2007b; Ugbomoiko *et al.* 2007). Despite its obvious importance as a public health problem, data on disease occurrence in endemic communities and reliable data on the geographical distribution of tungiasis are not available. As a consequence, control of tungiasis has rarely been attempted (Heukelbach *et al.* 2001; Pilger *et al.* 2008).

Our data show that identification of tungiasis on periungual areas of the feet can be used to estimate prevalence of tungiasis and of severe disease in culturally and geographically distinct communities in South America and West Africa. The method is cheap, reliable and can be rapidly applied, with minimal disturbance of affected individuals. The assessment can be performed by paramedical workers or community members, as diagnosis of tungiasis can easily be performed by lay personnel living in endemic areas (Heukelbach 2005). In fact, in endemic areas, locals commonly affected by the disease diagnose tungiasis usually with a higher degree of certainty than health professionals (Heukelbach 2004).

The method is an alternative to time-consuming and sophisticated analyses for the precise assessment of morbidity used in a previous study on tungiasis (Kehr *et al.* 2007). As the number of lesions and morbidity are closely co-related (Kehr *et al.* 2007), the estimation of prevalence of individuals with more than 20 lesions indicates the occurrence of severe morbidity in a community. However, in our study, the strength of association was lower for the estimation of prevalence of severe tungiasis than for the overall prevalence. The rapid estimation method for severe tungiasis cannot be applied in the case of low prevalence of tungiasis at periungual sites, as in this case severe disease is rarely observed in a community.

The delimitation of tungiasis-endemic areas based on valid data is essential to highlight the epidemiological situation in a country or region. It is also a prerequisite for disease control at the population level. Thus, the rapid epidemiologic assessment method proposed fills these gaps in endemic areas.

In fact, rapid assessment tools were developed for the diagnosis of lymphatic filariasis with similar objectives: to determine the distribution of disease, identify high risk communities, and raise the attention of health policy makers (Gyapong *et al.* 1996, 1998a, b). As a result, about a decade later the 'Global Programme to Eliminate Lymphatic Filariasis' was implemented in collaboration with WHO. On the other hand, rapid assessment methods established for schistosomiasis and onchocerciasis were required to plan and monitor mass interventions programmes (WHO 1993, 1995; Red Urine Study Group 1995). In general, all rapid approaches provide valid data quickly (Gyapong *et al.* 1996; Macintyre 1999). We believe that our rapid assessment method for tungiasis will be similarly helpful in launching, planning and monitoring community control measures against the disease.

Rapid methods for other parasitic diseases, for example, for schistosomiasis, onchocerciasis and lymphatic filariasis, rely on the presence of indirect clinical or laboratory markers (Lengeler *et al.* 1991; Ngoumou *et al.* 1994; Gyapong *et al.* 1996; Kipp & Bamhuhiiga 2002; French *et al.* 2007; Weerasooriya *et al.* 2008; Ugbomoiko *et al.* 2009). However, the objective of our study was not to use an indirect marker for prediction of disease in an individual. The proposed rapid assessment for tungiasis was based on direct identification of the parasite as diagnosis of tungiasis in an individual is easy to perform by clinical

Table 4 Estimated and true prevalences of tungiasis and severe tungiasis (>20 lesions)

	Brazil								Nigeria	
	1	2	3	4	5	6	7	8	9	10
Prevalence of tungiasis on periungual sites	37.8%	42.0%	21.1%	28.8%	18.8%	44.3%	15.0%	20.8%	44.1%	30.2%
Prevalence of tungiasis										
True prevalence	51.3%	52.1%	31.2%	33.6%	23.7%	54.4%	21.1%	28.9%	51.1%	40.5%
Estimated prevalence†	47.3%	52.0%	28.7%	37.2%	26.0%	54.6%	21.8%	28.3%	54.4%	38.8%
(95% CI)	(43.0–51.5)	(47.6–56.5)	(24.8–32.6)	(34.6–40.0)	(23.5–28.6)	(51.1–58.8)	(21.8–24.4)	(25.5–31.2)	(46.9–61.6)	(30.0–48.3)
Absolute error	−4.0%	−0.1%	−2.5%	3.6%	2.3%	0.2%	0.7%	−0.6%	3.3%	−1.7%
Prevalence of severe tungiasis (>20 lesions)										
True prevalence	6.0%	6.5%	2.8%	2.2%	1.3%	4.7%	0.1%	0.8%	10.2%	5.2%
Estimated prevalence‡ (95% CI)	5.7% (3.9–7.9)	6.7% (4.7–9.2)	1.7% (0.7–3.1)	3.5% (2.5–4.7)	1.1% (0.6–2.0)	7.2% (5.5–9.1)	0.2% (0.0–0.7)	1.6% (0.9–2.6)	7.2% (3.8–11.7)	3.8% (0.9–8.6)
Absolute error	−0.3%	0.2%	−1.1%	1.3%	−0.2%	2.5%	0.1%	0.8%	−3.0%	−1.4%

†According to the equation $y = 1.12\ (x) + 5.0$ where x is the prevalence determined to the rapid assessment method and y the estimated prevalence.
‡According to the equation $y = 0.24\ (x) - 3.4$ where x is the prevalence determined to the rapid assessment method and y the estimated prevalence.

examination. Thus, rapid diagnosis on the individual level with calculation of accuracy markers, such as sensitivity, is not needed in this case. On the other hand, reliable estimation of the true prevalence of tungiasis and severity of disease in a given community is useful. Our study shows that the strength of association when applying the rapid estimation was very high.

In communities of different size and with different point prevalences, absolute errors of the estimated prevalences were low and R^2 values were high. The reliability of the proposed rapid assessment method did not vary considerably between seasons or populations with distinct socio-cultural characteristics. The wide diversity of characteristics of the examined populations indicates that this rapid assessment method may also be applicable in other endemic regions in Latin America, the Caribbean or sub-Saharan Africa. However, its external validity still has to be determined for other settings with particular ecological, epidemiological, geographical and socio-cultural characteristics.

We cannot rule out that inter-observer as well as intra-observer bias may have influenced the results, as surveys were conducted by different members of the research group, and during a rather long period. We aimed to reduce this source of bias by training all investigators performing the clinical examinations in one study site in Brazil, and by cross-checking quality of clinical examinations.

Conclusion

Our rapid assessment method will be helpful in the identification of communities at risk, as well as in planning and monitoring control measures aimed at the reduction of tungiasis in affected communities. The assessment can be performed by community health workers and paramedical personnel.

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African corporate executives,[6] using the same ATP III criteria. This is probably because the latter study was purely on corporate executives who were already likely to be at risk of developing the syndrome due to the sedentary nature of their jobs. However, our subjects were unselected.

Although the frequency of abdominal obesity in our women (67.3%) is comparable to the 62.1% reported in African American women in the USA,[5] the higher frequency of metabolic syndrome in our female subjects (30.4%) is possibly as a result of the fact that they had a significantly higher frequency of low HDL-c compared to the male subjects. Using the ATP III criteria, Gupta et al. also reported a higher prevalence rate of 47.8% in women compared to 36.2% in men.[8]

Our results show that the odds of having the syndrome are increased in women and in the presence of generalized obesity, systolic or diastolic hypertension. Also, the risk is increased about eight-fold in those with a history of diabetes mellitus and impaired fasting glucose increased the odds by about seven-fold.

These findings underline the need to take a holistic approach in the management of patients with any cardiovascular risk factor as the presence of one may be a pointer to their having an underlying metabolic syndrome. To stem the tide of this non-communicable health condition, we need to provide health education at all levels. As prevention is paramount, there is a need to promote a healthy lifestyle in our communities, including heart-healthy diets and increased physical activity.

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Pigs are the most important animal reservoir for *Tunga penetrans* (jigger flea) in rural Nigeria

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SUMMARY We examined the domestic animals and rodents in a community in rural Nigeria. Of the 133 animals examined, 29 (21.8%) were infested, the highest prevalence of infestation and highest parasite load was found in the pigs (prevalence 54.8%, median = nine embedded parasites), followed by dogs (45.5%; median = 4), *Rattus rattus* (29.4%; median = 2) and *Mus minutoides* (15.4%; median = 1.5). Of all the tungiasis lesions identified 83% were found in pigs. Our data confirm that tungiasis is a zoonotic disease, and that pigs are its most important animal reservoir in this endemic community.

Introduction

Tungiasis is a parasitic skin disease caused by the jigger flea *Tunga penetrans.* The disease is present in resource-poor communities in Central and South America, the Caribbean and sub-Saharan Africa.[1] Domestic animals, such as pigs, dogs and cats have been repeatedly considered as important animal reservoirs, but data are scarce.[2–5]

A recently conducted community-based study in rural Nigeria revealed a high prevalence of tungiasis (45%) in the human population. A particular high parasite load was found in children and the elderly, and considerable morbidity caused by the infestation.[6] The most important independent risk factor for tungiasis, identified by another epidemiological investigation in that area, was the presence of pigs in a household (adjusted odds ratio = 18), with a population-attributable fraction of 38%.[7] We investigated tungiasis in domestic animals and rodents in this endemic community in order to describe the importance of domestic animals and rodents as a reservoir for *T. penetrans.*

Material and methods

The study was carried out during the dry season in Erekiti, a rural community located about 50 km west of the city of

Table 1 Animals examined for tungiasis, the number infested and their parasitic load

	Prevalence		*No. of lesions*		
	n positive	*Percentage (95% confidence intervals)*	*n*	*(%)*	*Median per animal* (interquartile range)*
Pigs	17/31	54.8 (36.0–72.7)	184	(83.3)	9 (6–14)
Dogs	5/11	45.5 (16.8–76.6)	21	(9.5)	4 (3–5)
Rattus rattus	5/17	29.4 (10.3–56.0)	13	(5.9)	2 (2–4)
Mus minutoides	2/13	15.4 (1.9–45.5)	3	(1.4)	1.5 (1–2)
Goats	0/28	–	–	–	–
Sheep	0/15	–	–	–	–
Cats	0/9	–	–	–	–
Cows	0/9	–	–	–	–
Total	29/133	21.8 (14.7–28.9)	221	100.0	6 (3–9)

*Of those with tungiasis

Lagos, Nigeria. The 1200 inhabitants are subsistence farmers, and many families keep domestic animals such as dogs, cats, goats and pigs that roam freely. Detailed characteristics of the study area and the population are presented elsewhere.[6]

First, we carried out a census of 50% of randomly selected households in Erekiti. Then, all households with domestic animals were visited for further investigation. After receiving the informed consent of their owners, pets and/or livestock were clinically examined over the whole body surface for the presence of embedded jigger fleas. Trapped rodents were killed with chloroform and examined.

Results

The overall prevalence of jigger flea infestation in the 133 animals examined was 21.8% (Table 1). The prevalence and intensity of the infestation in the animals varied considerably. It was noticeably higher in pigs and dogs than in the house rat, *Rattus rattus* (Table 1). The median number of lesions per animal in the pigs was more than twice that found in the dogs and more than four times that found in the rats (Table 1); 83% (184/221 lesions) of the total parasite load in the animals was seen in the pigs. There were no tungiasis lesions observed in the goats, sheep, cats or cows.

Discussion

Our data confirm the notion that infestation of animals with *T. penetrans* in endemic communities is a common phenomenon. In the community studied, human infestation correlated with the presence of pigs in the household.[7] We can now show that, in this community which is typical for rural Nigeria, pigs in fact appear to be the most important animal reservoir, followed by dogs and rodents, for *T. penetrans*. Pigs were the most commonly owned domestic animals. They presented with highest parasite load and accounted for the vast majority of the total number of tungiasis lesions found in the animals.

Other studies from West Africa, namely in Cameroon and São Tomé e Príncipe, also reported finding tungiasis in pigs.[3,4] Interestingly, this is in contrast to the observations in endemic communities in Brazil, where dogs and rats seem to be the most important reservoirs – free-roaming pigs were banned from endemic communities in Brazil some years ago.[1,8] Introducing the banning of free-roaming pigs in West African communities would probably also reduce human attack in that area.

We conclude that tungiasis is a zoonotic disease, and that pigs, dogs and rodents are important reservoir hosts in rural Nigeria. Consequently, we suggest that a sustained effort is made to: reduce the ownership of pigs and dogs in these areas; educate the public about the health issues; improve the standard of housing and treat any members of the community suffering from tungiasis. Pigs should be confined to pigpens. The reduction of the rodent population will further reduce the transmission of *T. penetrans*.

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Tungíase: doença negligenciada causando patologia grave em uma favela de Fortaleza, Ceará

Tungiasis: a neglected disease causing severe morbidity in a shantytown in Fortaleza, State of Ceará

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RESUMO

A tungíase, ectoparasitose causada pela pulga Tunga penetrans*, é endêmica em comunidades brasileiras de baixo poder aquisitivo. Neste estudo foram identificados habitantes de uma favela urbana em Fortaleza com carga parasitária elevada. Número de lesões, localização, estadiamento e patologias associadas foram registrados. Os 142 indivíduos identificados apresentaram condições de moradia extremamente precárias. Contou-se no total 3.445 lesões localizadas nos pés (mediana = 17 lesões; máximo = 98 lesões). Quase sem exceção, os indivíduos apresentaram deformações ungueais e edema e mais de 70% dor e fissuras. Perda de unha foi observada em 46% dos casos e deformação de dígitos em 25%; 42% apresentaram abscessos e 59% queixaram-se de dificuldade de andar. Nossos dados mostram que a tungíase em comunidade urbana de baixa renda típica no nordeste brasileiro está associada a patologia grave. A doença precisa ser reconhecida como problema de saúde pública na região estudada e em outras áreas endêmicas semelhantes.*

Palavras-chaves: *Tungíase.* Tunga penetrans*. Ectoparasitose. Morbidade.*

ABSTRACT

The parasitic skin disease tungiasis, caused by the jigger flea Tunga penetrans*, is endemic in low-income communities in Brazil. In this study, inhabitants of a shantytown in Fortaleza, northeastern Brazil, who had an elevated parasite load, were identified. The number of lesions, localization, staging and associated diseases were recorded. The 142 individuals identified were living in extremely precarious housing conditions. A total of 3,445 lesions located on the feet were counted (median = 17 lesions; maximum = 98 lesions). Almost without exception, the individuals had nail deformation and edema, and more than 70% presented with pain and fissures. There was nail loss in 46%; deformation of the digits in 25%; abscesses in 42%; and complaints of walking difficulty in 59%. Our data show that tungiasis in this low-income urban community typical of northeastern Brazil was associated with severe morbidity. Tungiasis needs to be recognized as a public health problem in this study area and other similar endemic areas.*

Key-words: *Tungiasis.* Tunga penetrans*. Ectoparasite infestation. Morbidity.*

A tungíase é uma doença ectoparasitária causada pela penetração da fêmea de *Tunga penetrans* (Linnaeus, 1758) na epiderme do seu hospedeiro. É uma pulga que hipertrofia subseqüentemente até alcançar o tamanho de cerca de um centímetro[1 15 19 26].

Em contraste com as ectoparasitoses escabiose e pediculose, a tungíase é autolimitada com duração de quatro a seis semanas[4]. Nas áreas endêmicas, porém, a re-infestação constante é a regra, e os indivíduos afetados podem apresentar algumas dezenas de parasitos em diferentes estágios de desenvolvimento[2 7 10 24]. Complicações graves e seqüelas são comuns nessas áreas com baixos indicadores de desenvolvimento humano, onde as condições de higiene são precárias e a remoção da pulga não é realizada em condições de assepsia[7 8 19]. Nessas circunstâncias, a superinfecção com bactérias patogênicas é presente sem exceção[8], e a lesão causada pela penetração da pulga pode servir como porta de entrada para *Clostridium tetani*, agente causador do tétano[13 27 34 35]. Seqüelas de infestação grave documentadas incluem dificuldade de andar, deformação e perda de unhas de dedo do pé, como também deformação e auto-amputação de dígitos, além de sepse e óbito[3 19 24 28 29 30].

Nos últimos anos, o número de publicações com o objetivo de aumentar a percepção da doença entre os gestores, profissionais de saúde e o mundo científico está aumentando, principalmente de países da América Latina e Caribe, como Argentina, Brasil e Haiti[2 11 19 22 24 31 32]. Entretanto, relatos clínicos sistemáticos de

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pacientes com doença grave ainda são escassos, reforçando o fato de que a tungíase é uma doença negligenciada.

Aqui apresentamos as características clínico-epidemiológicas de indivíduos gravemente infestados com *T. penetrans* de uma área endêmica urbana típica brasileira. Os resultados mostram que a tungíase – de forma alarmante – está associada com patologia clínica.

MATERIAL E MÉTODOS

Área de estudo. O estudo foi realizado na área Serviluz/ Vicente Pinzón II, uma conglomeração de favelas urbanas típicas de Fortaleza, Ceará. Estas comunidades localizam-se nas dunas próximas à beira mar. Os migrantes pobres do interior do Estado começaram a habitar o local no início dos anos 50 do século XX. Atualmente, a área tem população total de aproximadamente 20.000 pessoas vivendo em condições sócio-econômicas precárias. Muitas casas são feitas de material reciclado e sem piso cimentado. Doenças parasitárias de pele como escabiose, larva migrans, pediculose e tungíase ocorrem freqüentemente nessa população[21 22 23].

População e desenho de estudo. A população examinada foi definida como parte de um estudo intervencional sobre a tungíase. Indivíduos com tungíase foram identificados com a ajuda de líderes comunitários e agentes de saúde. Foram incluídas somente pessoas com cinco ou mais lesões nos pés causadas por *T. penetrans*, baseando-se que mais de 90% das lesões encontram-se nos pés[20]. No total, 142 indivíduos de ambos os sexos foram recrutados das favelas Luxou, Morro do Sandra's, Morro da Vitória e Novo Rumo. Os participantes do estudo foram examinados clinicamente pela presença de tungíase em junho 2005. Esse mês encontra-se no período da seca, quando a doença ocorre mais frequentemente na área[22] . A localização e estágio das lesões foram documentados e os pacientes foram interrogados a respeito de sintomas utilizando uma ficha estruturada pré-testada. Foi também documentada a existência de patologia clínica aguda e crônica associada.

Exame clínico. A tungíase foi diagnosticada clinicamente de acordo com os critérios de Eisele e cols[4]: a) presença de uma pulga na fase de penetração ou de um pequeno ponto vermelho-pardo com diâmetro de um a dois milímetros; b) presença de uma zona circular branca com diâmetro de três a dez milímetros com um ponto preto central; c) presença de uma *casca preta* (pulga morta com tecido necrosado). Os itens a) e b) foram definidos como lesões vitais e o item c) como lesão avital.

Após exame clínico, os sinais e sintomas de patologias associadas à tungíase foram observados e registrados, incluindo edema, eritema, dor, prurido, descamação, fissura e pústula. Complicações típicas de tungíase grave encontradas nos diferentes estágios de desenvolvimento da doença também foram registradas (deformação ou perda de unha, deformação de dedo, dificuldade de andar)[4 7].

Armazenamento e análise dos dados. Os dados foram inseridos em uma base de dados usando o programa Epi Info (versão 6.04d; *Centers for Disease Control and Prevention*, Atlanta, USA) e checados por erros de digitação. Para comparar as medianas das lesões entre os grupos, os testes de Mann-Whitney e de Kruskal-Wallis foram utilizados.

Considerações éticas. Este estudo foi aprovado pelo Comitê de Ética em Pesquisa da Universidade Federal do Ceará (Protocolo COMEPE no. 21/2003). Participaram do estudo apenas os indivíduos ou responsáveis legais que assinaram o termo de consentimento. Após exame clínico, todos os participantes da pesquisa foram tratados contra a tungíase com um repelente natural à base de óleo de côco por um período de, pelo menos, quatro semanas. Esse repelente se mostrou efetivo em reduzir a penetração de pulgas em indivíduos com infestação grave[9].

RESULTADOS

Características sócio-demográficas individuais e familiares. No total foram incluídos 142 indivíduos com pelo menos cinco lesões causadas por fêmeas da *T. penetrans*. Destes, 69 (48,6%) eram de sexo masculino e 73 (51,4%) feminino. A mediana da idade foi de nove anos, sendo os limites oito meses e 66 anos.

Os 142 participantes do estudo procederam de 73 famílias residentes na área. A maioria das casas possuía energia elétrica (97,3%) e abastecimento de água por rede geral (83,6%). Contudo, não havia rede de esgoto e de águas servidas. Quarenta e sete (64,3%) das casas eram feitas de madeira ou material aproveitado, e 37 (50,7%) tinham piso de areia. Na maioria (56/76,7%) das famílias, não tinha nenhum membro com o primeiro grau completo. A mediana da renda familiar mensal foi de R$ 119,00 (intervalo interquartil R$ 60,00 a R$ 200,00).

Localização das lesões e número de lesões (carga parasitária). O número de lesões (total, vitais, avitais e manipuladas por indivíduo) está indicado na Tabela 1. Ao todo foram contadas 3.445 lesões nos 142 indivíduos (mediana = 17); 11,3% (16/142) apresentaram mais de 50 lesões. O máximo de 98 lesões foi encontrado em uma menina de sete anos. Não houve diferença significativa do número mediano de lesões entre o sexo masculino e feminino (16 vs 17; p=0,4). O número mediano do total das lesões entre os grupos etários não mostrou diferença estatisticamente significativa (p=0,19). Entretanto, a mediana das lesões manipuladas foi maior nos indivíduos acima de 20 anos do que nos abaixo dessa idade (7 vs 4; p=0,002). Cinqüenta e uma (35,9%) lesões apresentavam-se de forma agrupada (em *cluster*, Figuras 1 e 2). A distribuição topográfica das lesões está sumarizada na Tabela 2.

Tabela 1 - Número total de lesões e distribuição de acordo com estágios, em uma favela urbana de Fortaleza, CE.

	Número de lesões		
Estágios	Mediana	IIQ**	Máximo
Total	17	12–30	98
Vitais*	6	4–11	74
Avitais*	6	3–11	49
Manipuladas	4,5	3–8,5	50

* de acordo com Eisele e cols[4]

** Intervalo interquartil

Figura 1 - Pé esquerdo de uma de menina de sete anos. Os dedos apresentam lesões em todos os estágios de desenvolvimento. Por exemplo, o hálux apresenta **cluster** ***de lesões vitais no canto proximal da unha e*** **cluster** ***de lesões em estágios vitais e avitais na área distal do dedo. Ovos podem ser identificados aderidos à pele e em todas as unhas (e.g., seis ovos no bordo lateral da unha do 4º pododáctilo). Inflamação está presente em todos os dedos; todas as unhas e o 5º pododáctilo apresentam deformação.***

Figura 2 - Região plantar dos pés de uma menina de sete anos. Lesões em todos os estágios de desenvolvimento estão presentes, como também sinais de lesões antigas tipo **punched out** ***(e.g., na área proximal ao 5º dedo pododáctilo do pé esquerdo). Vários agrupamentos de lesões (*****clusters*****) são visíveis em ambos os pés.***

Tabela 2 - Distribuição do número de lesões nos pés dos indivíduos examinados (n=142), em uma favela urbana de Fortaleza, CE.

	Indivíduos		Número de lesões			
Localização	nº	%	nº	%	Mediana	IIQ*
Dedos	141	99,3	2416	70,1	14	9–20
peri-ungueal	137	96,5	1864	54,1	11	7–17
não peri-ungueal	103	72,5	552	16,0	2	0–2
Planta	88	62,0	501	14,5	1	0–5
Calcanhar	57	40,1	341	9,9	0	0–5
Canto Lateral	33	23,2	187	5,4	0	0–0

* Intervalo interquartil

Patologia e sintomatologia associadas. As patologias e sintomatologias associadas com tungíase - diferenciadas em aguda e crônica - estão indicadas na Tabela 3. Praticamente, todos os participantes mostraram deformação de, pelo menos, uma unha e edema (Figura 1). A maioria se queixou de prurido e dor. De forma relevante, fissuras associadas a lesões foram encontradas em mais do que 2/3 dos indivíduos. Quase a metade perdeu pelo menos uma unha, e um quarto apresentou-se com deformação de dígitos, como seqüela crônica de infestação repetida e permanente (Figura 1). Mais da metade (59%) tinha dificuldade de andar.

Tabela 3 - Sintomas e patologias agudas e crônicas associadas a tungíase identificadas na população do estudo (n=142) em uma favela urbana de Fortaleza, CE.

	Indivíduos	
Sintomas e patologia	nº	%
Agudos		
edema e eritema	133	93,7
prurido	114	80,3
dor espontânea	101	71,1
dor a pressão*	100	70,9
fissura	98	69,0
dificuldade de andar*	83	58,9
abscesso/supuração	59	41,6
úlceras	38	26,8
Crônicos		
deformação de unha	141	99,3
hiperceratose	132	93,0
descamação	131	92,3
sinais de lesões antigas**	129	90,8
hipertrofia peri-ungueal	122	85,9
perda de unha	65	45,8
deformação de dígitos	35	24,6
pele brilhante	24	16,9

* dados disponíveis de 141 indivíduos. ** lesões residuais *punched out* conforme descritas em Eisele e cols[4].

DISCUSSÃO

Os dados descritos mostram que a tungíase, ainda hoje, é causa de patologia grave em uma comunidade urbana com baixos indicadores de desenvolvimento humano, e que nessas condições essa ectoparasitose precisa ser considerada como um importante problema de saúde pública. Como a área de estudo se assemelha às tantas outras favelas urbanas do Nordeste brasileiro, é possível supor que problema de igual gravidade seja bastante comum nessa região do país.

A tungíase é um exemplo evidente de uma doença associada à pobreza[18 19 24]. Muehlen e cols[31] mostraram que as condições precárias de construção da habitação, a baixa escolaridade, a presença de animais e o baixo nível sócio-econômico são os fatores mais importantes associados à presença de tungíase grave. Desde os anos 70 do século XX, a prevalência da doença vem decrescendo em muitas áreas, mas continua sendo alarmente em inúmeras comunidades desfavorecidas do Brasil[2 7 14 15 19 32]. Recentemente, a Organização Mundial de Saúde considerou importante o impacto negativo causado por doenças ectoparasitárias na qualidade de vida[5], sugerindo que no futuro essa ectoparasitose seja reconhecida de forma mais cuidadosa.

Neste estudo, as patologias associadas à tungíase são alarmantes. Incômodos como prurido e dor estavam presentes e mais da metade dos examinados tinha dificuldade em andar. Fissuras nos pés, que podem servir como porta de entrada para microorganismos patogênos, ocorreram em mais de 2/3 dos indivíduos examinados. De fato, foi relatado que no Brasil e em outros países a tungíase está associada a um amplo espectro de patologias clínicas agudas e crônicas[6 7 12 36]. A superinfecção bacteriana das lesões é uma constante e sua gravidade pode resultar em seqüelas como gangrena, auto-amputação de dígitos, sepse e tétano[7 8 19 25 27 34 35]. Recentemente, em estudo realizado no país mais pobre das Américas, Haiti, houve relato de quatro óbitos em adultos extremamente infestados, provavelmente devido ao tétano e/ou a sepse[24].

Esses relatos são preocupantes na medida em que a tungíase é uma doença autolimitada, que se agrava com as precárias condições de vida gerando seqüelas e desfechos potencialmente evitáveis.

Até o momento, o tratamento padrão consiste em remover a pulga com uma agulha estéril e aplicação de um antibiótico tópico[15 19]. A extração da pulga penetrada requer habilidade manual, instrumental adequado e condições de higiene satisfatórias – os quais raramente são disponíveis nas áreas endêmicas – do contrário pode causar mais danos do que benefícios[7]. Além desses aspectos, a extração das pulgas não é um procedimento tão viável nas comunidades altamente afetadas, nas quais a taxa de ataque pode ser superior a dez pulgas por indivíduo, diariamente[22].

Nos últimos anos, estudos clínicos controlados com uso tópico de ivermectina, tiabendazol e metrifonate mostraram pequeno efeito[16]. O uso de ivermectina oral também não se mostrou eficaz quando comparado ao placebo[17]. Recentemente, estudos mostraram que um repelente à base de óleo de côco, também recomendado contra picadas de insetos e carrapatos, é altamente eficaz tanto na regressão da patologia clínica de indivíduos gravemente infestados, como na prevenção de re-infestação[9 33]. O uso desse repelente talvez seja a medida mais adequada para reduzir a patologia associada à tungíase do que o tratamento após infestação[15 22].

Concluímos que independe dos esforços que têm sido realizados para o manejo clínico da tungíase, o controle sustentável requer o empenho dos gestores públicos de saúde na implementação de ações de controle e monitoramento no âmbito coletivo, aliado às melhorias da educação, do trabalho e da infra-estrutura urbana nas comunidades mais carentes.

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PLoS NEGLECTED TROPICAL DISEASES

Risk Factors for Tungiasis in Nigeria: Identification of Targets for Effective Intervention

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Abstract

Background: The parasitic skin disease tungiasis (caused by the flea *Tunga penetrans*) affects resource-poor communities in Latin America, the Caribbean and sub-Saharan Africa. Prevalences in endemic areas are high, and severe pathology occurs commonly. However, risk factors for infestation have never been assessed in Africa.

Methods and Findings: A cross-sectional study was conducted in Erekiti, a rural community in Lagos State (Nigeria), where tungiasis is endemic. Individuals were examined clinically for the presence of tungiasis, and a questionnaire was applied. Data from 643 individuals (86.6% of the target population) were analyzed; 252 (42.5%) were infested with *T. penetrans*. In the multivariate logistic regression analysis, presence of pigs on the compounds (adjusted odds ratio = 17.98; 95% confidence interval: 5.55–58.23), sand or clay floor inside houses (9.33; 5.06–17.19), and having the common resting place outside the house (7.14; 4.0–14.29) were the most important risk factors identified. The regular use of closed footwear (0.34; 0.18–0.62) and the use of insecticides indoors (0.2; 0.05–0.83) were protective against infestation. The population attributable fractions associated with tungiasis were: sand or clay floor inside the house (73.7%), resting usually outside the house (65.5%), no regular use of closed footwear (51.1%), and pigs on the compound (37.9%).

Conclusion: The presence of tungiasis in Erekiti is determined to an important extent by a limited number of modifiable variables. Effective and sustainable intervention measures addressing these factors need to be implemented in this and other West African communities with high disease burden.

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Introduction

The parasitic skin disease tungiasis is caused by the permanent penetration of the female sand flea *Tunga penetrans* into the epidermis of its host. After penetration, the female undergoes a hypertrophy and reaches the size of a pea. Tungiasis has many features of a neglected tropical disease and thus can be considered as a paradigm: it is endemic in poor communities and rural areas, it is associated with stigma, and there is no commercial market for products targeting the disease [1–3]. The disease only sporadically affects travelers to endemic areas in South America and Africa, whereas people living in local communities commonly suffer from severe infestation and associated pathology [4,5]. Associated pathology includes bacterial superinfection, pain, fissures hindering individuals from walking normally, as well as deformation and loss of toenails and digits [1,6–8]. Tungiasis lesions have also been described to be port of entry for tetanus infection [7,9,10].

The sand flea originally occurred only on the American continent and the Caribbean Islands, but spread in the late 19th century throughout sub-Saharan Africa and to Madagascar [1,11]. Two recent studies from Nigeria and Cameroon indicate that still today tungiasis is a major public health problem in West Africa [12,13].

In the past few years, the public health importance of tungiasis in resource-poor populations has been highlighted from different countries, including Brazil, Argentina, Haiti and Nigeria [7,14,15]. However, risk factors for infestation have only been addressed in a single study from Brazil [16], and sustainable intervention measures have never been assessed systematically. Control programs aiming at the reduction of severe morbidity are nonexistent.

Here we present the results of a cross-sectional study identifying major risk factors for tungiasis in a rural community in Nigeria. The results show that several modifiable factors, which can be addressed in control programs, are important determinants for infestation.

Methods

Study area

The study was conducted in Erekiti, a community located about 50 km west from Lagos, the capital of Lagos State, Nigeria.

The community can be regarded as typical for a small rural village in Western Nigeria; the characteristics have been described in detail elsewhere [13]. In brief, Erekiti has a population of about 1200 inhabitants. The community lacks appropriate urban

Author Summary

Tungiasis is a parasitic skin disease caused by the sand flea *Tunga penetrans*. After penetration into the skin, the flea grows and reaches the size of a pea. The disease is a neglected public health problem in endemic areas in Latin America, the Caribbean and Africa, and causes considerable morbidity in the affected communities. We performed a study in a rural community in Nigeria to detect factors associated with tungiasis. People were examined for the presence of sand flea lesions, and a questionnaire was applied. Of the 643 individuals examined, 252 (42.5%) had tungiasis. The most important factors independently associated with the disease were: presence of pigs on the compound (adjusted odds ratio [OR] = 17.98), sand or clay floor inside house (OR = 9.33), and having the common resting place outside the house (OR = 7.14). The regular use of closed footwear (OR = 0.34) and the use of insecticides indoors (OR = 0.2) were protective factors. Our data show that tungiasis in this community is determined to an important extent by some variables that may be a target for interventions.

services like health care centers, pipe-borne water and a public sewage system. Open wells and the nearby river serve as the source of water. The majority of the people walk barefooted, defecate in the surrounding bush and scatter domestic waste in the vicinity of their homes. Domestic animals (pigs, goats, chickens, dogs, cats) roam around freely.

Study population and design

This cross-sectional study was carried out during the hot and dry season in March 2006, when the prevalence of tungiasis and parasite load are known to be highest [14]. Before the onset of the study, information meetings were held with community members. Thereafter, 50% of the community's households (142 households, 643 individuals) were randomly selected using a random number table. For this selection, census data of the community were used, obtained from the Lagos State National Population Commission.

The households were visited, and every participant was examined thoroughly for the presence of embedded sand fleas. A pre-tested structured questionnaire was applied in *egun*, the local language.

The information collected consisted of four categories: (1) socio-demographic factors (such as sex, age, education); (2) housing and associated factors (such as type of construction of the house, type of floor inside house, sanitary conditions, presence of electricity, waste disposal); (3) ownership and presence of domestic animals; (4) knowledge, attitudes and practices related to tungiasis (such as knowledge on transmission, regular use of footwear, common resting place, preventive measures, treatment). Children of 6 years and above provided information directly, while in the other cases information was obtained from the guardians. A household was revisited when a family member was absent.

Clinical examination was performed by inspecting carefully the legs, feet, hands and arms. To guarantee privacy, other topographical regions of the body were not examined. We considered this approach as acceptable, as in endemic communities more than 99% of tungiasis lesions occur on these areas [17]. At the clinical examination we considered the following findings diagnostic for tungiasis: an itching red-brownish spot with a diameter of one to three mm, a circular lesion presenting as a white patch with a diameter of four to ten mm with a central black dot, black crust surrounded by necrotic tissue, as well as partially or totally removed fleas leaving a characteristic sore in the skin [18]. Localization and number of lesions were recorded. As defined by Muehlen et al. [16], the presence of less than 5 lesions was considered as mild, of 6–30 as moderate and of more than 30 lesions as heavy infestation.

To reduce observation bias, clinical examinations and interviews were done by different persons, and the interviewer was blinded to the infestation status of the household members. All clinical examinations and interviews were done by a single person, respectively, to eliminate inter-observer bias.

Prevalence of tungiasis, parasite load and associated morbidity in the study population has been presented elsewhere in detail [13].

Statistical analysis

Data were entered using Epi Info software (version 6.04d; Centers for Disease Control and Prevention, Atlanta, USA) and checked for entry errors by rechecking all data entries with the original data forms. Then, data were transferred to Stata® software package (version 9.0; Stata Corporation, College Station, USA) for analysis.

We applied Fisher's exact test to determine the significance of differences of relative frequencies. Variables were first analysed in a bivariate manner to identify those to be included in the unconditional logistic regression. Multivariate logistic regression using backward elimination was then performed, to calculate adjusted odds ratios for the independent association between tungiasis infestation and the explanatory variables. Only variables with a p value <0.3 in the Fisher's exact test were entered into the initial model, and then backward elimination was run. To remain in the model, a significance of $p<0.05$ was required. Confounding and interaction between variables were investigated by stratification and by constructing 2×2 tables. The variables entered in the logistic regression did not show any collinearity. All variables that remained in the final model are presented; odds ratios were adjusted for all other variables in this model.

Similar to Muehlen et al. [16], we assessed the population attributable fractions of factors associated with *T. penetrans* infestation. The population attributable fraction is the fraction of cases which would not have occurred in the community if the exposure had been avoided [16]. The population attributable fractions (PAF) were calculated for modifiable risk factors with high odds ratios, expressed as the percentage exposed among cases, multiplied by (OR-1)/OR. We based the calculation of the PAF on the adjusted odds ratios obtained from logistic regression analysis. As calculation of the PAF assumes that the exposure is causal and that the other risk factors remain unchanged, we calculated the PAF for those variables for which causality seemed to be likely and which are modifiable.

Ethical considerations

The Ethical Committee of the Badagry Local Government Public Health Board, which is composed of medical and administrative personnel, approved the study, including the fact that oral consent was obtained. Before the study, the objectives and the study protocol were explained during meetings with the community leaders of Erekiti and a representative of the Ethical Committee. The community leaders also approved the study.

In accordance with local requirements, consent was obtained after explaining the objectives from all study participants, or in case of minors, from their caretakers. The statement was translated into the local language by our interpreter. The consent was witnessed by a person not involved in the study (usually a community representative). The participants signed, by thumb-

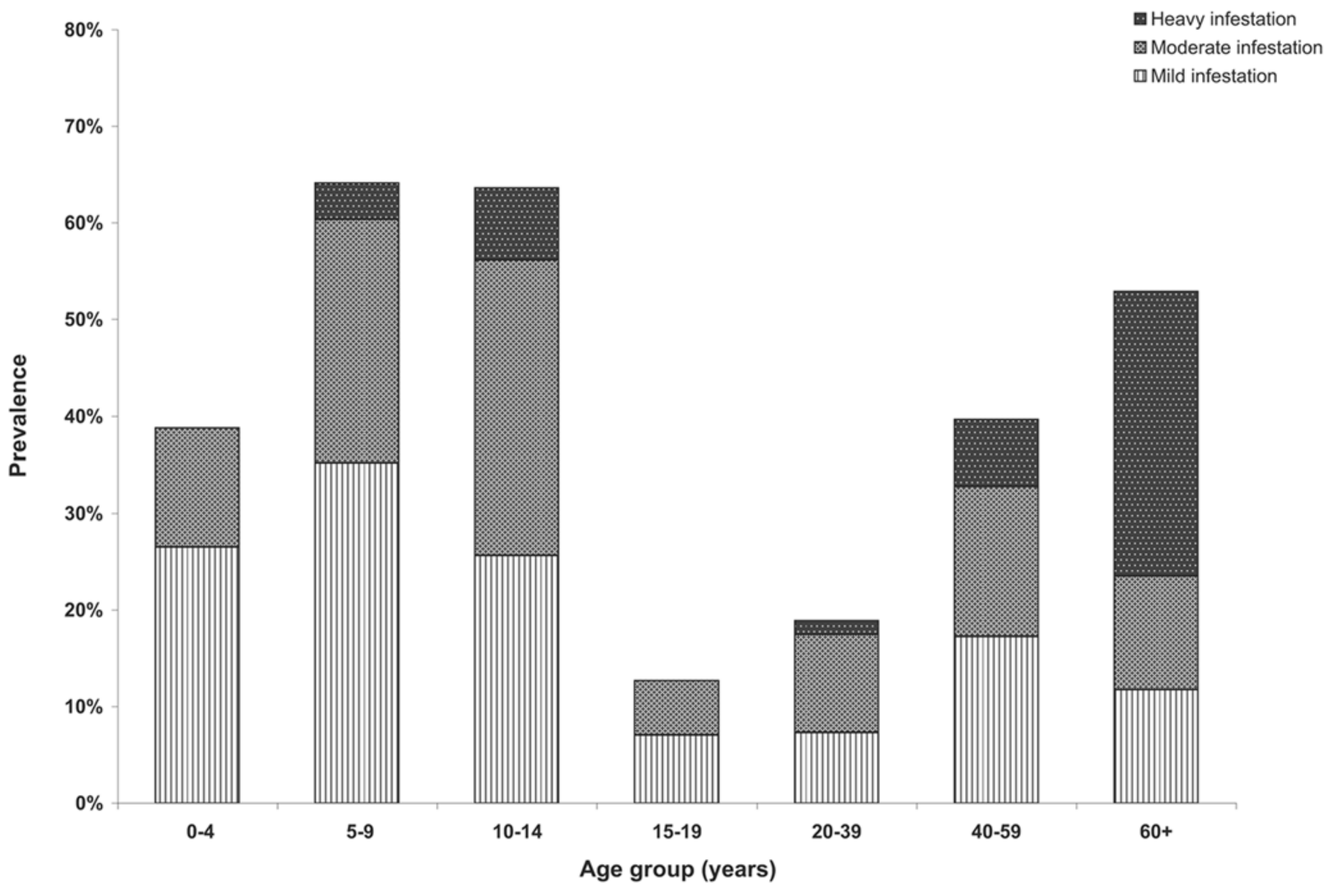

Figure 1. Prevalence of tungiasis stratified by age group and severity of infestation.
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printing, a spreadsheet containing details of their biodata. Data were kept strictly confidential.

Results

Of the 643 individuals of the target population, 557 (86.6%) were encountered and participated in the study. This represents 45.2% of the total population of the community. Of the participants, 299 (53.7%) were male and 258 (46.3%) female. Illiteracy rate was high (n = 445; 77.2%), and 100 individuals (56.5%) of the adult working population had a mean monthly income<US$50. Most people lived in brick houses (n = 414; 74.3%); 277 (49.7%) had inside a floor of sand or clay, 363 (65.2%) did not have any toilet facilities, and 326 (58.5%) littered domestic waste within the house premises. Seventy two (12.9%) individuals walked barefooted.

In total, 252 (42.5%) individuals were infested with *T. penetrans*. Of these, 122 (48.4%) presented with mild, 105 (41.7%) with moderate, and 25 (9.9%) with heavy infestation. The age-specific prevalences and intensities of infestation are shown in Figure 1. Prevalence followed an S-shaped pattern and was highest in children 5 to 9 years of age, 10 to 15-years old adolescents and the elderly. The highest proportion of individuals with heavy infestation was observed in the elderly.

Factors associated with tungiasis in the bivariate analysis are depicted in Table 1. Variables of all groups were detected to be associated with tungiasis. Odds ratios>10 were found for community members living in houses made of palm products; living in houses with sand or clay floor; with water supply exclusively from the river; with pigs on the compound, and those usually resting outdoors (Table 1). Other variables significantly associated with infestation included young age (OR = 9.0), low education (OR = 10.0), lack of knowledge on transmission (OR = 7.22), no regular use of footwear (OR = 5.9), no use of soap for bathing (OR = 5.9), and the non-use of commercialized insecticides used as a means of prevention (OR = 9.3).

Figure 2. A single tungiasis lesion on the finger of a 7-year-old boy from Brazil, with surrounding erythema.
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Figure 3. Multiple lesions on the left heel of a 13 year-old Brazilian girl.
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In the multivariate logistic regression analysis, pigs on the compounds (adjusted OR = 18.0) and sandy floors inside houses (adjusted OR = 9.3) were the most important independent risk factors for infestation (Table 2). After controlling for confounding, the type of house was not an independent risk factor for infestation. Other modifiable factors independently associated with tungiasis included the resting place commonly used and the presence of cats. Individuals living in families that use regularly insecticides indoors had a lower chance to be infested. The regular use of closed footwear was also an independent protective factor (Table 2).

The population attributable fractions for modifiable variables associated with tungiasis were: sand or clay floor inside the house (73.7%), resting commonly outside the house (65.5%), no regular use of closed footwear (51.1%), and pigs on the compound (37.9%; Table 3).

Discussion

Our data show that in Erekiti, a typical community in Western Nigeria with endemic tungiasis, several factors were independently associated with infestation by *Tunga penetrans*. In particular, sandy floor inside the house, behaviour (such as the common resting place and the use of closed footwear), as well as the presence of pigs on the compound contributed to an important extent to a high prevalence of tungiasis in the community. We identified the use of insecticides indoors and the use of soap, as well as the type of water supply as protective factors. In addition, the younger and older age groups were described as being most vulnerable for infestation.

So far, there is only one other study focussing on risk factors for tungiasis; this study was done in a poor fishing community in Brazil [16]. The importance of housing for the transmission dynamics has also been described in the Brazilian study. There, living in a house built on dunes, living in a house made of palm products, and having a floor of sand or clay inside the house were important risk factors for infestation in the multivariate analysis; adjusted odds ratios for these variables ranged from 1.9 to 4.7 [16]. Interestingly, in Nigeria the type of house was not an independent factor predisposing for infestation, but confounded by the type of floor inside the house and other factors. Thus, after controlling for confounding, the type of house *per se* did not predict infestation in Erekiti.

The findings of the present study corroborate our hypothesis made several years ago that the flea prefers sandy soil and shade for breeding and that, as an intervention, floors of houses could be cemented and streets paved [19]. This hypothesis is also confirmed by our finding that the resting place, which is commonly underneath a shady tree, is an important factor associated with infestation. We speculate that these places are preferred breeding sites of the flea, as there is abundant organic material for the larvae to feed on.

It is known that the animal reservoir plays an important role for transmission dynamics in endemic communities [20]. In particular, dogs, cats and rats have been described to be commonly infested [20–22], and several authors reported severe disease in pigs from different African countries, such as from São Tomé e Príncipe, Zaire, Cameroon and Tanzania [12,23–26]. These studies emphasized the importance of pigs as animal reservoir of *T. penetrans*. Our data suggest that the presence of pigs on a family compound is an important predictor for human tungiasis and that pigs may be the most important animal reservoir this Nigerian community. Although we did not perform a formal prevalence study on domestic animals, we observed severely infested pigs in the community (Ugbomoiko, unpublished observation). Pigs did not play a role for transmission in Brazil, as in the studied community free-roaming pigs were absent [16]. Interestingly, in Brazil a significant reduction of attack rates in humans has been observed after the prohibition to let pigs roam freely in the community [19]. Similar intervention measures in Erekiti would probably reduce the prevalence of tungiasis in the community significantly. In contrast to the Brazilian study, we did not identify dogs, but cats to increase the prevalence in the community. In Brazil, dogs are commonly infested with prevalences reaching 67.0% in an urban slum [27].

The higher prevalence in children and the elderly in Erekiti is probably due to higher exposure and different disease-related behavior. Children play around (mostly barefooted) in the community, and the elderly have more difficulties to take out embedded fleas than young people. We observed in the community that skilful older children carry out flea extraction for their friends and younger children at school and that such assistance is rarely rendered to less skilful, poor sighted elder people [13].

We did not find any significant gender differences to predispose for infestation. Gender differences seem to differ from community to community. Whereas in some study areas, the male sex seems to be more vulnerable for tungiasis, in other areas, the females are more prone to infestation, or no gender differences have been observed [21,28–32]. Thus, we speculate that gender differences are, similar to age, related to different exposure and disease-related behavior.

The use of proper footwear may decrease the prevalence in a community. According to our data, a consistent use of footwear would reduce infestation rates by about the half. However, economical, behavioural and cultural constraints may prohibit the intensive use of closed footwear in endemic communities in Western Africa.

Other socio-economic and behavioural factors found in this study, such as illiteracy, the type of water supply, and the use of soap, may be explained by an indirect relationship with tungiasis. For example, families with better access to water and using soap are prone to better hygiene standards. In addition, tungiasis can be regarded as a poverty-associated disease [1,19], and improving sanitation and waste collection have been discussed as factors to reduce the incidence of tungiasis [19]. However, the effectiveness of these measures is difficult to predict, and they are more costly than cementing floors of houses, confining pigs to pigpens, and realizing health education.

Similar to our results, the use of insecticides inside houses has been described as a protective factor in the Brazilian study. This

Table 1. Bivariate analysis of factors associated with tungiasis infestation.

	Examined n	Positive n (%)	OR (95% confidence interval)	*P* value
Socio-demographic factors				
Sex				
Female	258	111 (43.0)	Reference	
Male	299	141 (47.2)	1.18 (0.83–1.68)	0.35
Age group (years)				
≤14	329	198 (60.2)	9.00 (5.34–15.58)	<0.0001
15–39	153	22 (14.4)	Reference	
≥40	75	32 (42.7)	4.43 (2.22–8.88)	<0.0001
Religion				
Christian	445	203 (45.6)	Reference	
Muslim	75	36 (48.0)	1.10 (0.65–1.85)	0.71
None/other	37	13 (35.1)	0.65 (0.29–1.36)	0.23
Education				
Primary school completed	127	14 (11.0)	Reference	
Illiterate/Primary school not completed	430	238 (55.4)	10.00 (5.48–19.43)	<0.0001
Occupation				
School	380	203 (53.4)	2.77 (1.83–4.22)	<0.0001
Worker/employed	157	46 (29.3)	Reference	
Unemployed/Retiree	20	3 (15.0)	0.42 (0.07–1.58)	0.29
Housing and associated factors				
Distance to river (walking time)				
<15 min	199	92 (46.2)	1.06 (0.74–1.53)	0.79
≥15 min	358	160 (44.7)	Reference	
Type of house construction				
Bricks	414	150 (36.2)	Reference	
Adobe	123	83 (67.5)	3.65 (2.34–5.75)	<0.0001
Palm products	20	19 (95.0)	33.44 (5.18–1394.30)	<0.0001
Type of floor inside house				
Concrete	280	44 (15.7)	Reference	
Sand/Clay	277	208 (75.1)	16.17 (10.40–25.24)	<0.0001
Toilet				
Pit latrine/WC	194	61 (31.4)	Reference	
None	363	191 (52.6)	2.42 (1.65–3.56)	<0.0001
Water Supply				
Exclusively well/tank	185	34 (18.4)	Reference	
Well and river	268	133 (49.6)	4.38 (2.76–7.01)	<0.0001
Exclusively river	104	85 (81.7)	19.86 (10.25–38.99)	<0.0001
Waste disposal				
Burnt	98	29 (29.6)	Reference	
Disposed on compound	326	138 (42.3)	1.75 (1.05–2.95)	0.025
Disposed outside compound	133	85 (63.9)	4.21 (2.32–7.68)	<0.0001
Electricity				
Yes	373	138 (37.0)	Reference	
No	184	114 (61.9)	2.77 (1.90–4.06)	<0.0001
Animals on compound				
Pigs				
Yes	111	101 (91.0)	19.73 (9.87–43.43)	<0.0001
No	446	151 (33.9)	Reference	
Dogs				
Yes	106	61 (57.6)	1.85 (1.18–2.90)	0.007

Table 1. cont.

	Examined n	Positive n (%)	OR (95% confidence interval)	*P* value
No	451	191 (42.4)	Reference	
Cats				
Yes	57	34 (59.7)	1.91 (1.05–3.50)	0.025
No	500	218 (43.6)	Reference	
Goats and/or chickens				
Yes	273	117 (42.9)	0.83 (0.58–1.17)	0.27
No	284	135 (47.5)	Reference	
Knowledge. attitudes and practices				
Knowledge on possible causes of tungiasis				
Sand/animals	416	141 (33.9)	Reference	
Other/does not know	141	111 (78.7)	7.22 (4.51–11.73)	<0.0001
Use of closed footwear				
Regularly	318	87 (27.3)	Reference	
No/Occasionally	239	165 (69.0)	5.92 (4.03–8.71)	<0.0001
Resting place				
Inside the house	299	60 (20.1)	Reference	
Outside the house	258	192 (74.4)	11.58 (7.63–17.06)	<0.0001
Use of soap for bathing				
Yes	496	203 (40.9)	Reference	
No	61	49 (80.3)	5.89 (2.99–12.45)	<0.0001
Type of prevention used				
Commercialized insecticides	53	5 (9.4)	Reference	
Water/other/none	504	247 (49.0)	9.27 (3.59–30.10)	<0.0001
Method of treatment used				
Treatment by paramedical personnel	85	14 (16.5)	Reference	
Self-treatment*	326	203 (62.3)	8.36 (4.42–16.71)	<0.0001
None	146	35 (24.0)	1.6 (0.77–3.45)	0.24

*manipulation of lesions with non-sterile perforation instruments (such as needles. thorns). as well as application of hot oil. herbs etc.

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confirms further the notion of transmission indoors and also the need for *in vitro* studies on the effect of insecticides on pre-adult stages of *T. penetrans*.

The adjusted odds ratios and the population attributable fractions found in our study were very high for some variables. Although we have done an observational study, the strength of association, together with the biological plausibility of the discussed variables, increases the likelihood that the identified factors in fact have a causal relationship with tungiasis, even in the presence of unknown confounders. The identification of a limited number of obviously important factors helps to focus intervention measures on only a few variables which can be modified easily and

Table 2. Multivariate logistic regression analysis of factors associated with tungiasis.

	Adjusted OR (95% confidence interval)	*P* value
Presence of pigs on compound	17.98 (5.55–58.23)	<0.0001
Floor of sand or clay inside the house	9.33 (5.06–17.19)	<0.0001
Resting place outside house	7.14 (4.0–14.29)	<0.0001
Being ≤14 years or ≥40 years	5.02 (1.84–13.70)	0.002
Being illiterate/primary school not completed	4.16 (1.18–14.64)	0.026
Presence of cats on compound	4.16 (1.73–10.02)	0.001
Use of insecticides indoors	0.20 (0.05–0.83)	0.027
Use of soap for bathing	0.25 (0.08–0.77)	0.016
Use of water from well or tank	0.31 (0.16–0.59)	<0.0001
Regular use of footwear	0.34 (0.18–0.62)	<0.0001

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Table 3. Population attributable fractions of modifiable factors associated with tungiasis.

	Attributable risk	% exposed among cases	PAF
Floor of sand or clay inside the house	0,89	82.5	73.7
Common resting place outside house	0,86	76.2	65.5
Regular use of footwear	0,66	77.4	51.1
Presence of pigs on compound	0,94	40.1	37.9

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without elevated costs. For example, cementing the floors of those houses with sandy or clay floor in the community would reduce prevalence of tungiasis by almost 75%. In addition, this measure will reduce transmission on the long run without any additional costs for the next years. Similar, confining pigs to pigpens and explaining to community members the location of breeding sites and areas of high transmission would reduce considerably the prevalence in the community. As a spin-off, the discussed measures probably reduce also the transmission of other parasitic diseases, such as neurocysticercosis, ancylostomiasis and strongyloidiasis.

In conclusion, the presence of tungiasis in the community is associated to an important extent with a set of a few modifiable variables. Effective and sustainable intervention measures addressing these factors need to be implemented in the study area, and in other communities throughout West Africa, to reduce the burden of this neglected tropical disease. An integrated approach combining the control of animal reservoirs, housing and environmental factors, and health education is necessary. Intervention measures need to be designed by an interdisciplinary team together with the affected communities.

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Author Contributions

Conceived and designed the experiments: JH UU IEO. Performed the experiments: UU. Analyzed the data: JH UU LA. Contributed reagents/materials/analysis tools: JH. Wrote the paper: JH UU IEO LA.

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Original Article

Epidemiology and clinical aspects of tungiasis (sand flea infestation) in Alagoas State, Brazil

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Abstract

Background: Tungiasis (infestation with the sand flea *Tunga penetrans*) is common in resource-poor populations throughout Brazil. However, the epidemiological situation and the clinical aspects are not fully understood.

Methodology: To describe the prevalence and severity of tungiasis, associated pathology, as well as the seasonal variation in rural northeast Brazil, we performed two cross-sectional surveys: one in the rainy season, another in the dry season. Individuals were examined for the presence of tungiasis, number of lesions, symptoms and signs. In the rainy season, 88.6% (1,015/1,146), and in the dry season 91.1% (990/1,087) of the respective target populations were examined.

Results: The prevalence of tungiasis was 21.6% (95% confidence interval: 19.0-24.1) in the rainy season and 29.5% (26.6-32.3) in the dry season ($p<0.0001$). The highest prevalence was found in boys (5 – 14 years) in the dry season (48.3%; 40.6-56.0). Most lesions occurred on the feet (rainy season: 96.3%; dry season: 97.5%); a considerable number of individuals presented with lesions on the hands (6.9% and 5.1%, respectively). Common symptoms and signs were desquamation of the skin (57.5% in the rainy season; 44.5% in the dry season), hyperkeratosis (51.6% and 34.6%) and nail deformation (32.0% and 23.3%). Superinfection was present in 15.5% and 13.7% of cases, respectively. Severe pathology, such as deep fissures (10.5% and 9.3%), loss of toe-nails (5.5% and 2.4%) and difficulty walking (1.4% and 0.7%) occurred less commonly.

Conclusions: Tungiasis occurs to an important degree in Alagoas State, and prevalence and morbidity varies according to the season. Children were identified as a high-risk group.

Key Words: tungiasis, epidemiology, prevalence, morbidity, Brazil.

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Introduction

The tropical parasitic skin disease tungiasis is defined as an infestation with the sand flea *Tunga penetrans* (Linnaeus, 1758). The female flea penetrates into the epidermis and undergoes an extraordinary hypertrophy, eventually reaching the size of a pea.

Tungiasis is endemic in many communities in Latin America, from Mexico in the north to Argentina in the south, on several Caribbean islands, and in sub–Saharan Africa [1-7]. *T. penetrans* occurs in resource-poor communities in rural areas, in fishing villages along the coast, and in the slums of big cities. In poor communities in Brazil, Trinidad, Cameroon and Nigeria, prevalences ranged between 16% and 54% [4-6, 8-15]. In these settings the parasite load is high, and individuals harbour dozens or even hundreds of fleas [2,6,16].

Complications due to tungiasis are common in areas where constant re-infestation is the rule [1, 7,16]. Bacterial superinfection is often present [17]. Severe inflammation and deep fissures in the skin hinder individuals from walking normally. Sequels include deformation and loss of toenails, as well as deformation of digits [1,7,16]. Lesions may also be port of entry for *Clostridium tetani* [2,7,18,19].

In the State of Alagoas (northeast Brazil) anecdotal reports indicate the occurrence of tungiasis, but systematic studies assessing epidemiological and clinical characteristics have never been performed. To fill this gap, we performed a population-based study on tungiasis in a rural community in Alagoas.

Materials and Methods

Study Area and Population

Alagoas is the second smallest state of Brazil, situated in the northeast of the country, with a population of about 3 million. The economy of the state is based on agriculture, mainly sugar cane and coconut plantations, as well as fishing. The climate of Alagoas is tropical with intense rainfalls from April to August. During this period, 70% of the annual precipitation of 2,000 mm occurs. The average daily temperature is 26.6℃ in the dry season and 25.1℃ in the rainy season.

The study was carried out in Feliz Deserto, a typical village situated approximately 120 km south of Maceió, the capital of Alagoas. It is located at the coast and has a total population of 3,850 inhabitants.

The study area was defined as those districts of Feliz Deserto, where tungiasis commonly had occurred in the past (according to local health personnel, community leaders, and our own observations). A cohort of 1,250 individuals, about one third of the total population of the municipality, was involved in the study. Living conditions in these districts were more precarious than in the other areas of town.

Study Design

Two cross-sectional surveys were done: all households in the study area were visited in June/July 2003 (rainy season), and a second time in October/November 2003 (dry season). To be included in the study, individuals were required to spend at least four nights per week in a household in the study area. Anyone refusing to take part in the study was excluded. Individuals moving into the study area between the surveys were registered and took part in the second survey.

All household members were examined clinically for the presence of tungiasis. Numbers of lesions and associated pathology were documented on standardized questionnaires. Additionally, household members were interviewed to obtain socio-demographic and clinical data. If a household member was absent, the household was revisited three times. For some household members an appointment was made at work or at home. Each survey was carried out within a period of two months.

To reduce inter-observer bias, all clinical examinations were carried out by one investigator (A.J.).

Clinical Examination and Questionnaires

For the clinical examination, the head of the household was asked for a room with good light and in which privacy was guaranteed. In this room, the body was thoroughly examined for the presence of tungiasis.

Tungiasis was diagnosed if at least one embedded sand flea was present. Lesions were classified according to the Fortaleza classification [20]: a penetrating flea (stage I); an itching, reddish-brown spot with a diameter of one to three mm indicating the complete penetration of the flea into the epidermis (stage II); and a circular lesion presenting as a white patch with a central black dot and a diameter of four to ten mm indicating the maturity of the egg-expelling flea (stage III) are defined as viable lesions. Lesions with a black crust surrounded by necrotic tissue (stage IV), as well as partially or totally removed fleas leaving a characteristic sore in the skin are defined as nonviable tungiasis, i.e. the parasite is dead.

Lesions were counted and the topographic localization was documented on a visual record sheet.

According to Muehlen et al. [21] and Ugbomoiko et al. [22], a mild infestation was defined as the presence of 1 to 5, a moderate infestation as the presence of 6 to 30, and heavy infestation as the presence of >30 lesions.

Symptoms and signs associated with acute or chronic tungiasis were noted as previously defined [23]. Superinfection was diagnosed when pustules or suppuration were present. Socio-demographic data were assessed using pre-tested structured questionnaires.

Data Entry and Statistical Analysis

Data were entered twice into a database using the Epi Info software package (version 6.04d; Centers for Disease Control and Prevention, Atlanta, USA) and checked for entry errors. Then, data were transferred to Stata® software package (version 9.0; Stata Corporation, College Station, USA) for analysis. The Fisher's exact test was applied to determine the significance of differences of relative frequencies. As data were not normally distributed, the median and the interquartile ranges were used to indicate the average and the dispersion of data. Significance of differences between quantitative measurements was calculated by the Mann-Whitney test.

Ethical Aspects

Ethical clearance was obtained from the Ethical Committee of the School of Health Sciences of Alagoas (Escola de Ciências Médicas de Alagoas), the responsible ethical body in Alagoas State, as well as from an ad hoc ethical committee of the health department of the municipality of Feliz Deserto. Prior to the study, meetings were held with politicians, community leaders, and health care workers to explain the objectives of the study. All participants were informed about the study and gave their written consent. In the case of minors, the legal guardians were asked for written consent. Superinfected lesions were treated with topical antibiotic ointment or oral Roxithromycin (Floxid®, two doses of 150 mg over 5 days, Solvay Farma, São Paulo, Brazil). If other skin diseases were diagnosed during the surveys, the patients were referred to the primary health care centre of Feliz Deserto, where treatment is available free of charge.

Results

In the first survey in the rainy season (June/July 2003), 1,015 individuals of the target population of 1,146 (88.6%) were encountered and examined. During the second survey in the dry season (October/November 2003), 990 of 1,169 (91.1%) individuals were examined.

The overall prevalence of tungiasis was 21.6% in the rainy and 29.5% in the dry season ($p<0.0001$; Table 1). In both surveys, prevalence was highest in the children and decreased abruptly in the age groups ≥ 15 years. In the dry season, prevalence reached up to 40% in children between five and 14 years of age. Prevalence was already very high in children <5 years (Table 1).

The increasing prevalence in the dry season was most obvious in the adult age groups (20 to 39 and 40 to 59 years). In these age groups the prevalence of tungiasis doubled, as compared to the rainy season (Table 1). In contrast, in children <15 years, who were in general more affected, the relative increase in the dry season was less pronounced.

In both surveys, the overall prevalence of tungiasis was higher in males (rainy season: 23.5%; dry season: 32.2%), as compared to females (20.0% and 27.2%), but the difference was not statistically significant ($p=0.19$ and $p=0.09$, respectively).

Figure 1 depicts the prevalence by age groups and sex for the rainy and the dry season. Age-specific prevalence patterns are similar in both surveys, with higher prevalence in the dry season in almost all age groups. The highest prevalence was found in boys (5 to 14 years) in the dry season (48.3%; 95% confidence interval: 40.6-56.0; Figure 1). The age-specific prevalence followed an S-shaped curve. This pattern was most prominent when prevalence was highest, i.e. in the dry season.

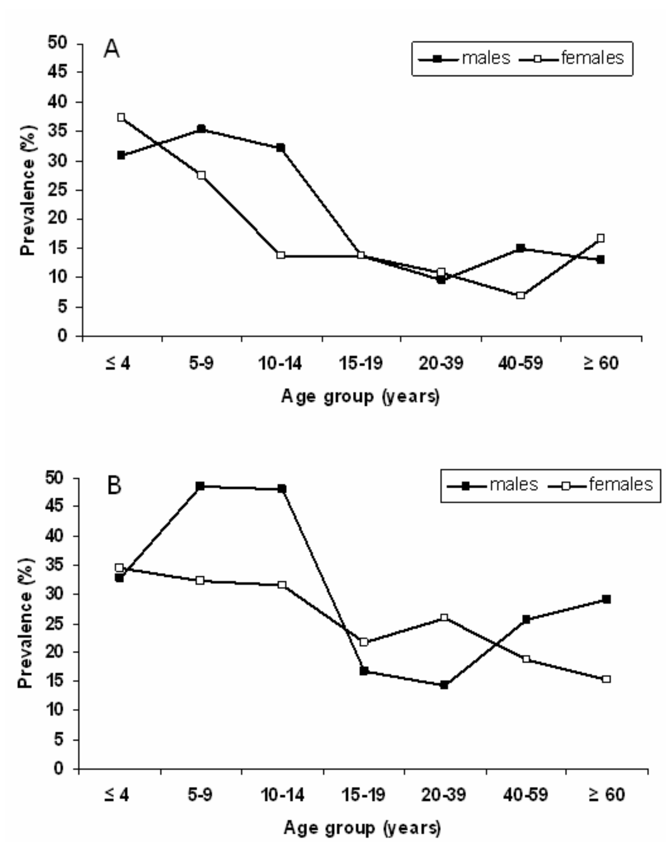

Figure 1. Prevalence of tungiasis, stratified by age group and sex. A. rainy season. B. dry season.

In total, 656 lesions were counted in 219 individuals during the rainy season, and 1,067 lesions on 292 individuals during the dry season. The median number of lesions was two in both surveys, with no statistical difference (p=0.5). The mean number of lesions in the rainy season was 2.99, and in the dry season 3.65 per case. A maximum of 42 lesions per individual was counted in the rainy season, and of 45 lesions in the dry season.

Table 1. Prevalence of tungiasis in the study area, stratified by age group and season.

Age group (y)	Rainy season (June/July) n positive	Rainy season % (95% CI)	Dry season (October/November) n positive	Dry season % (95% CI)	p value
0 – 4	53/154	34.4 (26.9–42.5)	51/151	33.8 (26.3–41.9)	1.0
5 – 9	61/194	31.4 (25.0–38.5)	78/193	40.4 (33.4–47.7)	0.07
10 – 14	47/154	30.5 (23.4–38.4)	58/145	40.0 (31.9–48.5)	0.09
15 – 19	13/95	13.7 (7.5–22.3)	17/88	19.3 (11.7–29.1)	0.3
20 – 39	26/252	10.3 (6.9–14.8)	51/241	21.2 (16.2–26.9)	0.001
40 – 59	12/119	10.1 (5.3–16.9)	26/122	21.3 (14.4–29.6)	0.02
≥ 60	7/47	14.9 (6.2–28.3)	11/50	22.0 (11.5–36.0)	0.4
Total	219/1015	21.6 (19.0–24.1)	292/990	29.5 (26.6–32.3)	<0.0001

Table 2. Topographic distribution of embedded sand fleas.

Topographic site	Rainy season (n = 219) Number of lesions (%)	Rainy season % of individuals with tungiasis†	Dry season (n = 292) Number of lesions (%)	Dry season % of individuals with tungiasis†
Feet:				
Toes without periungual sites	221 (33.7)	51.1	390 (36.6)	50.7
Toes periungual	302 (46.0)	69.4	539 (50.5)	70.6
Soles/plantar	93 (14.2)	18.3	96 (9.0)	14.4
Heels	15 (2.3)	3.7	13 (1.2)	3.8
Other	1 (0.2)	0.5	2 (0.2)	0.7
Ectopic sites:				
Hands	22 (3.4)	6.9	25 (2.3)	5.1
Other	2 (0.3)	0.9	2 (0.2)	0.7
All sites	656 (100)	100	1067 (100)	100

† Lesions occurred on more than one site.

In the rainy season 190/219 (86.8%), and in the dry season 246/292 (84.2%) individuals with tungiasis had a mild infestation (1–5 embedded sand fleas). Only one (0.5%) individual in the rainy and five (1.7%) in the dry season were heavily infested (>30 lesions). Interestingly, the only individual in the rainy season with heavy infestation, representing about 1/200 of the cases with tungiasis, had 42 lesions and thus was responsible for 6.4% of all lesions in the study population. In the dry season, the five most heavily infested individuals, despite representing less than 2% of the infested population, harboured 17.3% of the total parasite load in the community.

Table 3. Tungiasis-associated symptoms and signs.

Clinical feature	Rainy season (n = 219) n	Rainy season %	Dry season (n = 292) N	Dry season %
Desquamation of skin	126	57.5	130	44.5
Hyperkeratosis	113	51.6	101	34.6
Nail deformation	70	32.0	68	23.3
Sleep disturbance due to itching	64	29.2	61	20.9
Secondary infection	34	15.5	40	13.7
Oedema	27	12.3	20	6.9
Erythema	27	12.3	22	7.5
Pain upon pressure	27	12.3	34	11.6
Fissure	23	10.5	27	9.3
Constant pain	20	9.1	20	6.9
Ulcer	14	6.4	9	3.1
Loss of toe-nail(s)	12	5.5	7	2.4
Inguinal lymphadenopathy	8	3.7	24	8.2
Difficulty walking	3	1.4	2	0.7
Deformation of digits	2	0.9	5	1.7

Most lesions occurred on the feet (rainy season: 96.3%; dry season: 97.5%). However, a considerable number of individuals presented with lesions on the hands (Table 2). About 70% of infested individuals had periungual lesions, and 50% on the toes on topographic areas other than periungual.

The most common clinical signs in individuals with tungiasis were desquamation of skin and hyperkeratosis. Deformation of nails was also very common (Table 3). About 15% of cases showed signs of superinfection. Severe pathology, such as deep fissures, and difficulty walking was also common. Interestingly, 67% of the individuals stated that they felt the flea penetrating into the skin.

Discussion

Our data show that tungiasis is prevalent in the rural community under study, and that prevalence varies according to the season. Children were identified as a high-risk group. The prevalence of tungiasis encountered in Feliz Deserto (22% in the rainy season, 30% in the dry season) was impressively high, although considerably lower as compared to other studies in impoverished communities. For example, in population-based studies in rural Brazil and Nigeria, prevalences of 51% and 45% were found [6,9]. In an urban slum in Brazil, prevalence in the peak dry season was as high as 54% [24]. Njeumi et al. (2002) reported about 50% of school children to be infested in different communities in Cameroon [14].

The relatively low prevalence found in our study may have different reasons. Housing was much better than in the other impoverished communities studied: in Feliz Deserto all houses had access to piped water, and most had cemented floors. A sandy floor inside the house is known as a major risk factor for the presence of tungiasis and severity of infestation [21,22]. In Feliz Deserto, pigs were rare and not allowed to roam freely within the community - free-roaming pigs were common in a Nigerian community with a high prevalence and contributed to an important degree to transmission [22]. Since waste collection was performed daily, there was little waste littering the inhabited area, reducing the number of rats serving as an animal reservoir [25].

In Feliz Deserto the most severely affected age groups were children < 15 years of age, irrespective of the season. This seems to be a characteristic finding pertaining to many endemic areas [4-6,8-10,26]. Tungiasis has to be considered mainly a disease of the childhood.

The S-shaped age-specific distribution with peak prevalences in children and the elderly was less pronounced in Feliz Deserto than in other endemic communities [6,9,15]. Particularly, the increase of prevalence in the elderly was less accentuated. However, when age-related prevalences were stratified into males and females a peculiar pattern emerged: whereas prevalence in females decreased constantly with increasing age, in males the S-shaped curve was very clear.

The increased prevalence in the elderly male indicates that acquired immunity against *T. penetrans* is unlikely to develop. Re-increasing prevalences in elder male age groups are likely due to differences in exposure between men and women. In Feliz Deserto, adult men frequently work outside the endemic area during the day and commonly use closed shoes during work. In contrast, elderly males are usually retired, stay the whole day in the community, walk barefooted, and put their bare feet on the ground when sitting and chatting. Alternatively, they may care less about penetrated fleas, while elder women tend to take out sand fleas as soon as they perceive a penetrated flea.

In our study, the prevalence of tungiasis was slightly higher in the male sex in both surveys. Apparently, the pattern of occurrence of tungiasis in males and females differs from community to community. For example, Carvalho et al. (2003) observed significantly more females than males affected in a resource-poor community in South Brazil [5]. No difference in the prevalence between males and females was found in a rural community in Lagos State in Nigeria, and in a fishing community in Ceará State, Brazil [6,9]. In contrast, authors from Brazil, Trinidad, and Nigeria found that males were predominantly affected [4,8,10,26]. In a longitudinal study in an urban slum, tungiasis was consistently more common in the male sex during a study period of 12 months [24].

The parasite load and the maximum number of lesions found in Feliz Deserto were rather low (mean < 4 in both surveys). In a fishing community in Brazil, the mean parasite load was 8.9 [9], in a rural community in Nigeria 12.3 [6], in an urban slum in Ceará State 7.8 [10], and in several communities in Trinidad 8.0 [4]. In the latter two studies, prevalence was comparable to Feliz Deserto with 34% and 21%, respectively. Thus the hypothesis formulated previously that prevalence and intensity of infestation are positively related did not hold true for Feliz Deserto [9]. As it is

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known that a high exposure is correlated with a high parasite load [27], we assume that in Feliz Deserto exposure and transmission rates are low, as compared to the other endemic communities studied.

Parasite load was disproportionately distributed with only few individuals harbouring a high number of lesions, whereas the majority had only one or two embedded sand fleas. In the dry season, only five individuals were responsible for 17% of the total parasite load in the community. Similar patterns have been observed previously [6, 9,11,15]. For example, in a fishing community, 8% of infested individuals accounted for 55% of the total parasite load in the community [9]. The rather few severely infested individuals may contribute disproportionately to the excretion of eggs by embedded sand fleas and therefore are responsible for maintaining transmission dynamics at a high level. Thus, identifying the most severely infested individuals in a community and focusing control on their households could be an efficient way to reduce transmission rates, as well as the degree of morbidity in an endemic area.

In our study, the topographic distribution of sand flea lesions was similar to other previously published studies [6,9]: about 70% of individuals presented with lesions on periungual sites of the feet. Less than 5% of lesions occurred on ectopic sites, i.e. other topographic areas than the feet. The topographic distribution did not vary considerably between rainy and dry season, indicating that sand fleas prefer certain predilection sites, irrespective of environmental conditions. The number of ectopic lesions was lower, as compared to communities with higher prevalences in the general population. In these populations, lesions occurred on sites other than the feet in about 10% of cases [6,9]. As ectopic tungiasis is more common in individuals with a high parasite load [28], and because on the population level intensity of infestation is positively related to the prevalence, the occurrence of ectopic lesions could be used as a predictor for the prevalence of tungiasis in a community. As ectopic lesions, e.g. on the hands, are easily diagnosed, the presence of ectopic sand fleas may be useful as a rapid assessment method.

In the study area, nail deformations were frequent. Nail deformation is the consequence of repeated infestation with or without secondary infection. Nail deformation occurred in about 27% of cases. Severe sequels, such as difficulty walking and deformation of digits due to severe infestation existed, but were less common. This confirms the notion that tungiasis cannot be regarded as nuisance, but as an important health problem [6,16,29]. In Haiti, deaths were reported as a result of severe infestations, probably due to septicaemia and tetanus [7]. In rural Nigeria, difficulty walking occurred in 32%, deformation of toe-nails in 27%, and loss of toe-nails in 16% of the patients [6]. Between 20% and 29% of individuals infested with tungiasis stated that they woke up at night due to itching at the site of penetration. Itching has been repeatedly described as a predominant symptom of tungiasis [6,29,30]. However, other parasitic skin diseases, such as cutaneous larva migrans and scabies, are endemic in the study area [31,32], and polyparasitism may have occurred. Thus it is possible that these diseases also caused sleep disturbances in some individuals with tungiasis.

Our data show that the prevalence of tungiasis was significantly higher in the dry than in the rainy season. The difference was less pronounced than the seasonal variation observed in the only longitudinal study published so far [24]. Similar to our findings, in the latter study the highest prevalence was found in an urban slum in Brazil in the middle of the dry season. Prevalence differed by more than a factor three throughout the year (54% vs. 17%), and was clearly correlated to precipitation patterns [24]. Interestingly, in our study, in adults aged 20 to 59 years prevalence was twice as high in the dry season, as compared to the rainy season. This indicates that attack rates actually increased in the dry season. Seasonal variation of attack rates and incidence probably is caused by biological dynamics of the sand flea population, reflecting changes of environmental variables. During the rainy season, high soil humidity may impair the development of free-living stages of sand fleas, and heavy precipitations will wash away eggs, larvae, pupae, and adult stages from the area where they developed [24].

The varying incidence of *T. penetrans* during the year is a good explanation for the highly diverging prevalences observed in previous population-based studies. In fact, studies were performed in different seasons, and sometimes over a prolonged period of the year; and often period rather than point prevalences were assessed [4-6,8,9,11-15,33]. In the present study, each survey lasted about two months. Thus, we cannot exclude that the attack rate may have changed over time and that prevalences calculated are not true point prevalences. However, even if this error occurred, it should be irrelevant, as climate conditions did not change during each survey.

In the present study, we reduced participation bias by organizing meetings with the community members before starting the study. During field work, all individuals were invited to present at the health care centre, if they were not encountered at home, and households were visited three times. Households were visited also on weekends to increase the participation of working males. However, non-participation of these groups was still an issue. We excluded inter-observer bias, as only one investigator realized all clinical examinations in both surveys. Intra-individual bias was reduced by doing clinical pilot studies before the survey, and by rigorously defining the clinical criteria of tungiasis.

In conclusion, our study shows that tungiasis is common in a typical resource-poor community in Alagoas State, and that prevalence varies according to the season. The most vulnerable group was children. Tungiasis was associated with considerable morbidity. Few individuals contributed disproportionately to the total parasite load of the community and could be a good target for interventions.

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9.3 – ARTIGOS PUBLICADOS: LINHA DE PESQUISA

A simple approach improving the performance of urine reagent strips for rapid diagnosis of urinary schistosomiasis in Nigerian schoolchildren

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In Nigeria, schistosomiasis, caused predominantly by the species Schistosoma haematobium, *is highly endemic in resource-poor communities. We performed a school-based survey in two rural communities in Osun State (Southwestern Nigeria) and assessed macrohaematuria, microhaematuria and proteinuria as indirect indicators for the presence of disease. Urine samples were inspected macroscopically for haematuria and screened for microhaematuria and proteinuria using urine reagent strips. The microscopic examination of schistosome eggs was used as the gold standard for diagnosis. In total, 447 schoolchildren were included in this study and had a 51% prevalence of urinary schistosomiasis. The sensitivity of microhaematuria (68%) and proteinuria (53%) for infection with* S. haematobium *was relatively low. In patients with a heavy infection (≥ 500 eggs/10 mL), the sensitivity of microhaematuria was high (95%). When the presence of macrohaematuria and the concomitant presence of microhaematuria and proteinuria were combined, it revealed a sensitivity of 63%, a specificity of 93% and a positive predictive value of 91%. Macrohaematuria also showed high specificity (96%) and a positive predictive value of 92%, while sensitivity was < 50%. These data show that combining urine reagent strip tests (presence of proteinuria and microhaematuria) and information on macrohaematuria increased the accuracy of the rapid diagnosis of urinary schistosomiasis in an endemic rural West African setting. This simple approach can be used to increase the quality of monitoring of schistosomiasis in schoolchildren.*

Key words: urinary schistosomiasis - urine reagent strips - prevalence - rapid assessment - Nigeria

There are an estimated 200 million people infected with schistosomiasis throughout the world, and this disease is responsible for the loss of approximately 1.5 million DALYs/year (Chitsulo et al. 2000, Gryseels et al. 2006, Mathers et al. 2007). In sub-Saharan Africa, up to 280,000 annual deaths have been attributed to schistosomiasis (Gryseels et al. 2006). Urinary schistosomiasis remains an intractable parasitic disease, associated with populations living in poverty in sub-Saharan Africa and it has placed an enormous toll on the health sectors of affected countries (Chitsulo et al. 2000, Gryseels et al. 2006).

In all the geographical zones of Nigeria, there has been an unprecedented increase in disease prevalence in recent years, which is associated with the poor management of water resource schemes (Ofoezie & Asaolu 1997, Ofoezie 2002, Mafiana et al. 2003). The predominant species in this country is *Schistosoma haematobium,* which most commonly presents with haematuria, suprapubic pain and pain while urinating (Okoli & Iwuala 2004).

The Nigerian Schistosomiasis Control Programme has advocated mass administration of praziquantel, particularly in high risk areas, in order to reduce morbidity (WHO 2002). School-aged children are particularly vulnerable to infection and severe disease and are thus the focus of the Control Programme. However, to be effective, control strategies in resource-poor settings require rapid and accurate identification of disease, monitoring of populations at risk, adequate treatment and quantification of infection rates using limited economic and human resources (Mafe et al. 2000, French et al. 2007).

Since urinary schistosomiasis is a common cause of blood in the urine of people living in endemic areas, the presence of haematuria is commonly used as a rapid assessment method for identifying infected individuals and communities at risk.

In the present school-based study, we report the prevalence and intensity of urinary schistosomiasis in two Nigerian rural communities. To improve the rapid assessment of schistosomiasis in this setting, we assessed macrohaematuria, microhaematuria and proteinuria as

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indirect disease markers and described diagnostic performances based on these individual markers and their combinations.

MATERIALS AND METHODS

A survey was conducted in the four schools of the Ilobu and Erin-Osun communities, which consist of two contiguous villages with similar socio-economic and cultural characteristics in the Osun State of Southwestern Nigeria. The detailed characteristics of these communities have previously been described (Ugbomoiko et al. 2009, unpublished observations). Briefly, both communities border the Erinle Dam, which was constructed in the 1990s and is used principally for flood control, fishing and as a water supply. The communities are provided with primary and secondary schools, health centres and functional boreholes. The approximately 5,000 inhabitants of both communities are predominantly subsistence farmers and petty traders of the Yoruba ethnic group.

All schoolchildren, from both primary and secondary schools, were eligible for this study. After giving consent, the participants received pre-labelled screw-capped plastic containers for urine collection. To avoid false positive results, girls of child-bearing age who had menstruated within five days before sample collection were excluded from analysis. The freshly passed mid-day urine samples (collected between 10-14 h) were inspected macroscopically for gross haematuria and then screened for microhaematuria and proteinuria using commercially available urine reagent strips (medi-Test Combi 9, Analyticon Biotechnologies, Germany). The strip testing was performed in accordance with the manufacturer's instructions. The specimens were then transported to the laboratory within 4 h of collection and processed for microscopic examination of schistosome eggs.

Processing and egg counting followed the syringe filtration technique, which we considered the gold standard for diagnosis of schistosomiasis (Guyatt et al. 1999, WHO 1983, Lengeler et al. 1993). Two subsamples of 10 mL were drawn into plastic syringes from each well-mixed sample and strained through a nylon filter. The filter was then examined under the microscope, and *S. haematobium* eggs were counted.

Data were entered into an Excel spreadsheet, checked for entry errors and transferred into SPSS for Windows (version 11.0, SPSS Inc, Chicago, USA) for analysis. The sensitivity (number of individuals with a positive rapid test/individuals with a positive reference test), specificity (number of individuals with a negative rapid test/individuals with a negative reference test), the negative predictive value (probability that an individual with a negative rapid test is, in fact, free from disease) and the positive predictive value (probability that an individual with a positive rapid test is, in fact, diseased) were calculated for different combinations of rapid tests, as compared to the gold standard. Chi-square and ANOVA tests were applied to compare relative frequencies and the arithmetic means of egg counts between groups, respectively.

Ethics - At the time of this study, a formal ethical committee in state of Osun did not exist. Permission to perform this study was obtained from the local governments, community leaders and school heads. Informed consent was obtained from the study participants and their parents after a detailed explanation of the objectives of the study. All infected schoolchildren were referred to medical personal in the Area Office for praziquantel treatment.

RESULTS

In total, 447 schoolchildren and pre-schoolchildren were included in this study. Among the participants, 248 (56%) were male and the median age was 11 years (interquartile range: 9-13 years; range: 3-17 years). Prevalence and intensity of urinary schistosomiasis are depicted in Table I. The prevalence was significantly higher in Ilobu village. In boys, prevalence of infection was significantly higher than in girls and the mean egg count was approximately twice as high; however, the difference was not statistically significant (Table I). The prevalence increased significantly with age and showed a peak in participants who were ≥ 15 year-olds, with 78% of individuals infected.

Table II depicts the sensitivity, stratified by intensity of infection, of macrohaematuria, microhaematuria, proteinuria and their combinations in the diagnosis of urinary schistosomiasis. In general, sensitivities were low, but increased with severity of infection. In almost all patients presenting with heavy infection (95%), microhaematuria was observed. In contrast, macrohaematuria was detected in only 45% of the total of patients with schistosomiasis (Table II). Considering the rapid assessment as positive in the presence of macrohaematuria or, alternatively, in the presence of concomitant microhaematuria and proteinuria, an overall sensitivity of 63% and of 90% in heavy infections was revealed.

In Table III, the diagnostic performance values of the indicators macrohaematuria, microhaematuria, proteinuria and their different combinations are given using the presence of eggs in urine as the gold standard for diagnosis. The highest overall sensitivity was found for microhaematuria (68%), with a specificity of 83%. However, the specificity was highest (96%) when the concomitant presence of microhaematuria and proteinuria was used as an infection marker. Macrohaematuria also showed a very high specificity and positive predictive value (96% and 92%, respectively), but sensitivity was less than 50% (Table III). To combine the benefits of all diagnostic approaches, we assessed the accuracy of the concomitant presence of macrohaematuria or the presence of microhaematuria and proteinuria. This improved sensitivity to 63% while maintaining a high specificity of 93% (Table III) and it indicates that there were 37% false negative and 7% false positive results. In contrast, using a rapid test based merely on the presence of microhaematuria and proteinuria, or on the presence of macrohaematuria, resulted in a proportion of false negative results as high as 62% and 55%, respectively.

DISCUSSION

Our data show that combining indirect disease marker information obtained from both urine reagent strip tests and presence of macrohaematuria increased the accuracy of rapid diagnosis of urinary schistosomiasis in schoolchildren of two highly endemic rural communities in Nigeria.

When the macrohaematuria information was combined with data from urine reagent strips, a high positive predictive value was maintained with the benefit of an increased negative predictive value (the probability of children with a negative test being disease-free). Thus, this approach can be considered a cost-effective measure for increasing the quality of data on schistosomiasis infection in schoolchildren located in highly endemic communities.

With this approach, the positive predictive value of 91% (the probability of schistosomiasis among children with a positive test) was high and similar to the positive predictive value of macrohaematuria (92%). This indicates that almost all schoolchildren with positive rapid tests were, in fact, infected. However, since the predictive values depend on the prevalence of disease and intensity of infection, in low endemic settings the positive predictive value may be different. The negative predictive value of 63% indicates that the probability of schoolchildren having the disease, in the absence of macrohaematuria, is 37%. This probability was reduced to 29% when using our combined approach, but it is still high and should be taken into account when planning mass drug administration and monitoring intervention measures.

Previously, other authors have combined data on haematuria and proteinuria, improving the diagnostic performance of disease markers (Feldmeier et al. 1982, Mott et al. 1983). However, these authors did not integrate information gathered from reagent strips and on macrohaematuria. Our data further confirm previous studies on the diagnostic performance of microhaematuria and macrohaematuria, when compared to urine egg count as the gold standard (Mott et al. 1983, Eltoum et al. 1992, Lengeler et al. 1993, Mafe 1997, Guyatt et al. 1999). Haematuria and proteinuria have been widely used as indicators for urinary schistosomiasis since the 1980s and usually microhaematuria is considered more sensitive and specific than proteinuria (Mott et al. 1983, 1985, Murare & Taylor 1987, Taylor et al. 1990, Eltoum et al. 1992). Similar to our data, Mafe (1997) described sensitivity (69%) and specificity (80%) of microhaematuria for the diagnosis of schistosomiasis in Nigeria, albeit in the general population. In that study, the diagnostic performance of macrohaematuria was comparable to our results (Mafe 1997). French et al. (2007) observed, in a longitudinal study of schoolchildren from Zanzibar, consistently higher sensitivity (≥ 77%) and specificity (≥ 97%) of microhaematuria. Besides regional differences, the increased accuracy in this study may also be explained by the varying quality of reagent strips from different producers. Interestingly, the diagnostic values from the Zanzibar study remained relatively stable during various assessments, even when the prevalence was reduced during a control programme (French et al. 2007).

The presence of visible blood in urine (macrohaematuria) in settings without the availability of urine reagent strips is used as a specific rapid diagnostic marker for *S. haematobium* infection (Red Urine Study Group 1995, Mafe 1997, Ofoezie et al. 1997, Mafe et al. 2000, Anosike et al. 2001, Lengeler et al. 2002). Therefore, the almost 100% specificity found in our study was not a surprise. However, most of those studies were performed on a limited number of schoolchildren, and the accuracy of the results was influenced by prevalence, age and sex (Mott et al. 1983, Ansell et al. 1997, Guyatt et al. 1999).

TABLE I
Prevalence and intensity of infection of urinary schistosomiasis in schoolchildren of two endemic communities in Nigeria (n = 447)

	Positive/total n	Prevalence (95% confidence interval) %	Mean (± SD) egg count/10mL urine
Villages			
Erin-Osun	114/246	46.3 (39.9-52.8)	107.05 ± 476.09
Ilobu	113/201	56.2 (49.1-63.2)	138.78 ± 336.35
p-value		0.038	0.426
Sex			
Male	141/248	56.9 (50.4-63.1)	155.06 ± 503.38
Female	86/199	43.2 (36.2-50.4)	76.26 ± 275.69
p-value		0.004	0.057
Age group (years)			
1-4	4/11	36.4 (10.9-69.2)	2.27 ± 4.78
5-9	45/137	32.8 (25.1-41.4)	53.74 ± 206.69
10-14	147/259	56.8 (50.5-62.9)	142.25 ± 487.16
15-17	31/40	77.5 (61.5-89.2)	249.98 ± 498.05
p-value		< 0.001	0.030
Total	227/447	50.8 (46.0-55.5)	121.32 ± 418.92

TABLE II

Sensitivity of macrohaematuria, microhaematuria and proteinuria and their combinations for the diagnosis of schistosomiasis, as compared to the presence of eggs in urine, stratified by intensity of infection

	Rapid assessment method				
Intensity of infection (eggs/10 mL)	Presence of microhaematuria[a] n (%)	Presence of proteinuria[a] n (%)	Presence of both microhaematuria[a] and proteinuria[a] n (%)	Presence of macrohaematuria n (%)	Presence of microhaematuria[a] and proteinuria[a] or macrohaematuria n (%)
Light (1-50): n = 136	74 (54.4)	62 (45.6)	35 (25.7)	53 (39.0)	72 (52.9)
Moderate (51-499): n = 53	45 (84.9)	32 (60.4)	25 (47.2)	22 (41.5)	37 (69.8)
Heavy (≥ 500): n = 38	36 (94.7)	27 (71.1)	26 (68.4)	28 (73.7)	34 (89.5)
Total: n = 227	155 (68.3)	121 (53.3)	86 (37.9)	103 (45.4)	143 (63.0)

a: values expressed as + 1 to + 3 positivity levels.

TABLE III

Sensitivity, specificity and predictive values of macrohaematuria, microhaematuria, proteinuria and their combinations for the diagnosis of schistosomiasis, as compared to the presence of eggs in urine (n = 447)

	Rapid assessment method				
	Presence of microhaematuria[a] (95% confidence interval) %	Presence of proteinuria[a] (95% confidence interval) %	Presence of microhaematuria[a] and proteinuria[a] (95% confidence interval) %	Presence of macrohaematuria (95% confidence interval) %	Presence of microhaematuria[a] and proteinuria[a] or macrohaematuria (95% confidenceinterval) %
Sensitivity	68.3 (61.8-74.3)	53.3 (46.6-59.9)	37.9 (31.6-44.5)	45.4 (38.8-52.1)	63.0 (54.4-69.3)
Specificity	83.2 (77.6-87.8)	79.6 (73.6-84.7)	96.4 (92.9-98.4)	95.9 (92.4-98.1)	93.2 (89.0-96.1)
Positive predictive value	80.7 (74.4-86.1)	72.9 (65.5-79.5)	91.5 (83.9-96.3)	91.9 (85.3-96.3)	90.5 (84.8-94.6)
Negative predictive value	71.8 (65.8-77.2)	62.3 (56.3-76.9)	60.1 (54.7-65.2)	62.9 (57.6-68.2)	70.9 (65.3-76.1)

a: values expressed as + 1 to + 3 positivity levels.

In addition, the sensitivity of macrohaematuria is usually low, but may increase in the presence of heavy infection (Taylor et al. 1990, Mafe 1997), as also shown in our study. Haematuria can be seen as a sign of tissue damage occurring principally in severe infections. Thus, in extremely resource-poor settings, where no urine reagent strips are available, the mere presence of macrohaematuria may be used as an indicator for infection and to detect the most severely infected individuals.

Macrohaematuria may also be assessed using questionnaires, which generally have an acceptable diagnostic performance (Lengeler et al. 2002). However, the specificity and/or sensitivity of questionnaire-based approaches vary among studies and socio-cultural settings and the accuracy of this approach was low in several cases (Guyatt et al. 1999, Poggensee et al. 2000, Lengeler et al. 2002, Stothard et al. 2002).

The present study further revealed a high rate of *S. haematobium* transmission in the rural population around the Erinle Dam in Southwestern Nigeria. The overall prevalence of schistosomiasis in schoolchildren (51%) was about four times higher than the previously estimated prevalence in Nigeria's general population (13%) (Oladejo & Ofoezie 2006). A recently conducted study in two rural communities in the same area reported a similar prevalence of 47% (Oladejo & Ofoezie 2006), indicating that infection has remained unabated in this and, most likely, other dam regions of Nigeria. Age and sex-related prevalence and the intensity of infection in the present study were similar to those reported from other West African endemic foci (Okoli & Odaibo 1999, Mafe et al. 2000, Okoli & Iwuala 2004, Oladejo & Ofoezie 2006).

Our study is subject to several limitations. First, the survey only included schoolchildren and as such, data cannot be inferred to the general population. It is known that the diagnostic performance of haematuria and proteinuria decreases with increasing age, but it is usually stable in children and teenagers (Mott et al. 1983, Mafe 1997). However, combining reagent strips with the macrohaematuria observations will probably increase the diagnostic accuracy when applied to the general population. Secondly, the results may only be valid in settings with a high prevalence of schistosomiasis. In areas with a lower prevalence and where infection intensity is consequently lower, diagnostic performance may be less reliable (Hammad et al. 1997). However, another study has shown that rapid assessment using reagent strips may not vary considerably, even when prevalence is decreased (French et al. 2007). An additional shortcoming of our study is its cross-sectional nature: we did not assess day-to-day variation of egg excretion or haematuria, which may have influenced diagnostic performance. In fact, the accuracy of macrohaematuria, as an indicator for infection, may be better when considering day-to-day variations (Savioli et al. 1990). When the assessment of macrohaematuria is repeated several times during a period of a few days, the accuracy of this indicator is expected to increase.

It can be concluded that new strategies are needed to improve the control and monitoring of urinary schistosomiasis in Nigerian dam areas and in other countries with highly endemic areas. These approaches should be validated by performing studies in other African schools in the endemic areas. If urine reagent strips are available, a combined approach of directly observing macrohaematuria and the concomitant presence of proteinuria and microhaematuria may improve the performance of rapid diagnosis. In resource-poor populations, the proposed approach is feasible since no additional costs and minimal logistic efforts are needed when macrohaematuria data are simply added to the analysis of microhaematuria and proteinuria, as determined by urine reagent strips.

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Research article

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A highly efficacious pediculicide based on dimeticone: Randomized observer blinded comparative trial

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Abstract

Background: Infestation with the human head louse (*Pediculus humanus capitis*) occurs worldwide. Existing treatment options are limited, and reports of resistance to commonly used pediculicides have been increasing. In this trial we assessed the efficacy of a product containing a high (92%) concentration of the silicone oil dimeticone (identical in composition to NYDA®), as compared to a 1% permethrin lotion.

Methods: Randomized, controlled, observer blinded clinical trial. Participants were recruited from a poor urban neighbourhood in Brazil where pediculosis capitis was highly prevalent. To minimize reinfestation during the trial, participants (145 children aged 5–15 years with head lice infestations) were transferred to a holiday resort outside the endemic area for a period of 9 days. Two applications of dimeticone or 1% permethrin were done, seven days apart. Outcome measures were defined as cure (absence of vital head lice) after first application and before and after second applications, degree of itching, cosmetic acceptability, and clinical pathology.

Results: Overall cure rates were: day 2 – dimeticone 94.5% (95% CI: 86.6% – 98.5%) and permethrin 66.7% (95% CI: 54.6% – 77.3%; $p < 0.0001$); day 7 – dimeticone 64.4% (95% CI: 53.3% – 75.3%) and permethrin 59.7% (95% CI: 47.5% – 71.1%; $p = 0.5$); day 9 – dimeticone 97.2% (95% CI: 90.3% – 99.7%) and permethrin 67.6% (95% CI: 55.4%-78.2%); $p < 0.0001$). Itching was reduced similarly in both groups. Cosmetic acceptability was significantly better in the dimeticone group as compared to the permethrin group ($p = 0.01$). Two mild product-related incidents occurred in the dimeticone group.

Conclusion: The dimeticone product is a safe and highly efficacious pediculicide. Due to its physical mode of action (interruption of the lice's oxygen supply of the central nervous system), development of resistance is unlikely.

Trial registration: Current Controlled Trials ISRCTN15117709.

Background

Infestation with the human head louse (*Pediculus humanus capitis*) occurs worldwide, and pediculosis capitis is hyperendemic in many resource-poor populations in the developing world [1,2]. In high income countries, head lice are a problem mainly in school-aged children [3,4], with an increasing number of reports of resistance to commonly used pediculicides, such as permethrin and malathion [5-13]. In addition, there is a growing public concern about the potential hazards of pediculicides with a neurotoxic mode of action. Thus, existing treatment options are limited.

Dimeticones (linear polydimethylsiloxanes of varying chain length) are silicone oils with a low surface tension and special creeping and spreading properties. They are a new class of anti-head lice compounds with a physical mode of action. It has recently been demonstrated that NYDA® (Pohl-Boskamp GmbH & Co. KG, Hohenlockstedt, Germany), an anti-head lice product containing two dimeticones with different viscosities in a total concentration of 92%, rapidly penetrated into the spiracles of lice. The product filled the entire tracheal system within minutes, thereby interrupting oxygen supply and leading to rapid death of the insect [14,15]. In addition, we recently reported a high *in vitro* efficacy of NYDA® against adult head lice [16]. The product is commercialized in Germany and other European countries since 2006 and sold as an over-the-counter medical device.

Two randomized controlled trials in the United Kingdom showed that a product containing only 4% dimeticone (Hedrin®) had a similar efficacy as d-phenotrin (0.5%), with cure rates of about 70% [17], and a better efficacy than malathion [18].

In the present observer blinded comparative trial we assessed the efficacy of a product identical in composition with NYDA® in comparison with 1% permethrin lotion (Kwell®), in individuals recruited from an area where pediculosis capitis is hyperendemic.

Methods

Participants, setting and eligibility criteria

Participants were recruited from a resource-poor community in Fortaleza, the capital of Ceará State in northeast Brazil. In the community, head lice infestations are very common (prevalence in the general population > 40%). In general, intensity of the infestation is high, and pediculosis capitis is associated with considerable morbidity [1]. Children aged 5 – 15 years with a head lice infestation were identified by community health care workers. Individuals were included in the study if one or more active head lice were found by visual inspection. Visual inspections were done by a trained auxiliary nurse, following a standardized procedure. It took three minutes, or was interrupted earlier when 25 lice were found. Fine tooth combing was not performed as a diagnostic test at this stage, as combing would have reduced the number of head lice present on the scalp and thereby bias cure rates.

We opted for a comparatively insensitive diagnostic method (visual inspection) [19,20] to reduce the number of individuals included with only few head lice on their scalp and to select participants with a moderate or a high intensity of infestation.

Individuals were not admitted to the study if one or more of the following criteria were present:

- use of head lice products, anthelminthics, or antibiotics within the previous four weeks;

- severe skin disorders of the scalp (such as generalized impetigo, eczema, psoriasis or chronic dermatitis of unknown origin);

- bleached or colour treated hair within the previous four weeks;

- known sensitivity to any ingredients in the products;

- mental disease;

- drug abuse;

- pregnant or lactating girls;

- unwillingness to stay for 9 days in a holiday resort outside the endemic area where the clinical trial would be carried out;

- participation in another clinical study in the previous month.

Study location

As recent trials in the United Kingdom have shown rapid reinfestation after cure [17,18] and because reinfestation is known to occur very rapidly in the setting where participants were recruited from (Pilger et al., manuscript submitted), participants were transferred to a holiday resort outside the endemic area for a period of nine days. It was expected that this would reduce the occurrence of re-infestation.

Intervention

Participants with head lice were randomized to receive either topical treatment with a product containing a high percentage of dimeticones (92%), equivalent in composition to NYDA® (G. Pohl-Boskamp GmbH & Co. KG, Hohenlockstedt, Germany), or permethrin 1% lotion (Kwell®, GlaxoSmithKline, Brazil). The first product was prepared at the Department of Pharmacy of the Federal University of Ceará by an experienced pharmacist, the latter bought locally at a pharmacy. As NYDA® was not registered as a medical device in Brazil, a parallel formulation was produced locally. The product was prepared using the identical constituents obtained from the same commercial source as the components of the branded product NYDA®. It was stored in 500 ml glass bottles and kept in a refrigerator until use. Permethrin is commonly used in Brazil and many other countries as a first line therapy for head lice infestation. In the study area, permethrin resistance has not been observed. However, there are no systematic studies available, and the resistance situation is not fully understood (Heukelbach, unpublished observation).

Participants were treated immediately upon arrival at the resort (day 1) and, according to the suggestion of a Cochrane Expert Panel [21], a second time 7 days later (day 8) to kill newly hatched lice from eggs which may have survived the first treatment. The producers of both products claim that the substances have an ovicidal effect.

The products were used according to the producers' recommendations. However, following a suggestion made by Dodd [21], the fine tooth comb provided by both producers together with the pediculicide was not used after the application of the products. The dimeticone-based product was applied to dry hair and then left to dry naturally. After 8 hours the hair was washed with a commercial shampoo not containing dimeticones. Permethrin was applied to wet hair, left for 30 minutes and thereafter washed out in an identical manner as dimeticone.

Both products were applied systematically onto the hair from the hair shafts to the tips, and a normal comb was used to spread the liquids evenly.

Objective

The trial was done to test the efficacy of a dimeticone-based product chemically identical to NYDA® to cure head lice infestations, in comparison to permethrin 1% lotion (Kwell®).

Outcomes

The primary outcome measure was defined as the proportion of participants cured of head lice infestation 1, 6 and 8 days after the first treatment (i.e. days 2, 7 and 9, respectively).

Cure was defined as the complete absence of viable lice on the scalp, as determined by wet combing with a high quality plastic head louse comb. This is considered a sensitive method to diagnose active lice infestation [19]. Diagnostic wet combing was performed after the application of a commercially available conditioner without silicone oil. Prior to the study, the conditioner had been tested in vitro to exclude any pediculicidal effect (20 head lice were fully coated with the conditioner, placed on a humid paper and observed for vital signs). Diagnostic wet combing was performed on day 2 (24 hours after first application), day 7 (one day before the second treatment) and day 9 (24 hours after second treatment). Head lice found were carefully removed and examined after 0.5 to 2 hours under a dissecting microscope for vitality signs as described previously, and stringent criteria for mortality were used [16].

Secondary outcomes included the reduction of clinical pathology, reduction of the degree of itching, cosmetic acceptability of the products, and safety (number and type of adverse events). The degree of itching was assessed daily based on a pre-tested ordinal visual analogue scale ranging from 0 to 4 (Figure 1). Cosmetic acceptability was assessed using a summary score ranging from -4 (extremely negative) to +4 (extremely positive), using a standardized questionnaire including subjective assessment of smelling, irritation of scalp, cosmetic changes of hair, and changes in the easiness to comb the hair. Clinical pathology included the presence of erythema, papules, excoriations, eczema, secondary infection and enlarged cervical or retro-auricular lymph nodes.

The assessment of clinical pathology was made before each application (days 1 and 9) and on days 2, 4 and 7. Cosmetic acceptability was determined on days 2, 4, 7 and 9.

Assessors for cure rate, itching, clinical pathology, and cosmetic acceptability were blinded regarding treatment groups.

Participants were instructed to report any adverse events at once and were specifically asked about possible adverse events at assessments of cosmetic acceptability. All adverse events reported by participants or noted by investigators during examination, and any inter-current illness was recorded in an Adverse Event Report Form, regardless whether or not they were considered to be related to the intervention.

The final assessment was undertaken 24 hours after the second treatment. If lice were found, they were removed and collected for analysis of activity. Before leaving the holiday resort, participants were treated with ivermectin 200 μg/kg in a single dose. In Brazil, oral ivermectin is a registered treatment for pediculosis.

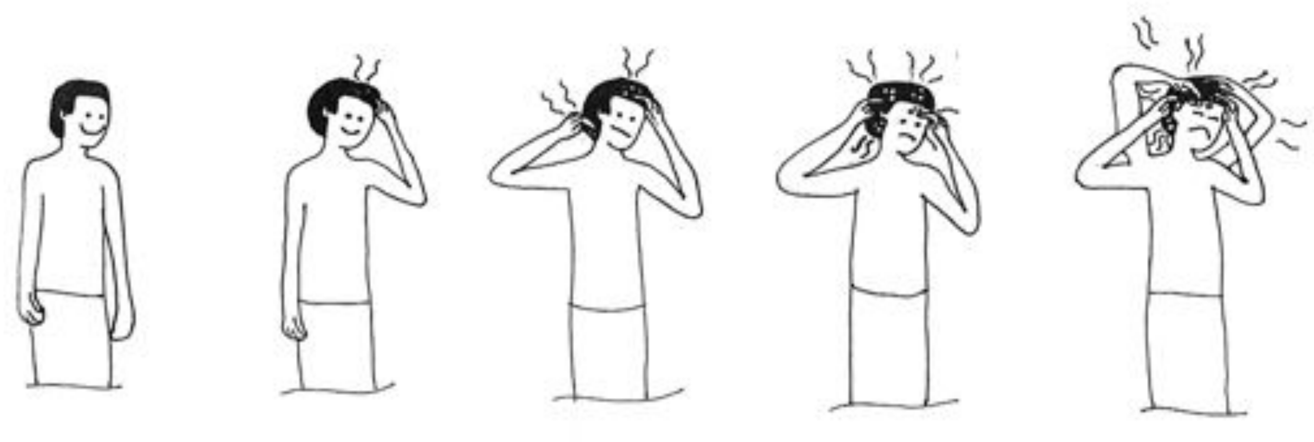

Figure 1
Assessment of degree of itching using an ordinal visual scale ranging from 0 to 4.

Sample size
Assuming a cure rate of 80%, a study size of 62 participants would be needed per group to detect an absolute difference of 25% in cure rates between treatment groups (power = 80%). Considering loss to follow-up (children who wanted to return from the holiday resort to their homes during the study period) and possible post-randomization protocol violations, a study size of about 70 participants per group was considered to be sufficient.

Random allocation
Participants had an equal probability of assignment to the groups. The randomization code was created by an investigator not involved in assessment of outcome measures or analysis of the study, using a computer generated random list. Blocked randomisation was used with a block length of six.

Blinding
The study was observer-blinded. As the two products looked considerably different, had a different smell and distinct cosmetic characteristics, a double-blinded design was not possible. All study personnel directly or indirectly involved in assessments of primary or secondary outcomes were blinded to treatment assignment for the duration of the study. Only the auxiliary personnel who applied the topical treatment and one investigator supervising the treatment had access to unblinded data. Although complete blinding of the participants was not possible, they were not informed to which treatment groups they belonged to. Treatment and assessment of outcome measures were done at distinct locations of the holiday resort. During the study period each participant carried an ID number in a badge so that no study participant could be mistaken for someone else.

Statistical methods
Data were entered twice into an Epi Info data base (version 6.04d, CDC, Atlanta, USA) and cross-checked for entry errors. Data analysis was done using STATA software (version 9; Stata Corporation, College Station, USA).

Analysis was based on the intention-to-treat population. The intention-to-treat population included all participants allocated to one treatment group and who received at least the first treatment. Differences between the groups in baseline characteristics, safety, cosmetic acceptability, reduction of clinical pathology and efficacy was tested using the chi squared test, the Fisher's exact test and the Mann-Whitney test, where appropriate.

Ethical aspects
This study was conducted in accordance with the revised Declaration of Helsinki. Each participant and his/her guardian gave written informed consent after having received an information leaflet and after a verbal explanation of the objectives and the procedures of the study had been given. At the end of the study, all participants were treated with oral ivermectin to cure any persistent head lice infestation, and to eliminate intestinal helminths. Ivermectin is known to be an effective drug against a variety of ectoparasites and intestinal helminths [22,23].

The study was approved by the Ethical Review Board of the Federal University of Ceará.

Results

Recruitment

The trial was divided into two parts. Two holiday camps were organized at the same resort in January 2007, each with duration of nine days. Both camps were carried out during school holidays. A total of 145 children aged 5 to 15 years agreed to participate. In the first camp, 77 individuals participated, and in the second 68. Conditions at both camps were identical. Randomization was done only once, before the beginning of the study. There was no difference in demographic or clinical characteristics of study participants at both camps.

Participant flow (Figure 2)

The total number of participants assigned to the dimeticone group was 73, and to the permethrin group 72. All 145 participants received two treatments. All participants were examined for the primary outcome at days 2 and 7. In each group, one participant was lost during follow-up. Consequently, at day 9, 72 participants in the dimeticone and 71 in the permethrin group were available for assessment of cure.

Eight participants in the dimeticone group and five in the permethrin group left the holiday resort during the study period due to homesickness. They were visited in their homes at the respective days to receive second treatment and to assess primary and secondary outcome measures, and were included in analysis. Their family members were treated with ivermectin to reduce the occurrence of reinfestation.

Baseline data

Both treatment groups were similar in age, sex, intensity of infestation, and hair length (Table 1).

Cure rates

Cure rates in the dimeticone group were very high at days 2 and 9 and significantly better than in the permethrin group. Cure rates at days 2, 7 and 9 are depicted in Table 2.

As an indicator for reinfestation, we assessed the presence of adult lice on day 7 in the head louse-free population on day 2. In the dimeticone group, of the 26 participants with head lice on day 7, 24 had been classified as cured on day 2, and only 2 had head lice at both points of time. Of the 24 incident cases, 21 (87.5%) had adult head lice on their scalps on day 7. In the permethrin group, there were 29 participants with head lice on day 7. Of these, 13 were not infested on day 2, and 16 continued being infested. Of the 13 incident cases in this group, 12 (92.3%) had adult head lice on their scalps on day 7.

Participants were stratified according to the number of head lice found at the beginning of the study. Cure rates were high in both treatment groups for participants with low or moderate intensity of infestation, with a significant higher efficacy of dimeticone at day 2 and day 9 (Table 3). In heavy infestation (arbitrarily defined as ≥ 5 active head lice after 3 min visual inspection), the cure rate remained very high in the dimeticone group at days 2 and 9, whereas in the permethrin group it was low.

In the dimeticone group, cure rates were similar at all three assessments when stratified by hair length and sex. Cure rates were also similar in the permethrin group at days 2 and 7, but differed significantly at day 9 with a higher cure rate in participants of male sex (59.3% in females and 94.1% in males; $p < 0.01$) and with shorter hair (90.5%, 69.2% and 54.1% for short, middle-sized and long hair, respectively, $p = 0.02$).

Secondary outcomes

Degree of itching (on an ordinal scale from 0 to 4) was reduced similarly in both treatment groups (Table 4).

Both treatments were perceived as cosmetically pleasant with a significantly better acceptance of dimeticone at days 4, 7 and 9 (Table 5).

Frequency of cervical lymphadenopathy decreased similarly in both groups during the study period (Table 6). Bacterial superinfection was rare and not observed on day 7 or later.

Adverse events

The number of participants experiencing any adverse events was similar in both groups, and only two product-related incidents occurred.

In the dimeticone group, 29 adverse events were reported in 25 participants. Of these, two were related to treatment (ocular irritation). The liquid had entered into the eyes after topical application. The irritation resolved spontaneously in both cases after washing the eyes with clean water. The other events were classified as unrelated or unlikely to the study (such as superficial wounds after falls, headache etc.).

In the permethrin group, 32 adverse events were reported in 26 participants, all of them unrelated or unlikely to be related to treatment.

Discussion

Our study shows that a product containing a high percentage of dimeticone (a parallel formulation of NYDA®) is significantly more effective in curing head lice infestations than permethrin lotion (Kwell®). Dimeticone reduced the degree of itching similar to permethrin and had a higher cosmetic acceptability.

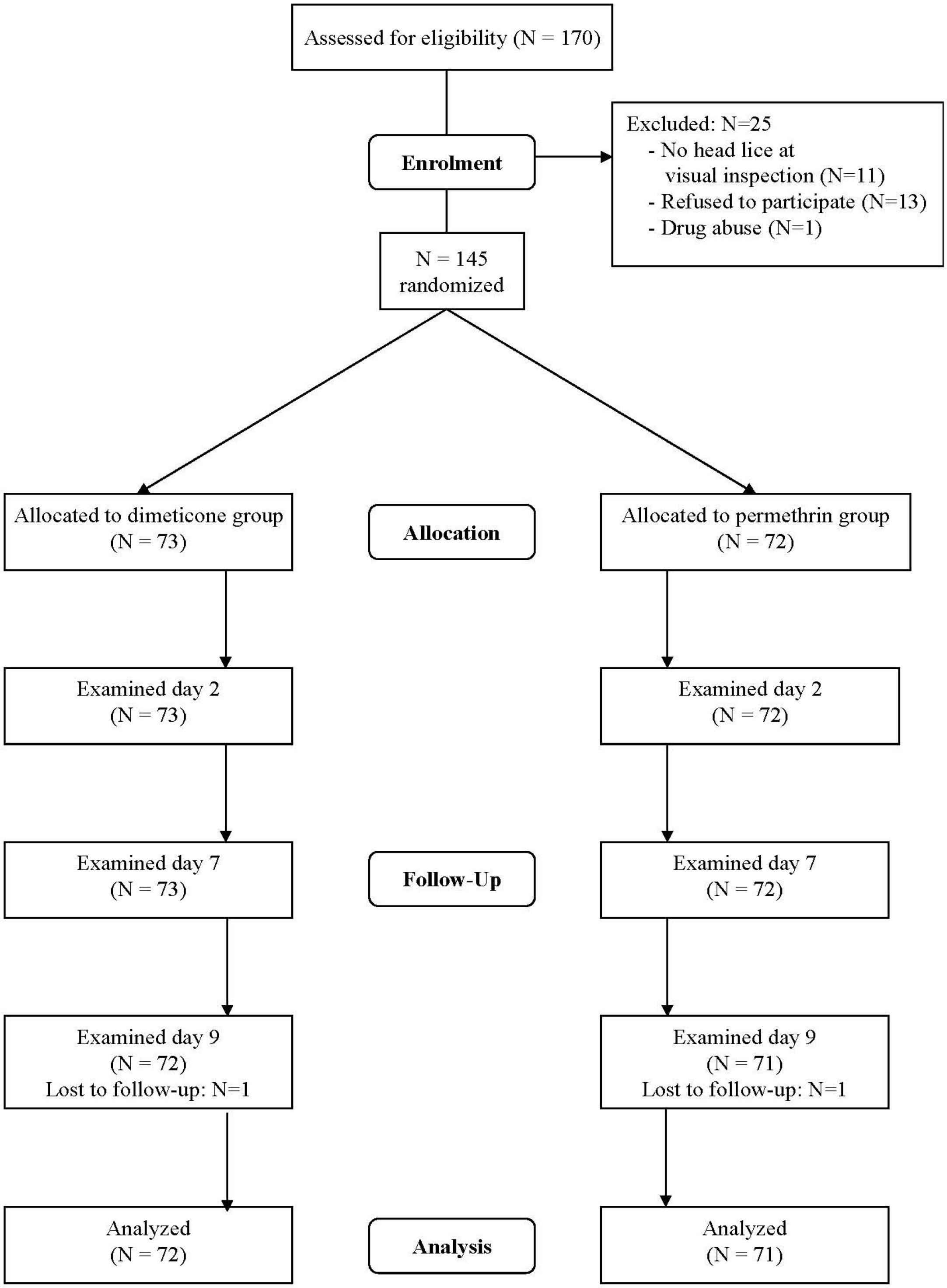

Figure 2
Flow of participants through each stage of the trial.

Table 1: Baseline demographic and clinical characteristics of both treatment groups

	Dimeticone group (n = 73)	Permethrin group (n = 72)	P value
Sex:			
Male	54 (74.0%)	55 (76.4%)	
Female	19 (26.0%)	17 (23.6%)	P = 0.7
Age (years):			
Median (interquartile range)	10 (7–12)	10 (8.5–12)	P = 0.2
Intensity of infestation*			
Median (interquartile range)	4 (2–12)	6 (2–14)	P = 0.5
Hair length:			
Short	21 (28.8%)	21 (29.2%)	
Middle-sized	16 (21.9%)	13 (18.1%)	
Long	36 (49.3%)	38 (52.8%)	P = 0.8

*Number of lice found during three minutes of visual inspection. Inspection was stopped when 25 vital lice were found.

In contrast to the high cure rates in the dimeticone group, cure rates in the permethrin group were 67% and 68% at days 2 and 9. Interestingly, in two recent trials from the UK assessing the efficacy of 4% dimeticone, cure rates of about 70% were reported, but in moderately infested individuals, cure rates were only 39% and 64%, respectively [17,18]. In our study, in the dimeticone group cure rates were not influenced by the intensity of infestation, contrary to the permethrin group.

It may be argued that in countries where resistance to permethrin or malathion has been known since long, such as in the UK, a dimeticone product may perform better, simply because a part of the head lice population would be resistant to insecticides. We believe that the difference in efficacy observed between dimeticone and permethrin in our study reflects the failure of permethrin to kill all head lice on the scalp. This resulted in persistence of infestation in the children treated with this pediculicide, particularly when the intensity of infestation was high. However, we are aware that permethrin resistance cannot be ruled out – although it seems unlikely – because resistance of head lice to insecticides has never been studied systematically in northeast Brazil.

Seven days after the first application, cure rates were considerably lower. This observation can be attributed mainly to reinfestation initiated by children who had remained infested after the first treatment: the vast majority of those study participants that were cured on day 2, but infested on day 7, had vital adult lice detected on this day. As adult head lice found up to one week after cure by definition derive from reinfestation (no newly hatched nymphs can develop into adults within one week) [21,24,25], we believe that the increase in the number of infested children seven days after first application is caused mainly by reinfestation and not by a low ovicidal activity of dimeticone. Children played together during the day, frequently had intimate body contact and slept together in dormitories, irrespective to which treatment group they belonged to. Hence, our data not only show the comparative efficacy of the two tested compounds, but also the effectiveness of head lice treatment in the setting of a holiday resort.

Other studies also provided evidence that reinfestation is common if study participants are not completely cured, or if they stay in close contact to other infested people [17,18]. In fact, we observed in another study that NYDA® reduced hatch rates of eggs to < 4% after 60 min incubation, as compared to a hatch rate of 80% in eggs treated with 0.5% permethrin alcoholic solution (Heukelbach, unpublished data). A few children had mixed stages including nymphs (data not shown). As larval stages were not further defined during the study, we were unable to

Table 2: Cure rates, defined as the complete absence of active lice.

	Dimeticone group		Permethrin group		P value	Effect size
	Cured/total	**% (95% CI)**	**Cured/total**	**% (95% CI)**		**RR (95% CI)**
Day 2	69/73	94.5% (86.6% – 98.5%)	48/72	66.7% (54.6% – 77.3%)	P < 0.0001	1.42 (1.19–1.68)
Day 7	47/73	64.4% (53.3% – 75.3%)	43/72	59.7% (47.5% – 71.1%)	P = 0.5	1.22 (0.59–2.52)
Day 9	70/72	97.2% (90.3% – 99.7%)	48/71	67.6% (55.4% – 78.2%)	P < 0.0001	1.44 (1.22–1.70)

Topical treatments were applied on days 1 and 8.

Table 3: Cure rates stratified according to infestation intensity (assessed by 3 minutes of visual inspection before treatment)

	Dimeticone group		Permethrin group		P value	Effect size
	Cured/total	% (95% CI)	Cured/total	% (95% CI)		RR (95% CI)
Low or moderate infestation[a]						
Day 2	37/38	97.4% (86.2% – 99.9%)	23/31	74.2% (55.4% – 88,1%)	P = 0.004	1.31 (1.06–1.63)
Day 7	32/38	84.2% (68.7% – 94.0%)	23/31	74.2% (55.4% – 88,1%)	P = 0.3	1.14 (0.88–1.46)
Day 9	36/37	97.3% (85.5% – 99.9%)	25/31	80.6% (62.5% – 92.5%)	P = 0.02	1.21 (1.01–1.45)
Heavy infestation[b]						
Day 2	32/35	91.4% (76.9% – 98.2%)	25/41	61.0% (44.5% – 75.8%)	P = 0.002	1.50 (1.15–1.95)
Day 7	15/35	42.9% (26.3% – 60.4%)	20/41	48.8% (32.9% – 64.9%)	P = 0.6	0.88 (0.54–1.44)
Day 9	34/35	97.1% (85.1% – 99.9%)	23/40	57,5% (40.9% – 73.0%)	P < 0.0001	1.69 (1.29–2.22)

[a] < 5 active head lice at the beginning of the study; see material and methods
[b] ≥ 5 active head lice

prove that in some cases eggs may have not been killed by the initial treatment.

Dimeticones are regarded as chemically inert and non-toxic, and are components of many cosmetic skin and hair care products. Since the mode of action of dimeticones is physical, development of resistance is unlikely. Besides, the repeated applications are not expected to increase the risk for adverse events. The two randomized clinical trials recently performed in the UK compared dimeticone in a concentration of only 4% (Hedrin®) with α-phenotrin and malathion, respectively [17,18]. We opted to assess the therapeutic efficacy of a product containing a 92% mixture of two dimeticones of different viscosity (a low viscosity, also at room temperature more readily volatile dimeticone, responsible for the highly creeping and spreading properties of the product, and a higher viscosity, less volatile dimeticone) in an environment where the intensity of infestation was extremely high. As NYDA® is claimed to kill lice by entering into the spiracles and filling the tracheal system with subsequent blocking of the oxygen supply [14,15], it can be assumed that the high creeping and spreading properties of the product in connection with the high percentage of the more viscous dimeticone component in NYDA® is responsible for the increased cure rates, as compared to Hedrin®. In fact, we have shown that NYDA® killed all lice *in vitro*, collected from individuals living in the community where our participants were recruited from, and that it performed better than 4% dimeticone (Hedrin®) [16].

Our study is subject to limitations. Usually, a period of 14 days is recommended for the final assessment, to detect all lice hatching from eggs not killed by the products [21,26]. However, we had perceived in discussions with community representatives prior to the study that neither parents nor children would have agreed to a prolongation of the stay in the resort for more than 10 days. Thus, we could not adhere to recommendations made previously and opted to perform the final assessment after nine days.

In the dimeticone group we observed only two adverse events related to the use of the product. The product had entered the eyes and caused mild irritation which resolved quickly. We conclude that the dimeticone-based product is a safe pediculicide. Dimeticones are physiologically inert and non-toxic silicone oils. They are widely used in cosmetic products to facilitate the use of a comb and to

Table 4: Degree of itching, assessed by an ordinal visual scale from 0 to 4 (see Methods)

	Dimeticone group Median (interquartile range)	Permethrin group Median (interquartile range)	P value
Before treatment	2 (1–4)	2 (1–3)	p = 0.02
6 h after treatment	1 (0–1)	1 (0–1)	P = 0.8
24 h after treatment (day 2)	1 (0–1)	1 (0–1)	P = 0.6
Day 3	1 (0–1)	1 (0–1)	P = 0.07
Day 4	1 (0–1)	0 (0–1)	P = 0.8
Day 5	1 (0–1)	0 (0–1)	P = 0.13
Day 6	1 (0–1)	0 (0–1)	P = 0.13
Day 7	1 (0–1)	1 (0–1)	P = 0.14
Day 8	1 (0–1)	0 (0–1)	P = 0.3
Day 9	0 (0–1)	0 (0–1)	P = 0.5

Table 5: Cosmetic acceptability of products (minimum score: -4; maximum score: +4; see Methods)

	Dimeticone group Median (interquartile range)	**Permethrin group** Median (interquartile range)	**P value**
Day 2	1 (0 – 2)	1 (-1 – 2)	P = 0.5
Day 4	1 (0 – 2)	0 (-0.5 – 1)	P = 0.003
Day 7	1 (1 – 2)	1 (0 – 2)	P = 0.04
Day 9	1 (1 – 2)	1 (-1 – 2)	P = 0.01

make the hair silky and soft [27]. After oral ingestion, the oil is not absorbed but eliminated unaltered in the faeces. Oral dimeticones are used as anti-flatulents to alleviate gastrointestinal discomfort.

Non-insecticidal treatment options against head lice infestations are limited and include some natural products with good efficacy [28,29], but also physical methods and home remedies with rather low efficacy, such as combing with a fine tooth comb or application of vinegar [30-34]. The dimeticone product, being highly efficacious and non-toxic, can be considered an ideal pediculicide. It is acceptable for individuals who do not want to use insecticides with a neurotoxic potential and for those who look for a high cosmetic acceptability. A recent study has shown that time necessary to treat children with head lice infestations is an important aspect for parents to opt for one or another therapy [35]. As efficacy of dimeticone was very high without using a head louse comb, dimeticone will also be ideal for those parents who find combing nasty and time consuming.

Conclusion

The dimeticone-based head lice product (similar to the branded product NYDA®) is an efficacious alternative to chemical pediculicides with no inherent risk for development of resistance. The cure rate was >97%, even in individuals with a high intensity of infestation. Severity of itching was reduced to negligible.

Competing interests

JH and HF have been scientific consultants to G. Pohl-Boskamp GmbH & Co. KG, the producer of NYDA®. The company had no role in the design, execution, or interpretation of the study. The other authors do not have any conflicts of interest to declare.

Authors' contributions

JH: study design, conducted the study, statistical analysis, contributed to the manuscript; DP: study design, conducted the study, statistical analysis, contributed to the manuscript; FAO: study design, conducted the study, contributed to the manuscript; AK: conducted the study, contributed to the manuscript; LA: conducted the study, statistical analysis, contributed to the manuscript; HF: study design, contributed to the manuscript. All authors read and approved the final manuscript.

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Table 6: Clinical pathology in both treatment groups

	Dimeticone group n (%)	**Permethrin group** n (%)	**P value**
Cervical lymphadenopathy:			
Before treatment	49/73 (67.1%)	54/72 (75.0%)	P = 0.3
Day 2	51/73 (69.9%)	52/72 (72.2%)	P = 0.8
Day 4	52/73 (71.2%)	49/72 (68.1%)	P = 0.7
Day 7	39/73 (53.4%)	46/72 (63.9%)	P = 0.2
Day 9	41/72 (56.9%)	45/71 (63.4%)	P = 0.7
Bacterial superinfection of lesions:			
Before treatment	1/73 (1.4%)	0/72 (0%)	P = 0.3
Day 2	1/73 (1.4%)	1/72 (1.4%)	P = 1.0
Day 4	1/73 (1.4%)	0/72 (0%)	P = 0.3
Day 7	0/73 (0%)	0/72 (0%)	P = 1.0
Day 9	0/72 (0%)	0/71 (0%)	P = 1.0

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The epidemiology of scabies in an impoverished community in rural Brazil: Presence and severity of disease are associated with poor living conditions and illiteracy

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Background: We sought to study the epidemiology of scabies and to identify risk factors of severe disease in an impoverished rural community in northeast Brazil.

Methods: The study was designed as a repeated cross-sectional study based on two door-to-door surveys. One survey was carried out in the rainy season, the other in the dry season. The inhabitants of the community were examined for the presence of scabies and demographic, socioeconomic, and behavioral risk factors were assessed. Risk factors were analyzed using bivariate and multivariate regression analysis.

Results: The overall prevalence was 9.8% with no significant variation between seasons and the incidence was estimated to be 196/1000 person-years. The highest prevalence (18.2%) was observed in children younger than 4 years. Risk factors in the bivariate analysis were young age, presence of many children in the household, illiteracy, low family income, poor housing, sharing clothes and towels, and irregular use of shower. Age younger than 15 years, illiteracy, sharing of clothes, and living in the community for more than 6 months remained significant independent risk factors in multivariate regression analysis.

Limitations: We used a clinical case definition; specificity and sensitivity were not verified. Men were underrepresented in the study population.

Conclusions: In this impoverished community scabies is an important health problem characterized by continuous transmission throughout the year. The parasitic skin disease is embedded in a complex web of causation characterized by poor living conditions and a low level of education. (J Am Acad Dermatol 2009;60:436-43.)

Key words: Brazil; epidemiology; impoverished community; population-based study; risk factors; scabies.

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In developing countries scabies is a common parasitic skin disease, and it is associated with considerable morbidity, such as excoriations, eczematization, secondary infection leading to impetigo, suppuration, abscess formation, lymphadenopathy, and poststreptococcal glomerulonephritis.[1-10] In resource-poor urban and rural communities the prevalence of the infestation with *Sarcoptes scabiei* may reach 10% in the general population and 59% in children.[1,2,4,7,9,11-19] In an urban slum in Bangladesh, the incidence in children younger than 5 years was 952/1000/year, indicating that nearly all children experienced at least one infestation per year.[20] This is in contrast to the situation in industrialized countries, where the disease occurs sporadically in all age groups, particularly in sexually active adults, or causes epidemics in institutions and nursing homes.[8,21-26]

Many factors have been suggested to determine the epidemiology of scabies in impoverished communities, including social attitudes, population movements, malnutrition, lack of access to health care, inadequate treatment, deficient hygiene, and crowding, but so far these assumptions have not been substantiated.[3,6,7] As in most countries scabies is not a notifiable disease, usually only large outbreaks tend to be reported.[27] By consequence, what is known about the epidemiology of scabies is mainly based on data from hospital and outpatient records or certain high-risk groups.[6,28-36] Risk factors for occurrence of disease have rarely been studied in Africa and Asia,[1,2,7,20] but have not been investigated in the Americas.

We studied the epidemiology of scabies in an impoverished rural community in Brazil during two seasons of the year, and identified risk factors associated with the presence of scabies and the occurrence of severe disease. Our results show that in this setting scabies is predominantly a disease of children with the occurrence and severity of infestation being related to poor living conditions and illiteracy, and that transmission remains stable throughout the year.

METHODS

Study area

The study was performed in Feliz Deserto, a small coastal town (3850 inhabitants) situated about 120 km south of Maceió, the capital of Alagoas State in northeast Brazil. The study area was confined to those districts of Feliz Deserto where, according to the agents of the National Health Program Family Health Program (Programa de Saúde da Família), scabies repeatedly occurred in the past 5 years. Climatic, social, cultural, and economic characteristics of the study area were described previously.[10]

Study design

Two cross-sectional studies were performed: all households in the study area were visited in June/July 2003 (end of rainy season) and a second time in October/November 2003 (peak of dry season). All individuals who had spent at least 4 nights per week in their household during the last 3 months were eligible for the study. This excluded individuals only temporarily present in the area who might have confounded the risk factor analysis. In both door-to-door surveys, households were revisited 3 times if an eligible household member was absent. Each survey was carried out within a period of 10 weeks. The household members were examined for the presence of scabies and other parasitic skin diseases. Using standardized questionnaires, information on demographic, socioeconomic, environmental, and behavioral variables were obtained. These questionnaires were tested before their use. To exclude interobserver bias, all clinical examinations were carried out by one investigator (A. J.). However, some degree of recall bias cannot be excluded in our setting.

Clinical examination and case definition

The household leaders were asked for a room with good light and in which privacy was guaranteed. In this room, the whole body including the breasts and the genital area was thoroughly examined for the presence of skin lesions typical for scabies. Children younger than 10 years were only examined in the presence of a caretaker, usually the mother. The diagnosis of scabies was made clinically after well-established and approved methods in the developing world.[1,2,6,9,37] Skin scraping cannot be considered to be of help in this setting, as its sensitivity is low, and the method is not feasible for surveys in resource-poor settings.[38-42]

Scabies was suggested if itchy papular, papular-crusted, or vesicular lesions were present. An individual was defined to have scabies if at least two of the following 3 requirements were fulfilled: presence of one or more typical lesions for longer than 2 weeks, pruritus that intensified at night, or at least one more family member with similar lesions. The validity of this case definition in resource-poor settings has been shown previously.[9]

After the diagnosis of scabies was made, the patients and their families were treated with 0.2% deltamethrin lotion (Deltacid, Solvay Farma, São Paulo, Brazil).

Bacterial superinfection was diagnosed when pustules, abscesses, or suppuration were present. Superinfected lesions were treated with oral roxithromycin (Floxid, Solvay Farma). The draining lymph nodes were palpated for the presence of swelling and pain (lymphadenitis).

To determine the severity of infestation, the body was divided into two halves (right and left). Each half was subdivided into 16 areas: interdigital spaces, hand, wrist, arm, elbow, axilla, leg (excluding the medial area of the thigh), foot, abdomen, ventral thorax, mamillar/perimammilar area, back, buttocks, genitals, inguinal area/medial area of the thigh, and head (scalp/neck/face). Thus, the number of affected areas possibly ranged from 0 to 32. Severe scabies was arbitrarily defined as the presence of 12 or more infested topographic areas.[10]

Illiteracy was defined as the inability to read and write more than one's own name.

Data storage and analysis

Data were entered twice into a database using a software package (Epi Info, Version 6.04d, Centers for Disease Control and Prevention, Atlanta, GA) and checked for errors that may have occurred during their entry. Then, data were transferred to another software package (Stata, Version 9.0, Stata Corp, College Station, TX) for analysis. Fisher exact test was used to determine the significance of differences of relative frequencies. For the identification of possible risk factors, the odds ratios with the respective 95% confidence intervals were calculated.

Three individuals were given a diagnosis of scabies during the first and the second survey. These cases were entered into the risk factor analysis only once. Control subjects were all individuals without scabies during the first survey plus individuals who had immigrated into the area after the first survey and who were without scabies during the second survey.

In a second step multivariate logistic regression using backward elimination was performed to calculate adjusted odds ratios for the independent association between exposure variables and the presence of scabies. All variables on a significance level of P less than .2 were included in the multivariate regression model. Socioeconomic and behavioral variables were based on households, except sharing of beds, clothes, and towels, and use of shower and soap. These exposure variables were entered in the model on the individual level. Incidence (I) was calculated according to the formula $I = P/D$; where P is the prevalence and D the average duration of disease. As the mean duration of scabies in resource-poor settings is estimated between 2 and 8 months,[2] the incidence was calculated assuming 2, 6, and 8 months of disease duration, respectively.

Ethical considerations

The study was approved by the ethical committee of the Escola de Ciências Médicas de Alagoas, the responsible ethical body in Alagoas State, Brazil. Before the study, meetings were held in the community with health care workers and community leaders to explain the objectives. All participants were informed about the study, and informed written consent was obtained. In the case of minors, the guardian was asked for written consent. If patients were illiterate, the informed consent was read for them and patients had to sign the informed consent by their finger print. Any inhabitant of the study area was free to refrain from participating without any disadvantage for oneself or other family members.

If other skin diseases were diagnosed during the examination, patients were referred to the primary health care center of Feliz Deserto, where all treatment is free of charge. At the end of the study, mass treatment of all inhabitants of the village was performed using ivermectin ($2 \times 200\ \mu g/kg$ body weight) to relieve subjects from ectoparasites and remaining intestinal helminths. Children younger than 5 years were treated with mebendazole (2×100 mg).

RESULTS

In total, 2002 individuals were examined, 1014 during the first survey in the rainy season, and 988 during the second survey in the dry season. This corresponded to 88.5% and 90.9% of the target population, respectively. Men disproportionately accounted for nonparticipants in both surveys. Boys and young men (15-29 years) often worked on surrounding farms during the week, where they stayed from Monday to Friday, and therefore failed to fulfill the admission criteria of spending 4 nights per week in the study area.

Of the studied households, 89.3% had access to electricity, and 81% had toilets on their compounds. In all, 49.6% of the study members lived in brick-built houses. Of the households, 83% had more than 4 members and 61.7% had a monthly income of less than R$200 (the official minimum wage; approximately US$105). The education level was low: 34.2% of those aged 15 years or older were illiterate.

During the first door-to-door survey, 102 scabies cases were detected (10.1%) and during the second, 94 (9.5%; $P = .71$). Three individuals were given a diagnosis of scabies during the first and the second survey, although these cases had been treated at the end of the first survey. It remained unclear whether this was a result of drug failure or a reinfestation. Table I depicts age- and sex-specific prevalence during the rainy and the dry seasons. The frequency of scabies and severe scabies, and the proportion of superinfected lesions (35.3% in the rainy vs 38.3% in the dry season) were similar in both surveys.

Table I. Prevalence and estimated incidence of scabies in rainy and dry season, stratified by sex

	Prevalence rainy season		Prevalence dry season		
	N	% (95% CI)	n	% (95% CI)	*P* value
Total*	102/1014	10.1 (8.3-12.1)	94/988	9.5 (7.8-11.5)	.71
Sex					
Male	41/459	8.9 (6.5-11.9)	43/453	9.5 (6.9-12.6)	.82
Female	61/555	11.0 (8.5-13.9)	51/535	9.5 (7.2-12.3)	.49
Age, y					
≤4	31/154	20.1 (14.1-27.3)	26/151	17.2 (11.6-24.2)	.56
5-9	28/194	14.4 (9.8-20.2)	28/193	14.5 (9.9-20.3)	1.00
10-14	23/154	14.9 (9.7-21.6)	18/145	12.4 (7.5-18.9)	.62
15-19	2/95	2.1 (0.3-7.4)	5/88	5.7 (1.9-12.8)	.26
20-39	7/252	2.8 (1.1-5.6)	9/241	3.7 (1.7-7.0)	.62
40-59	8/118	6.8 (3.0-12.9)	7/120	5.8 (2.4-11.6)	.80
≥60	3/47	6.4 (1.3-17.5)	1/50	2.0 (0.0-10.6)	.35

CI, Confidence interval.
*The 94 cases identified during second survey (dry season) were different from 102 cases diagnosed during first survey (rainy season).

Therefore, for further analysis the data of the two surveys were combined.

The frequency of severe scabies was disproportionately high in children. The estimated overall incidence based on a mean duration of disease of 6 months (range: 2-8 months) was 195.8 (146.9-587.4)/1000 person-years. The incidence was higher in female (205.5; 154.1-616.5) than in male (184.2; 138.2-552.6) individuals, however, similar to the prevalence, the difference was not significant.

In 4 age groups (10-14, 15-19, 20-39, and 40-59 years) the infestation occurred more often in female than in male individuals; however, the difference was only significant for 20- to 39-year-olds ($P = .04$). A particular pattern emerged when data were stratified according to age, sex, and season of the year. Whereas in the rainy season age-specific prevalence in female individuals was consistently higher than in male individuals (with exception of the elderly) and prevalence curves were almost parallel, in the dry season, prevalence in women remained higher only in 4 of 7 age groups as compared with men. Moreover, although in the rainy season prevalence peaked in small children, children aged between 10 and 14 years, and adults aged 40 years or older, in the dry season the prevalence of scabies in boys and men decreased constantly with increasing age. In contrast, in female individuals two peaks were observed: one in teenaged girls, and one in women. However, irrespective of sex and season, children aged 4 years or younger constantly had the highest disease burden; they accounted for 29.1% (57/196) of all scabies cases diagnosed in both surveys. Children aged 14 years or younger showed the highest prevalence as compared with all other age groups (15.5% vs 4.2%, $P < .0001$).

The results of the bivariate analysis of risk factors for the presence of scabies and severe disease are shown in Table II. Age less than 15 years, many children in the household (indicated by a ratio of children/adults >2), living in the community longer than 6 months, illiteracy, low monthly family income, poor housing (absence of a solid floor, no access to electricity, no toilet on compound), sharing clothes and towels with other family members, and irregular use of shower were all significant risk factors for the presence of both scabies and severe disease. Crowding (number of persons/household, number of individuals/room) was no significant risk factor. Most importantly, a strong correlation among young age, the presence of scabies, and the severity of disease was found. Children younger than 4 years had a 5.7-fold higher chance of acquiring scabies and a 7.6-fold higher chance for severe disease, as compared with the reference age group (Table II).

In the multivariate logistic regression analysis young age, many children in the household, sharing of clothes, living in the community longer than 6 months, and illiteracy remained significant risk factors for the presence of scabies and severe disease (Table III).

DISCUSSION

Despite the fact that in resource-poor communities scabies is an individual and public health problem characterized by high prevalence, intensity of infestation, and severe morbidity,[10,42] investigations have rarely attempted to study the epidemiology of this ectoparasitosis in impoverished settings and to identify risk factors for its presence and the severity. To our knowledge, for the Americas, no reliable community-based data are available at all. Our study

Table II. Bivariate analysis of exposure variables and scabies infestation/severe scabies in one of two surveys (n = 1183)

		Presence of scabies (n = 151)			Presence of severe scabies[†] (n = 68)		
Exposure variable	**Examined n***	**Positive n (%)**	**OR (95% CI)**	***P* value**	**Positive n (%)**	**OR (95% CI)**	***P* value**
Sex							
Female	624	87 (13.9)	1.25 (0.88-1.80)	.22	37 (5.9)	1.07 (0.64-1.82)	.80
Male	559	64 (11.5)	Ref.		31 (5.6)	Ref.	
Age, y							
≤4	184	41 (22.3)	5.66 (3.11-10.53)	<.0001	24 (13.0)	7.63 (3.22-19.99)	<.0001
5-9	214	43 (20.1)	4.97 (2.76-9.16)	<.0001	21 (9.8)	5.54 (2.29-14.68)	<.0001
10-14	171	29 (17.0)	4.03 (2.12-7.76)	<.0001	11 (6.4)	3.49 (1.25-10.19)	.009
15-39	415	20 (4.8)	Ref.		8 (1.9)	Ref.	
≥40	199	18 (9.1)	1.96 (0.95-4.01)	.05	4 (2.0)	1.04 (0.23-3.95)	1.00
Ratio children/adults							
≤2	1018	117 (11.5)	Ref.		48 (4.7)	Ref.	
>2	165	34 (20.6)	2.00 (1.27-3.09)	.002	20 (12.1)	2.79 (1.52-4.94)	.001
Persons/household							
≥4	902	120 (13.3)	1.76 (0.99-3.32)	.05	50 (5.5)	1.16 (0.55-2.73)	.86
<4	187	15 (8.0)	Ref.		9 (4.8)	Ref.	
No. of individuals/room							
>2	94	17 (18.1)	1.64 (0.88-2.92)	.10	7 (7.5)	1.46 (0.54-3.36)	.34
≤2	995	118 (11.9)	Ref.		52 (5.2)	Ref.	
Child age < 15 y with scabies in household							
Yes	293	109 (37.2)	11.96 (7.98-18.08)	<.0001	53 (18.1)	12.88 (6.99-24.99)	<.0001
No	890	42 (4.7)	Ref.		15 (1.7)	Ref.	
Time living in area, mo							
>6	956	129 (13.5)	3.30 (1.43-9.35)	.002	57 (6.0)	4.15 (1.07-35.50)	.04
≤6	133	6 (4.5)	Ref.		2 (1.5)	Ref.	
All family members illiterate							
Yes	162	35 (21.6)	2.28 (1.44-3.54)	.0004	18 (11.1)	2.70 (1.42-4.95)	.002
No	927	100 (10.8)	Ref.		41 (4.4)	Ref.	
Monthly family income, R$[‡]							
<200	661	94 (14.2)	1.56 (1.05-2.37)	.02	43 (6.5)	1.79 (0.97-3.45)	.05
≥200	428	41 (9.6)	Ref.		16 (3.7)	Ref.	
Type of floor							
Sand/clay	147	26 (17.7)	1.64 (0.98-2.66)	.04	15 (10.2)	2.32 (1.16-4.39)	.01
Concrete/tiles	942	109 (11.6)	Ref.		44 (4.7)	Ref.	
Electricity							
No	126	25 (19.8)	1.92 (1.13-3.15)	.01	12 (9.5)	2.05 (0.96-4.07)	.04
Yes	963	110 (11.4)	Ref.		47 (4.9)	Ref.	
Toilet							
No	210	37 (17.6)	1.70 (1.09-2.61)	.01	17 (8.1)	1.76 (0.92-3.23)	.06
Pit latrine/WC	879	98 (11.2)	Ref.		42 (4.8)	Ref.	
Presence of dog or dogs							
Yes	401	59 (14.7)	1.29 (0.89-1.86)	.17	27 (6.7)	1.30 (0.76-2.21)	.29
No	782	92 (11.8)	Ref.		41 (5.2)	Ref.	
Sharing bed/hammock/ mattress with others							
Yes	774	109 (14.1)	1.31 (0.88-2.00)	.18	52 (6.7)	1.69 (0.91-3.35)	.10
No	343	38 (11.1)	Ref.		14 (4.1)	Ref.	
Sharing clothes with others							
Yes	168	43 (25.6)	2.80 (1.81-4.24)	<.0001	25 (14.9)	3.87 (2.18-6.74)	<.0001
No	949	104 (11.0)	Ref.		41 (4.3)	Ref.	

Continued

Table II. Cont'd

		Presence of scabies (n = 151)			Presence of severe scabies† (n = 68)		
Exposure variable	**Examined n***	**Positive n (%)**	**OR (95% CI)**	***P* value**	**Positive n (%)**	**OR (95% CI)**	***P* value**
Sharing towel with others							
Yes	532	85 (16.0)	1.60 (1.11-2.32)	.01	44 (8.3)	2.03 (1.33-4.09)	.001
No	585	62 (10.6)	Ref.		22 (3.8)	Ref.	
Taking shower regularly							
No	690	103 (14.9)	1.53 (1.04-2.28)	.03	51 (7.4)	2.19 (1.19-4.25)	.009
Yes	427	44 (10.3)	Ref.		15 (3.5)	Ref.	
Using soap regularly							
No	21	3 (14.3)	1.10 (0.21-3.84)	.75	1 (4.8)	0.79 (0.02-5.12)	1.00
Yes	1096	144 (13.1)	Ref.		65 (5.9)	Ref.	

CI, Confidence interval; *OR*, odds ratio; *Ref.*, reference; *WC*, water closet.
*Data were not available in all cases.
†Individuals with ≥ 12 topographic areas affected.
‡R$1 ≈ US$0.53.

area can be considered representative for other impoverished rural communities in the Brazilian backlands. Housing is rather poor, income is generally low, illiteracy is frequent, and social attitudes and behavior facilitate the transmission of *S scabiei*.

In Feliz Deserto, scabies was mainly a disease of children younger than 4 years, who accounted for almost 30% of all cases diagnosed during the two surveys. In Brazil, children of this age group usually wear only diapers, slips, or shorts, independent of their sex. They have frequent body contacts with other children during playing and sleeping, and with older siblings, their mothers, and other women, who carry around babies and toddlers during the day.

In children aged between 10 and 14 years the infestation was also very common, with the prevalence ranging between 9.3% and 16.4%, according to sex and season. Young age remained a significant independent risk factor for the presence of scabies and severe disease in the multivariate regression analysis. Previous studies in resource-poor settings also found that children are the most vulnerable population group.[1,2,4,5,7,9,31]

The overall prevalence did not vary between the surveys, although 102 individuals with scabies were treated in the first survey. We, therefore, cannot exclude that without treatment the prevalence would have been higher in the dry season. However, a clear seasonal variation has not been detected. This corroborates findings from other tropical areas,[9,20] but is in contrast to observations made in industrialized countries with a cold or moderate climate or developing countries with a rather cold and dry winter such as Malawi or Turkey.[4,21,29,43-46] Obviously, in the hot climate of Northeast Brazil reduced off-host viability of mites because of high environmental temperatures does not impede continued transmission throughout the year.[47,48] We suggest that in impoverished communities in the tropics reduced off-host viability of mites is compensated by intense exposure through prolonged and intimate body contact. In these settings, major parts of the body are not covered with clothes during day and night, irrespective of whether it is dry or raining, as air temperature remains more or less stable. Babies and small children are carried around on the hip by their mothers and older girls for several hours during the day. This should facilitate the transmission of mites from person to person.[49]

The high degree of transmission occurring within households is best demonstrated by the fact that individuals who had lived in the community for more than 6 months had 3.6-fold higher odds for a diagnosis of scabies—and a 4.2-fold higher odds for the presence of severe scabies—as compared with individuals who had recently arrived. In a study in rural India an almost linear increase in the occurrence of scabies with increasing household size was observed.[2] However, crowding (defined as >4 individuals/household) was not associated with the presence of scabies in this study. This suggests that the risk of acquiring scabies in the household is not directly linked to the number of persons living in that household.

Illiteracy of adult household members was a very good predictor for the presence of scabies and severe disease, and remained a significant risk factor in the multivariate regression analysis (odds ratio 2.8 and 3.2, respectively) (Table III). A low level of education has been identified as a risk factor for scabies in developing and industrialized countries.[20,50] Because illiteracy usually goes along with a low socioeconomic status, the inability to read and write can be taken as a proxy for poor living

Table III. Multivariable logistic regression analysis for presence of scabies and severe scabies in the community, adjusted by sex

	Scabies		Severe scabies	
	Adjusted OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value
Living in area > 6 mo	3.61 (1.53-8.54)	.003	4.23 (1.00-17.98)	.05
Age < 15 y	3.51 (2.29-5.39)	<.001	4.13 (2.04-8.37)	< .001
All family members illiterate	2.82 (1.77-4.49)	<.001	3.25 (1.74-6.08)	< .001
Sharing clothes with others	1.85 (1.17-2.93)	.008	2.20 (1.19-4.08)	.009
Proportion children/adult in household	–		1.99 (1.04-3.80)	.04

CI, Confidence interval; *OR*, odds ratio.

conditions. In fact, variables that are direct or indirect indicators of poverty (eg, poor housing, no access to electricity, low monthly family income) were significantly associated with the presence of scabies and severity of disease.

Two behavioral factors, the sharing of clothes and towels, were significantly associated with the presence of scabies in the bivariate analysis. This could point to a substantial contribution of fomites regarding the transmission of mites in the study area. So far the current dogma states that fomites only play a negligible role in transmission dynamics.[8] However, previous studies on transmission of *S scabiei* have been performed in cold climate settings and their results may not pertain to transmission dynamics in the tropics. In fact, sharing towels and bed linens was likely to be responsible for a high prevalence in semiurban India.[1] Probably transmission by fomites only plays a role when infested individuals shed hundreds or thousands of mites per day, as was likely the case in some of the patients studied, particularly in children.

Surprisingly, regularly taking a shower was identified as a protective factor, whereas the use of soap was not. Although scabies has been considered as a disease of inadequate hygiene and deficient body care since ancient times, this assumption has rarely been confirmed before. In Bangladesh, Stanton et al[20] found poor hygiene practices (lack of hand washing, sari misuse [eg, to dry dirty hands or wipe the anus after defecation]) positively associated with the incidence of scabies, but failed to provide a plausible explanation. To the contrary, a high prevalence of scabies has been reported from the Cunha Indians in Panama, a population that cares much about personal hygiene and where individuals bathe several times a day.[14] It may, therefore, be concluded that good hygiene and personal care go together with a higher level of education and a higher socioeconomic status, and are not protective factors by themselves.

Clearly, our study has several limitations. First, men were underrepresented in the study population. One can, therefore, not conclude that prevalence of scabies was identical in male and female participants in both seasons of the year, because a small percentage of the adult male population were not examined, either because individuals did not fulfill the admission criterion (presence in the village for at least 4 days a week during the last 6 months), or because they were absent when the door-to-door surveys were carried out. However, previous studies in similar settings indicate that the prevalence of scabies is similar in male and female individuals irrespective of age group.[9] Second, because of technical constraints we were not able to verify the specificity and sensitivity of the case definition used. Because of technical and logistical constraints skin scrapings could not performed. Dermatoscopy was not considered to be an alternative because, in our experience, this technique frequently yields false-negative results in colored skin as was the case with the study participants (J. Heukelbach, unpublished observation 2007).

In conclusion, our data confirm that poor living conditions (inadequate housing, numerous children in the household), illiteracy, and frequent body contact are the main factors that keep transmission of *S scabiei* at a high level in impoverished communities. We suggest that in the developing world scabies is embedded in a complex web of causation that makes the control of parasitic skin diseases a difficult task.

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Prevalence and risk factors of hookworm-related cutaneous larva migrans in a rural community in Brazil

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The epidemiology of hookworm-related cutaneous larva migrans (HrCLM) in endemic communities is not well understood. To describe the prevalence of HrCLM and to identify environmental and behavioural risk factors for the infestation, two cross-sectional surveys were conducted in a small village in an endemic area of north–eastern Brazil — one in the rainy season and the other in the dry season. The members of each household were examined clinically for the presence of HrCLM, and information on possible risk factors was collected. HrCLM, which was diagnosed in 45 individuals in the rainy-season survey and in 17 in the dry-season survey, was significantly more prevalent in the rainy season (4.4% *v.* 1.7%; $P<0.001$). The age-specific prevalences peaked, at 14.9%, in infants and children aged $\leqslant 4$ years.

In a logistic regression analysis, the independent risk factors for current infestation or infestation in the preceding 6 months were identified as young age (odds ratio=0.96; 95% confidence interval=0.94–0.98), living in a house without a solid floor (odds ratio=1.99; 95% confidence interval=1.22–3.23), and walking barefoot (odds ratio=1.77; 95% confidence interval=1.12–2.80). In the study area, therefore, HrCLM is a common parasitic skin disease in children, is associated with behavioural and environmental risk factors, and shows marked seasonality in its prevalence. Local control of HrCLM should be based primarily on the health education of mothers and the elder girls who take care of their younger siblings.

Hookworm-related cutaneous larva migrans (HrCLM) is a parasitic skin disease of humans caused by infestation with larvae from 'non-human' hookworms such as *Ancylostoma braziliense* and *A. caninum* (Caumes and Danis, 2004). The larvae penetrate rapidly into the epidermis when the exposed skin of a human (usually the foot) comes into contact with soil that is contaminated with the faeces from an infected mammal, such as a dog or cat. The larvae cannot penetrate the basal membrane of human skin, however, and are therefore trapped in the epidermis (Davies *et al.*, 1993; Albanese *et al.*, 1995; Blackwell and Vega-Lopez, 2001; Heukelbach *et al.*, 2002), where they migrate aimlessly through the stratum corneum, for weeks or even months, until they die (Jelinek *et al.*, 1994; Caumes *et al.*, 1995; Blackwell and Vega-Lopez, 2001). The condition occurs world-wide but predominantly affects inhabitants of warm-climate countries (McCrindle *et al.*, 1996; Heukelbach *et al.*, 2003).

In the cooler, temperate regions of the world, HrCLM is now commonly diagnosed in travellers returning from tropical and subtropical countries (Jelinek *et al.*, 1994;

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Caumes *et al.*, 1995; Romano *et al.*, 2004; Ansart *et al.*, 2005; Boggild *et al.*, 2006; Diaz, 2006; Freedman *et al.*, 2006). In endemic communities in the developing world, HrCLM occurs mainly in children and is associated with considerable morbidity (Heukelbach *et al.*, 2004; Jackson *et al.*, 2006). Usually, several larval tracks co-exist, frequent re-infestation is the rule, and the skin lesions rapidly become super-infected (Heukelbach *et al.*, 2004; Jackson *et al.*, 2006). In a recent study in a resource-poor community in north–eastern Brazil, 81% of those suffering from HrCLM said that they were unable to sleep normally because of the infestations (Jackson *et al.*, 2006).

There have been few attempts to identify the most vulnerable groups and risk factors for HrCLM in endemic communities. The aim of the present study was to explore such epidemiological characteristics of the infestation in Feliz Deserto, a village in north–eastern Brazil, using data collected in two door-to-door surveys — one in the dry season of 2003 and the other in the rainy season.

SUBJECTS AND METHODS

Setting

At the time of the present study, 3850 people lived in Feliz Deserto, which lies on the Atlantic coast, about 120 km south of Maceió, the capital of Alagoas state, in north–eastern Brazil. The village is typical of many rural communities in the region.

To get some idea of the prevalences of HrCLM and other parasitic skin diseases in the target population, and to determine the sample size necessary for a risk-factor study, a pilot study was performed in 105 randomly selected households, which together held 521 people, in those districts of Feliz Deserto, where — according to local health personnel and community leaders — HrCLM had occurred in the previous 5 years. These districts, which were defined as the study area, had a combined population of about 1250. The results of the pilot study showed that HrCLM is a known entity in the study community and is correctly diagnosed by all affected individuals or their care-givers.

Study Design

After the pilot study, two cross-sectional, door-to-door surveys covering every household in the study area were conducted, one in June–July 2003 (the end of rainy season) and the other in October–November 2003 (the middle of the dry season). The members of each household were examined clinically for the presence of HrCLM and other parasitic skin diseases. At the same time, using standardized pre-tested questionnaires, information on socio–demographic, environmental and behavioural variables was collected and each subject who did not have HrCLM was asked if they had suffered from the infestation in the previous 6 months. If a household member was absent, the household was revisited up to three times, or an appointment was made for the absentee at the local healthcare centre. To be included in the study, individuals had to spend at least 4 days per week in a household in the study area. To eliminate inter-observer bias, all the clinical examinations were carried out by the same investigator (A.J.).

Clinical Examination and Diagnosis of HrCLM

In each study household, in a room with good light and in which privacy was guaranteed, the skin of each subject was thoroughly examined for the presence of HrCLM. Body areas that a subject did not want to show (the genitals and/or breasts) were not examined.

The diagnosis of HrCLM was based upon the characteristic clinical picture: an elevated linear or serpiginous lesion which had moved forward during the preceding days, with associated pruritus and with or without an erythematous papule. Any clinically evident super-infection was documented. The clinical characteristics of the HrCLM seen in Feliz Deserto were recently described by Jackson *et al.* (2006).

Data Analysis

Version 6.04d of the Epi Info software package (Centers for Disease Control and Prevention, Atlanta, GA) was used for the data storage. All the data were entered into an Epi Info database, checked for entry errors and then analysed in version 9.0 of the Stata® software package (StataCorp, College Station, TX). Fisher's exact tests were used to determine the significance of the differences seen in relative frequencies. After bivariate analysis, multivariate logistic regression, using backward elimination, was performed to calculate adjusted odds ratios for the independent associations between the explanatory variables and HrCLM. To increase the number of positive observations, logistic regression was performed using not only the data on the current presence of HrCLM (determined by clinical examination) but also those on an history of HrCLM in the previous 6 months (identified through interview). Each variable that gave a *P*-value of <0.2 in the bivariate analysis was considered in the multivariate regression model.

Ethical Considerations

Ethical clearance was obtained from the Ethical Committee of the *Escola de Ciências Médicas de Alagoas,* the main ethical body in the state of Alagoas, as well as from an ad-hoc ethical committee of the health department of the municipality of Feliz Deserto. All participants were informed about the study and written consent was obtained from each subject (in the case of adults) or his or her care-givers (in the case of children). Patients with HrCLM were treated, immediately post-diagnosis, with topical thiabendazole. Subjects found to have other parasitic skin diseases were referred to the local primary-healthcare centre, for appropriate treatment.

RESULTS

In the first door-to-door survey, in the rainy season, 1015 (88.6%) of the 1146 eligible individuals in the study area were examined. Between the first and the second surveys, 17 families moved out of the study area and 13 families moved in. In the second survey, in the dry season, 990 (91.1%) out of the 1087 individuals then eligible for inclusion in the study were examined.

Overall, 62 cases of HrCLM (45 in the first survey, and 17 in the second; see Table 1) were diagnosed, in a total of 60 subjects (two individuals were found to have the disease in both surveys).

The disease was more common in children than in adults (Table 1). In the rainy-season survey, for example, 15% of infants and children aged $\leqslant 4$ years but only 0.7% of adults aged >20 years had HrCLM. The overall prevalence of HrCLM among the subjects aged $\leqslant 4$ years was significantly higher than that in any other age-group considered (with *P*-values of 0.04 for the comparison with the 15- to 19-year-olds and $\leqslant 0.003$ for all the other comparisons). Subjects aged <10 years accounted for 48 (77.4%) of the 62 cases of HrCLM detected in the community.

Although, in both surveys, the prevalence of HrCLM was higher in males than in females, the differences were not statistically significant (with *P*-values of 0.3 in the rainy season and 0.2 in the dry season; Table 1).

Although the overall prevalence of HrCLM was 2.5-fold higher in the rainy season than in the dry season (4.4% *v.* 1.7%; $P<0.001$), the level of seasonal variation in prevalence was not equal across all age-groups (Table 1). The increase in prevalence in the rainy season (compared with the corresponding dry-season value) was most prominent in children aged $\leqslant 4$ years, independent of their gender, although there was only a slightly smaller increase in adolescent males aged 15–19 years (see Figure).

The risk-factor analysis was performed not only for the 60 subjects found to have HrCLM in one or both of the surveys but also for the combination of these 60 individuals and the 90 subjects who said that they had HrCLM at least once in the 6 months preceding either survey (Table 2). Young age and walking barefoot were clearly associated with HrCLM in the bivariate analysis, whether the analysis was confined to the cases of current infestation or expanded to also cover those with a recent history of the infestation (Table 2). Low family income, the absence of solid floors in the houses, and lack of a toilet on the compound were each significantly associated with current/recent HrCLM, but not with just current HrCLM.

The results of the logistic regression analysis, which was based on the data for the 150 subjects with current/recent HrCLM, identified young age, living in a house without a solid floor, and walking barefoot as independent risk factors (Table 3).

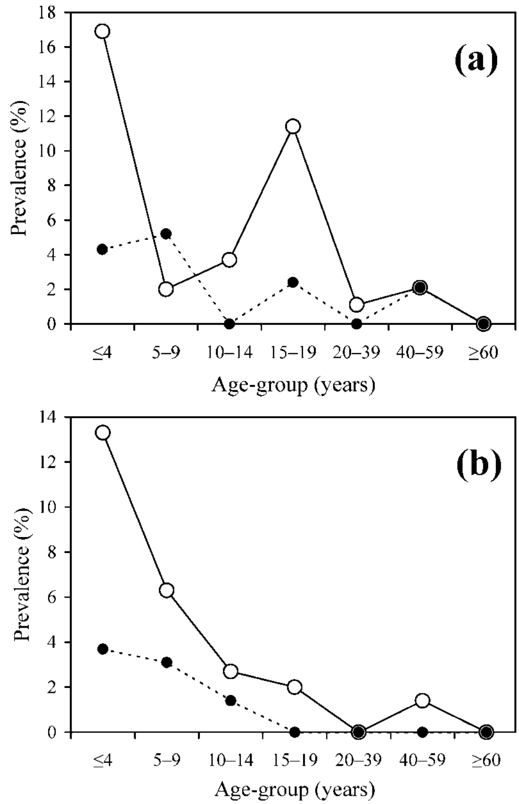

FIG. The age-specific prevalences of hookworm-related cutaneous larva migrans observed, during the rainy (○) and dry seasons (●), in the male (a) and female (b) subjects.

TABLE 1. *Prevalences of hookworm-related cutaneous larva migrans (HrCLM) during the dry and rainy seasons, stratified by gender and age-group*

	Dry season			Rainy season				
	No. of subjects: Examined	No. of subjects: With HrCLM	Prevalence and (95% confidence interval) (%)	No. of subjects: Examined	No. of subjects: With HrCLM	Prevalence and (95% confidence interval) (%)	*P*	Ratio of rainy-season:dry-season prevalence
Total	990	17	1.7 (0.9–2.5)	1015	45	4.4 (3.2–5.7)	<0.001	2.6
GENDER								
Female	537	7	1.3 (0.3–2.3)	556	21	3.8 (2.2–5.4)	0.01	2.9
Male	453	10	2.2 (0.9–3.6)	459	24	5.2 (3.2–7.3)	0.02	2.4
AGE-GROUP (years)								
⩽4	151	6	4.0 (0.8–7.1)	154	23	14.9 (9.2–20.6)	0.001	3.7
5–9	193	8	4.2 (1.3–7.0)	194	8	4.1 (1.3–6.9)	1	0.9
10–14	145	1	0.7 (0–2.1)	154	5	3.3 (0.4–6.1)	0.22	4.7
15–19	88	1	1.1 (0–3.4)	95	6	6.3 (1.3–11.3)	0.12	5.7
20–39	241	0	0 (–)	252	1	0.4 (0–1.2)	1	–
40–59	122	1	1.0 (0–2.4)	119	2	1.7 (0–4.0)	0.6	1.7
⩾60	50	0	0 (–)	47	0	0 (–)	–	0

TABLE 2. *Bivariate analysis factors associated with hookworm-related cutaneous larva migrans (HrCLM), determined using the data from 1184 subjects*

		Current HrCLM (*N*=60)			Current or previous HrCLM (*N*=150)*		
Variable	No. of subjects	No. and (%) positive	Odds ratio and (95% confidence interval)	*P*	No. and (%) positive	Odds ratio and (95% confidence interval)	*P*
SOCIO–DEMOGRAPHIC FACTORS							
Gender							
Male	559	33 (5.9)	1.38 (0.80–2.43)	0.23	70 (12.5)	0.96 (0.68–1.40)	0.93
Female	625	27 (4.3)			80 (12.8)		
Age-group (years)							
<15	569	50 (8.8)	5.82 (2.88–13.00)	<0.0001	108 (19.0)	3.20 (2.17–4.78)	<0.0001
⩾15	615	10 (1.6)			42 (6.8)		
Literacy							
Illiterate	354	23 (6.5)	1.48 (0.82–2.64)	0.19	51 (14.4)	1.19 (0.81–1.74)	0.34
Literate	760	34 (4.5)			94 (12.4)		
Monthly family income (R$)†							
<200	662	33 (5.0)	1.20 (0.64–2.29)	0.66	95 (14.4)	1.71 (1.14–2.63)	0.01
⩾200	428	18 (4.2)			38 (8.9)		
No. of people in household:							
⩾4	903	45 (5.0)	1.58 (0.66–4.61)	0.35	120 (13.3)	2.05 (1.12–4.06)	0.14
<4	187	6 (3.2)			13 (7.0)		
HOUSING AND ASSOCIATED FACTORS							
Type of house							
Palm products or similar	14	1 (7.1)	1.58 (0.04–10.91)	0.49	4 (28.6)	2.94 (0.66–10.35)	0.08
Bricks/adobe	1076	50 (4.7)			129 (12.0)		
Type of floor inside house							
Sand/clay	148	11 (7.4)	1.81 (0.82–3.70)	0.09	30 (20.3)	2.07 (1.27–3.30)	0
Concrete/tiles	942	40 (4.3)			103 (10.9)		
Electricity?							
No	127	8 (6.3)	0.37 (0.57–3.19)	0.37	20 (15.8)	1.41 (0.79–2.39)	0.2
Yes	963	43 (4.5)			113 (11.7)		
Toilet							
None	211	12 (5.7)	1.30 (0.61–2.59)	0.47	35 (16.6)	1.58 (1.01–2.44)	0.035
Pit latrine/water closet	879	39 (4.4)			98 (11.2)		
Public waste collection?							
No	139	9 (6.5)	1.50 (0.63–3.21)	0.28	23 (16.6)	1.52 (0.89–2.51)	0.1
Yes	951	42 (4.4)			110 (11.6)		
BEHAVIOURAL FACTORS							
Dog ownership?							
Yes	401	17 (4.2)	0.76 (0.41–1.39)	0.4	53 (13.2)	1.08 (0.74–1.56)	0.71
No	783	43 (5.5)			97 (12.4)		
Cat ownership?							
Yes	391	13 (3.3)	0.55 (0.27–1.04)	0.07	46 (11.8)	0.88 (0.60–1.30)	0.58
No	793	47 (5.9)			104 (13.1)		
Spends evening in area?							
Yes	1032	54 (5.2)	1.52 (0.47–7.80)	0.62	139 (13.5)	1.76 (0.79–4.06)	0.18
No	86	3 (3.5)			7 (8.1)		
Walks barefoot?							
Always	43	5 (11.6)	11.6 (1.52–20.33)	0.006	8 (18.6)	3.09 (1.14–7.52)	0.013
Sometimes	480	30 (6.3)	3.03 (1.42–7.03)	0.002	82 (17.1)	2.79 (1.78–4.43)	<0.0001
Never	465	10 (2.2)			32 (6.9)		

*The 60 individuals with current infestation plus 90 with history of infestation in the previous 6 months.
†At the time of this study 2.40 Brazilian Reais (R$) were the equivalent of U.S.$1.00.

DISCUSSION

Although generally neglected by the public-health sector and the scientific community, HrCLM can be a common condition in warm-climate countries, especially in resource-poor communities. There are few basic epidemiological data available and control in the endemic areas has rarely been attempted (McCrindle *et al.*, 1996). Thus, HrCLM can be considered another neglected disease of neglected populations (Molyneux *et al.*, 2005; Harms and Feldmeier, 2007).

The present results indicate that, in a typical rural village in Brazil, HrCLM is a common parasitic skin disease in small children and male adolescents. While the infants and small children appear to be at constant high risk of acquiring HrCLM, boys aged 15–19 years are predominantly affected in the rainy season. The latter observation may be explained by gender-related behaviour patterns that are accentuated in the rainy season. Adolescent girls generally stay at home during the day, performing domestic chores, chatting with friends, styling their hair, or grooming younger siblings, whereas their male counterparts, whatever the season, tend to linger in the streets or play soccer barefoot in public squares, where dogs and cats stroll around.

The age-, gender- and season-specific trends seen in the prevalence of HrCLM in Feliz Deserto are useful indicators of where and when the larvae that cause the disease are acquired. In rural Brazil, infants and toddlers are allowed to crawl or sit on the ground inside the house or in the surrounding compound, whatever the season, sometimes without wearing nappies or underwear. Given these habits, the observation that, in children aged <5 years, prevalence was high (and 3.7-fold higher in the rainy season than in the dry season) indicates that most transmission to humans of the larvae causing HrCLM probably occurs in domestic or, particularly, peridomestic areas.

In the rainy season, animal faeces will be dispersed with each precipitation, thereby increasing the area of contamination, and the parasites that cause HrCLM are more likely to develop successfully into the mammal-infective third-stage larvae, and also survive longer, in damp soil than in dry soil (Heukelbach *et al.*, 2003). This is why, in another endemic area of Brazil, precipitation and the incidence of HrCLM were found to be closely related (Heukelbach *et al.*, 2003). Interestingly, those living in endemic areas are often aware that HrCLM is associated with rainfall (Dafalla *et al.*, 1977; Heukelbach *et al.*, 2003).

Although tourists to endemic areas rarely visit resource-poor communities, they may often walk barefoot, across soil that may well be contaminated with the larvae that can cause HrCLM, on their way to and from beaches and on the beaches themselves. In France, Ansart *et al.* (2007) recently found tourists to be at significantly greater risk of HrCLM than migrants, expatriates or business travellers. In a group of Canadian tourists who had visited Barbados, walking

TABLE 3. *The results of a logistic regression analysis for factors associated with hookworm-related cutaneous larva migrans*

Factor	Adjusted odds ratio and (95% confidence interval)	*P*
Age (years)	0.96 (0.94–0.98)	<0.001
Monthly family income <R$200*	1.50 (0.97–2.33)	0.07
Sand or clay floor inside house	1.99 (1.22–3.23)	0.005
Always walks barefoot	1.77 (1.12–2.80)	0.014

*At the time of this study 2.40 Brazilian Reais (R$) were the equivalent of U.S.$1.00.

barefoot to and on the beach were found to be significant risk factors for acquiring HrCLM (Tremblay *et al.*, 2000). In a recent study on international travellers who had had vacations in north–eastern Brazil, all of those who had acquired HrCLM during their stay had visited beaches (Heukelbach *et al.*, 2007). Thus, walking barefoot appears to be a universal risk factor, not only for the residents in endemic areas but also for visitors.

Besides behavioural characteristics, several socio–economic variables were found to be risk factors for current/recent HrCLM in the present study. These were family income, lack of a toilet on the compound, and a floor consisting of sand or clay. Theoretically, in dwellings without a solid floor, transmission may occur inside, if animals defecate in the house or carry faecal material, attached to their paws, from outside into the interior. In practice, however, transmission within houses is probably unlikely, and the absence of a solid floor — together with a lack of basic sanitation and a low family income — simply indicates a household of relatively low economic status.

Although dog or cat ownership were not identified as risk factors in Feliz Deserto, most dogs and cats in the community are free to roam where they want and this presumably means that owners are no more likely to come into contact with dog or cat faeces than those who do not own a dog or cat themselves.

The present results have to be treated with a little caution because they are based only on a clinical diagnosis of current HrCLM and self-diagnosis of recent HrCLM, and other conditions that may cause creeping eruptions, such as scabies, gnathostomiasis, loiasis or dracunculiasis, may be mistaken for HrCLM (Caumes, 2006). The entire body of each subject was specifically checked for (and found free of) the typical clinical signs of scabies, however, and no gnathostomiasis, loiasis or dracunculiasis has ever been reported in the study area.

The present data indicate that the most effective strategy for controlling HrCLM in Feliz Deserto (and probably many other rural communities in north–eastern Brazil) may be health education that is targetted at mothers and the elder girls who take care of their younger siblings. If infants, toddlers and small children were not allowed to play or sit on the ground outside their houses, most cases of HrCLM in the community could be avoided. Health education will probably fail to reduce the incidence in the second high-risk group: male adolescents. Most families in Feliz Deserto are too poor to afford shoes for all their children and, in any case, children with shoes still often walk and play soccer barefoot. In theory, the incidence of HrCLM could be greatly reduced by the regular treatment of all dogs and cats with anthelminthic drugs, but this is a difficult endeavour given the costs and the large number of stray animals to be found in Feliz Deserto and many other resource-poor communities. It may be much more feasible and effective to fence around public places used for soccer, to prevent the faecal contamination of the playing area. General improvements in houses and compounds, though cost-intensive, may also be beneficial and help protect children from HrCLM as well as other parasitic diseases, such as tungiasis (Muehlen *et al.*, 2006).

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Research article

Parasites of importance for human health in Nigerian dogs: high prevalence and limited knowledge of pet owners

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Abstract

Background: Dogs are the most common pet animals worldwide. They may harbour a wide range of parasites with zoonotic potential, thus causing a health risk to humans. In Nigeria, epidemiological knowledge on these parasites is limited.

Methods: In a community-based study, we examined 396 dogs in urban and rural areas of Ilorin (Kwara State, Central Nigeria) for ectoparasites and intestinal helminths. In addition, a questionnaire regarding knowledge and practices was applied to pet owners.

Results: Nine ectoparasite species belonging to four taxa and six intestinal helminth species were identified: fleas (*Ctenocephalides canis, Pulex irritans, Tunga penetrans*), mites (*Demodex canis, Otodectes* sp., *Sarcoptes scabiei* var. *canis*), ticks (*Rhipicephalus sanguineus, Ixodes* sp.), and lice (*Trichodectes canis*); and *Toxocara canis, Ancylostoma* sp., *Trichuris vulpis, Dipylidium caninum*, Taenidae and *Strongyloides* sp. Overall prevalence of ectoparasites was 60.4% and of intestinal helminths 68.4%. The occurrence of *C. canis, R. sanguineus, T. canis, Ancylostoma* sp. and *T. vulpis* was most common (prevalence 14.4% to 41.7%). Prevalence patterns in helminths were age-dependent, with *T. canis* showing a decreasing prevalence with age of host, and a reverse trend in other parasite species. Knowledge regarding zoonoses was very limited and the diseases not considered a major health problem. Treatment with antiparasitic drugs was more frequent in urban areas.

Conclusion: Parasites of importance for human health were highly prevalent in Nigerian dogs. Interventions should include health education provided to dog owners and the establishment of a program focusing on zoonotic diseases.

Background

Dogs are the most successful canids, adapted to human habitation worldwide. They have contributed to physical, social and emotional well-being of their owners, particularly children [1,2]. However, in spite of the beneficial effects, close bonds of dogs and humans (in combination with inappropriate human practices and behaviour) remain a major threat to public health, with dogs harbouring a bewildering number of infective stages of parasites transmissible to man and other domestic animals [2-

4]. For example, well-known and important zoonotic diseases are cutaneous and visceral larva migrans, hydatid disease and tungiasis [5-8].

In low-income settings, treatments to eliminate these parasites are – if done at all - often applied in advanced stages of disease, causing distress on pets and their owners [9,10].

In many African countries, including Nigeria, appropriate policies regarding pet ownership and their effects on individual and community health are nonexistent. Prevalence of parasite infection in dogs with importance for human health is usually high, resulting in risk of zoonotic transmission from dogs to humans. The risk is further increased by non-favourable ecological and human behavioural factors [11-13].

Previous epidemiological studies on dog parasites in Nigeria were focused on the prevalence with little or no information on quantitative measure of infection and/or were not community-based [14-17]. Thus, we examined a representative population of dogs in urban and rural areas in a Nigerian city for the presence of possibly zoonotic parasites.

Methods

Study Area

The study was conducted in the city of Ilorin (Central Nigeria), and the neighbouring rural communities (longitude 4° 30' – 4° 45'N and latitude 8° 28' – 8° 38'E; Figure 1). Ilorin is an urban centre and the capital of Kwara State. The city covers an area of about 38 square miles, with an estimated population of 1.4 million people. It is located in Nigeria's central savannah region with intense rainfalls from April to October and daily temperatures between 23°C and 37°C.

The urban area of Ilorin is surrounded by rural villages with mainly agricultural-based economy. Living conditions are particularly poor in these rural communities, and a substantial proportion of the villagers keeping dogs have no access to veterinary services. Therefore, most dogs have never been treated for any form of parasitic diseases prior to the study. In addition, most dogs are not vaccinated.

Study design

A random house-to-house screening of dogs was conducted between October 2006 and May 2007. With the informed consent of dog owners, interviews were conducted using pre-tested structured questionnaires to obtain information on the dogs' age, sex, regimen, defaecation sites, previous anthelminthic treatment and disease-related knowledge of owners. Thereafter, pre-labeled specimen containers were distributed for the collection of stool samples. A screening of ectoparasites on dogs was performed before fecal specimen collection.

In households with more than one dog, only one dog (chosen by the dog owner) was included.

Sample collections

Dogs were thoroughly examined for ectoparasites by combing the entire body surfaces on a clear sheet of white paper. To facilitate the extraction of ectoparasites, the

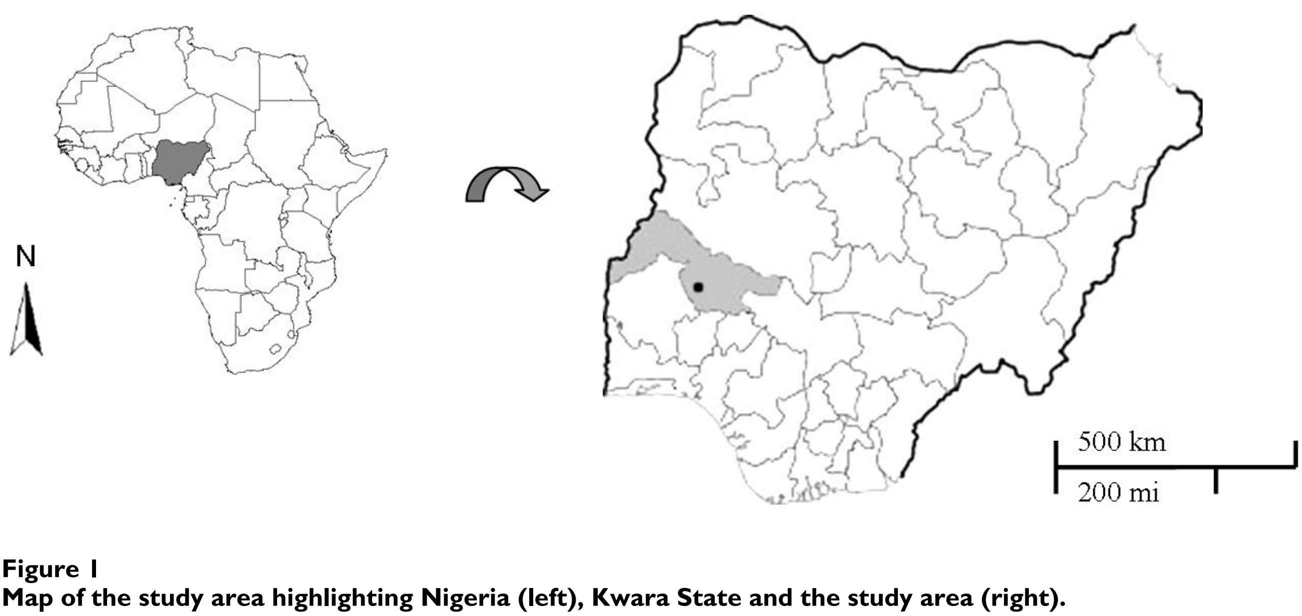

Figure 1
Map of the study area highlighting Nigeria (left), Kwara State and the study area (right).

dogs were rubbed with a piece of cotton-wool soaked in ether. The ectoparasites recovered were preserved in 70% alcohol for identification.

For the diagnosis of intestinal helminths, freshly passed faecal samples from dogs were collected from dog owners and examined macroscopically for proglottides. Thereafter, a sub-sample of faeces was taken into a pre-labelled clean sterile universal plastic bottle containing 10% formaldehyde solution. All samples were carried to the parasitology laboratory at the University of Ilorin and processed for microscopic examination.

Laboratory procedures

Fleas, ticks and lice were cleared in 10% potassium hydroxide (KOH) solution overnight, dehydrated in ascending strength of alcohol and mounted in Canada balsam. Mites were mounted directly in Berlese fluid. Examination was done at 40× magnification under a dissecting microscope.

A duplicate 50 mg Kato-Katz thick smear was prepared from each faecal sample, using the Kato-Katz technique, as modified by Forrester and Scott [18]. In short, a small portion (1–3 g) was sieved through double-ply gauze to remove rough materials. The filtrate was centrifuged at 3000 rpm for 3 min, the supernatant decanted, and the tube allowed to stand for 10 min. Fifty mg of the sediment delivered by Kato-Katz template was taken onto a degreased glass slide, and covered with a cellophane strip soaked overnight in 50% solution of glycerol-malachite green. Slides were examined for helminths eggs under a light microscope immediately after preparation. Parasite eggs were identified based on the morphological characteristics. Density of infection, as expressed by eggs per gram (EPG) of faeces, was calculated by multiplying each slide count by 20 [19].

Data Entry and Statistical Analysis

Data were entered using an excel spreadsheet and checked for entry errors, by comparing data entries with the original data forms. Then, data were transferred to Stata® software package (version 9.0; Stata Corporation, College Station, USA) for analysis. The Fisher's exact test was applied to determine the significance of differences of relative frequencies and the one-way ANOVA test to determine significance of differences of mean egg counts.

Results

A total of 396 dogs, consisting of 180 (45.5%) males and 216 (54.5%) females was examined; 192 (48%) dogs lived in urban, and 204 (52%) in rural areas.

All dog owners agreed to participate and completed the questionnaires. Table 1 summarizes the differences in dog regimen and the perception of dog owners to diseases transmissible by their animals, stratified by urban and rural areas. In the rural area, significantly more individuals kept dogs for hunting and observed their dogs catching prey than in the city ($p < 0.0001$), whereas 29.2% and 18.1% of dog owners in the urban and rural areas kept dogs as watch dogs, respectively (Table 1). Treatment with antiparasitic drugs was a more frequent practice for dogs from urban than rural areas.

Interestingly, more than half of dog owners in the rural communities, and about a third in the urban area did not perceive diseases transmitted by dogs as a health problem ($p < 0.0001$). The bonds of humans with their animals were close, and children played with virtually all dogs included in the study (Table 1). When asked about possible diseases transmitted by their dogs, less than 10% of owners mentioned helminths ("worms") as a health problem, but about two third were aware of the risk of rabies transmission (Table 1).

Ectoparasites

At least one of nine ectoparasite species identified, belonging to four taxa, was encountered in 239 (60.4%) of the 396 dogs. Dogs from rural areas (77.9%) were more commonly infested than those from urban areas (41.7%; $p < 0.0001$). Eighty (20.3%) dogs harboured two or more species. Dogs from rural areas were more frequently parasitized with two or more ectoparasites than the urban dogs (Table 2).

In total, 155 (39.1%) were infested with fleas, 94 (23.7%) with ticks, 51 (12.9%) with mites, and 42 (10.6%) with lice. The prevalence detailed for each ectoparasite species is depicted in Table 2, stratified by urban and rural areas.

The common dog flea, *Ctenocephalides canis*, was the most prevalent species and present in almost one third of dogs, followed by the brown dog tick *Rhipicephalus sanguineus*, *Trichodectes canis*, *Otodectes* sp., *Pulex irritans* and *Ixodes* sp. (Table 2). Infestations due to the sand flea *Tunga penetrans*, the mange mite *Sarcoptes scabiei* var. *canis* and *Demodex canis* were less common.

The prevalence of *C. canis* and of *Otodectes* sp. was significantly higher in rural dogs than in urban dogs. A similar trend was observed for *P. irritans* and *R. sanguineus* (Table 2).

Intestinal helminths

In total, 271 (68.4%) of the examined dogs were infected with at least one intestinal helminth species. Six species, namely *Toxocara canis*, *Ancylostoma* sp.*Trichuris vulpis*, *Dipylidium caninum*, Taenidae and *Strongyloides* sp. were identified in dogs of both urban and rural areas (Table 3).

Table 1: Characteristics of dogs and knowledge and attitudes of dog owners regarding potential zoonotic disease in urban and rural communities.

Variables	Urban n = 192		Rural n = 204		Urban Vs. rural
	N	%	N	%	*p* value
Sex of dogs					
Male	91	47.4%	89	43.6%	0.5
Female	101	52.6%	115	56.4%	0.5
Age of dogs (months)					
0–6	61	31.8%	73	35.8%	0.4
7–11	49	25.5%	59	28.9%	0.4
≥ 12	82	42.7%	72	35.3%	0.1
Reasons for keeping dogs					
Hunting	71	37.0	115	56.4	< 0.0001
Watch dog	56	29.2	37	18.1	0.013
Companion	43	22.4	32	15.7	0.1
No specific reason	22	11.5	20	9.8	0.6
Where do dogs usually roam?					
Confined to dog house on compound	18	9.4	7	3.4	0.022
Inside the house	3	1.6	11	5.4	0.055
Within the compound	57	29.7	33	16.2	0.002
Anywhere within and outside the compound	114	59.4	153	75.0	0.001
How do dogs leave house premises					
Always accompanied	35	18.2	10	4.9	< 0.0001
Occasionally accompanied	67	34.9	80	39.2	0.4
Never Accompanied	90	46.9	114	55.9	0.09
Usual place of defecation					
Within the house premises	66	34.4	54	26.5	0.1
Within/out of house premises	126	65.6	150	73.5	0.1
Preferred type of floor where dogs defecate					
Only impervious (cemented/tiles)	29	15.1	16	7.8	0.027
Only pervious (grass, soil, etc)	56	29.2	86	42.2	0.009
Both pervious/impervious	107	55.7	102	50.0	0.3
Observation on dogs catching prey	118	61.5	164	80.4	< 0.0001
Last anthelminthic treatment of dogs					
< 12 months ago	42	21.9	20	9.8	0.001
≥ 12 months ago	56	29.2	38	18.6	0.018
Never	94	49.0	146	71.6	< 0.0001
Dog owners' knowledge of possible diseases/conditions transmitted or caused by dogs*					
Rabies	124	64.6	136	66.7	0.7
Wound from dog bite	75	39.1	85	41.7	0.6
Scabies	35	18.2	28	13.7	0.3
Worms	11	5.7	15	7.4	0.5
Dysentery	6	3.1	10	4.9	0.4
Other bacterial/viral diseases	5	2.6	12	5.9	0.14
Do children play with dogs?					
Yes	191	99.5	204	100	0.5
No	1	0.5	0	0	0.5
Dog owners' perception of diseases transmitted by dogs					
Serious	35	18.2	23	11.3	0.064
Not serious	91	47.4	72	35.3	0.019
Do not cause any disease	66	34.4	109	53.4	< 0.0001

*more than one option possible

Table 2: Prevalence of ectoparasites in dogs, stratified by urban or rural communities.

	Overall (n = 396)		Urban (n = 192)		Rural (n = 204)		Urban vs. Rural
	N infected	% (95%CI)	N infected	% (95%CI)	N infected	%(95%CI)	*p* value
Fleas							
Ctenocephalides canis	127	32.1(27.5 – 6.9)	40	20.8(14.9 – 26.7)	87	42.6(35.8 – 49.7)	< 0.0001
Pulex irritans	26	6.6(4.3 – 9.5)	7	3.6(1.5 – 7.4)	19	9.3(5.7 – 14.2)	0.026
Tunga penetrans	2	0.5 (0.0 – 1.8)	0	0.0	2	1.0(0.0 – 3.5)	0.5
Mites							
Demodex canis	4	1.0 (0.0 – 2.6)	0	0.0	4	2.0(0.0 – 4.9)	0.12
Otodectes sp.	39	9.8(7.1 – 13.2)	6	3.1(1.2 – 6.7)	33	16.2(11.4 – 22.0)	< 0.0001
Sarcoptes scabiei var. canis	8	2.0(0.1 – 3.4)	1	0.5(0.0 – 2.9)	7	3.4(1.3 – 6.9)	0.069
Ticks							
Rhipicephalus sanguineus	76	19.2(15.4 – 23.4)	25	13.0(8.6 – 18.6)	51	25.0(19.2 – 31.5)	0.003
Ixodes sp.	18	4.5(2.7 – 7.1)	7	3.6(1.5 – 7.4)	11	5.4(2.7 – 9.4)	0.5
Lice							
Trichodectes canis	42	10.6(7.8 – 14.1)	15	7.8(4.4 – 12.6)	27	13.2(8.9 – 18.7)	0.1
Number of ectoparasite species per host							
One ectoparasite species	159	40.2(35.3 – 45.2)	60	31.3(24.8 – 38.3)	99	48.5(41.5 – 55.6)	< 0.0001
Two ectoparasite species	72	18.2(14.5 – 22.3)	19	9.9(6.1 – 15.0)	53	26.0(20.1 – 32.6)	< 0.0001
Three ectoparasite species	7	1.8(0.7 – 3.6)	1	0.5(0.0 – 2.9)	6	2.9(1.1 – 6.3)	0.12
Four or more ectoparasite species	1	0.3(0.0 – 1.4)	0	0.0	1	0.5(0.0 – 2.7)	1.0

The most common parasites were *T. canis*, followed by *Ancylostoma* sp. and *T. vulpis* (Table 3). Prevalence of the dog tapeworm, *D. caninum*, Taenidae and *Strongyloides* sp. were <10%.

Except for *D. caninum*, Taenidae and *Strongyloides* sp., the prevalence of intestinal helminths was not statistically different in urban or rural areas. However, multiple infections with 2 and 3 parasites species per host were significantly higher in rural than in urban areas (Table 3).

The pattern of prevalence and distribution of helminth parasites, stratified by age of dogs, is depicted in Figure 2. In general, prevalence of parasite infection increased with age of the dog. An exception was observed in *T. canis* infection, which was by far the most common infection in puppies, and showed decreasing prevalence with age. The density of infection, expressed by mean egg counts per gramme (epg) paralleled the prevalence data (Table 4).

Discussion

The present study provides the first systematic assessment on quantitative estimates of parasites in dogs in Nigeria's Kwara State. The results show that ectoparasitic and intestinal helminth species were abundant, and that prevalence and density of infection was very high. The knowledge and perception of dog owners regarding zoonotic diseases transmitted by pets was insufficient.

Table 3: Prevalence of intestinal helminths parasite in dogs, stratified by communities.

	Overall (n = 396)		Urban (n = 192)		Rural (n = 204)		Urban vs. Rural
	N infected	% (95% CI)	N infected	% (95% CI)	N infected	% (95% CI)	*p* value
Parasite species							
Toxocara canis	165	41.7 (36.8 – 46.7)	72	37.5 (30.6 – 44.8)	93	45.6 (39.6 – 53.7)	0.13
Ancylostoma sp.	67	16.9 (13.4 – 21.0)	27	14.1 (9.5 – 19.8)	40	19.6 (14.4 – 25.7)	0.18
Trichuris vulpis	57	14.4 (9.7 – 16.6)	28	14.6 (9.9 – 20.4)	29	14.2 (9.7 – 19.8)	1.0
Dipylidium caninum	36	9.1 (6.5 – 12.4)	11	5.7 (2.9 – 10.0)	25	12.3 (8.1 – 17.6)	0.035
Taenidae	33	8.3 (5.8 – 11.5)	3	1.6 (0.3 – 4.5)	30	14.7 (10.2 – 20.3)	< 0.0001
Strongyloides sp.	15	3.8 (2.1 – 6.2)	3	1.6 (0.3 – 4.5)	12	5.8 (3.1 – 10.1)	0.033
Number of intestinal helminth species per host							
One helminth species	196	49.4 (44.2 – 54.3)	92	47.9 (40.7 – 55.2)	104	51.0 (43.9 – 58.3)	0.6
Two helminth species	52	13.1 (10.0 – 16.9)	17	8.9 (5.2 – 13.8)	35	17.5 (12.3 – 23.0)	0.017
Three helminth species	18	4.6 (2.7 – 7.1)	4	2.1 (0.6 – 5.2)	14	6.9 (3.8 – 11.2)	0.029
Four or more helminth species	5	1.3 (0.0 – 2.9)	0	-	5	2.5 (0.1 – 5.6)	0.062

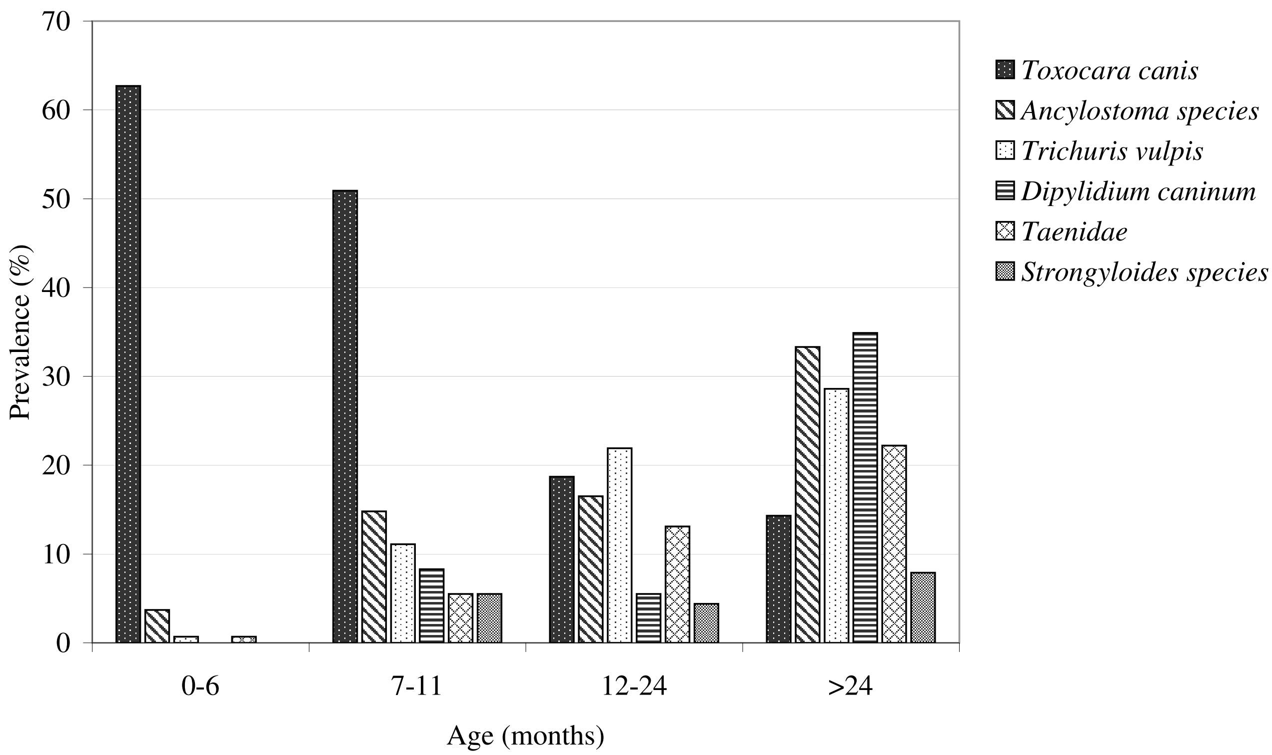

Figure 2
Prevalence of intestinal helminths species diagnosed in dogs, stratified by age of dogs.

The parasites reported in this study have been previously documented in dogs throughout the world, with a pronounced difference in prevalence and density between regions [16,17,20-27]. In our study, the overall prevalence of intestinal helminths (68%) was similar to that reported from different ecological and epidemiological settings in Nigeria [17,26] and to the prevalence of 71% reported from Spain [28]. In South Africa (76%), Mexico (85%) and Morocco (100%), prevalences were even higher [22,23,29].

This potential for human zoonotic disease has rarely been addressed in control programs in Nigeria and other low income countries. Considering the high prevalence of ectoparasites and intestinal helminth infections found in dogs, and the close bonds in which dogs live together with people, the risk of transmission of these parasites to humans seems to be obvious. For example, *Toxocara* infection in humans may cause visceral larva migrans, in severe cases leading to blindness [30], and dog hookworm infections put humans at risk for cutaneous larva migrans

Table 4: Density of intestinal parasites infection in dogs, stratified by rural and urban communities.

Parasite	Overall n = 396	Urban n = 192	Rural n = 204	Urban vs. Rural
	Mean (SD)	Mean (SD)	Mean (SD)	*p* value
Toxocara canis	375.6 (569.5)	264.1 (441.3)	480.47 (651.9)	0.001
Ancylostoma sp.	84.2 (221.5)	70.4 (207.6)	97.29 (233.5)	0.54
Trichuris vulpis	147.8 (440.6)	126.23 (404.2)	168.12 (477.4)	0.79
Dipylidium caninum	46.8 (189.7)	10.12 (85.9)	81.29 (246.2)	0.028
Taenidae	126.8 (435.0)	77.38 (336.6)	173.29 (507.1)	0.001
Strongyloides sp.	11.3 (68.1)	7.25 (57.8)	15.18 (76.5)	0.92

which is endemic in many resource-poor communities [31]. *Rhipicephalus* ticks have been described to parasitize humans [32], and may transmit rickettsial disease and visceral leishmaniasis [33]. Fleas may transmit human plague, rickettsioses and trypanosomes [34], and serve as intermediate hosts for the dog tapeworm, *D. caninum*.

Our data show that the prevalence pattern was age-dependent; *T. canis* decreased with age of dog, whereas *A. caninum, T. vulpis*, Taenidae, *D. caninum* and *Strongyloides* sp. increased with age, even though to a less extent. These patterns have been observed previously [16,17,20,23,27]. In Nigeria, Sowemimo and Asaolu [27] found by far the highest prevalence of toxocariasis in puppies, whereas the age dependency of hookworm infection was less pronounced. The high prevalence of ascarid infections in puppies is in accordance with the transmission pattern of the parasite, which is mainly by transplancental and transmammary routes; acquired age-dependent immunity may be caused by repeated exposure [35,36]. Increased infection rates in older dogs are caused by parasite species which are not transmitted to dogs at early age, and thus do not elicit a specific immune response.

The prevalence detected in our study differs from those of Sowemimo and Asaolu [27] who recorded 24% in a Nigerian city in a neighbouring state with similar characteristics as Ilorin. However, these data were not population-based, but included dogs presented to veterinary clinics. These authors also argued that the reduction of prevalence as compared to a study done in the 1970s [31] may be caused by increased awareness of pet holders regarding deworming practices. In contrast, our data can be regarded as representative for the dog population, as pet owners who bring their animals to veterinary clinics may deworm their animals more regularly. As a consequence, studies based on veterinary clinics underestimate prevalence of parasitic infections and infestations. Our data, though, show that the majority of dogs received antiparasitic treatment never or more than a year ago, and only few people were aware of the zoonotic potential of dog parasites; 60% of dogs examined had never visited a clinic for any form of treatment.

The reduced prevalence of *D. caninum* over time was claimed to be caused by the reduced prevalence of the intermediate host *C. canis*. This may hold true for pets brought to veterinary clinics, but our study shows that *C. canis* is very common in dogs in the community and thus probably continue being important for the transmission of *D. caninum*.

The intensities of *T. canis*, Taenidae and *D. caninum* were statistically higher in rural dogs than those in the urban area. Similarly, Habluetzel et al. [38] observed that twice as many dogs from rural areas had nematodes infections, as compared to urban dogs. These differences in the level of infection from different locations have been described also in other studies [39,40] and may be partly due to variation in local environmental conditions affecting spatial aggregation and infective stages of parasites. Besides, differences in health care and animal management practices may account for these differing characteristics. Urban dog owners may feel encouraged by their proximity to veterinary clinics, which are nonexistent in rural areas.

The number of intestinal parasite species per host revealed that single infection was more common; polyparasitism with more than two parasites species was less frequently observed. A similar pattern was observed in ectoparasite infestation. These results are in agreement with Fontanarrosa et al. [24] who explained that interactions among parasite species depend on parasite burden rather than the mere presence of other species.

The high prevalence of ectoparasites (60%) was consistent with another study, where fleas and ticks were the most commonly found taxa [41]. Ugochukwu and Nnadozie [42] recorded in Bendel State (Nigeria) a low prevalence of ectoparasites in dogs, including *Demodex canis, R. sanguineus* and *C. canis*. Bryson et al. [43] identified several species of ixodid ticks, fleas and lice from dogs in South Africa. However, *C. felis* and *Echidnophaga gallinacea* which were frequently reported in dogs in other study areas [39,42-44] were not encountered in our study.

The variation in distribution and prevalence of ectoparasites can be ascribed to differences in the availability of infective stages, host habitat/climatic factors and the sampling period. Peak prevalences of ectoparasites usually occur during the warm dry months [40,45,46]. Gracia et al. [40] revealed that accumulation of organic wastes and the presence of other pet animals influence the survival and abundance of ectoparasites, especially fleas. This also explains why *P. irritans* and *T. penetrans*, relatively low host-specific ectoparasites, occurred only in rural areas, where dogs were frequently in contact with other natural host animals, such as pigs, rats and small ruminants [47-49].

Unfortunately, due to the absence of funding, we were unable to identify the prevalence of other zoonotic diseases and to specify the species in Taenidae encountered, such as *Echinococcous granulosus* causing hydatid disease. The diagnostic technique of parasites done in this study, based on the morphological characteristics of ova under light microscope, has the disadvantage that it fails to distinguish *E. granulosus* from other Taenidae. Thus, *E. granulosus*, a major zoonotic parasite of livestock and dogs in Nigeria [11,14,15], has possibly been present but not reported in our survey. The fact that dogs enjoy unrestrained association with humans, scavenge for food in an environment contaminated with faecal material of potential intermediate hosts and feed on offal of slaughtered livestock in abattoirs (Ugbomoiko, personal communication) makes transmission of hydatid disease predictable in the setting studied.

In general, the trend in prevalence, density and species composition of parasites observed in this study may reflect the degree of environmental contamination and inequalities in the health care service between urban and rural areas. In particular, *T. canis*, *A. caninum* and *D. caninum* are zoonotic parasites constituting public health problems in the study areas.

Conclusion
Our study shows that parasites of importance for human health were highly prevalent in Nigerian dogs and that intervention measures are necessary to reduce the risk of transmission of parasites from dogs to humans. Interventions should focus on health education provided to dog owners and the establishment of a program based on zoonotic diseases.

Authors' contributions
USU: study design, conducted the study, statistical analysis, contributed to the manuscript; LA: statistical analysis, contributed to the manuscript; JH: study design, statistical analysis, contributed to the manuscript. All authors read and approved the final manuscript.

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