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Associations of Perceived Risk Factors for the Development of Buruli Ulcer

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ABSTRACT

Mycobacterium ulcerans disease or Buruli Ulcer (BU), is an indolent, necrotizing infection of skin, subcutaneous tissue and occasionally, bones. Primary risk factor associated with BU apart from proximity to slow moving water and exposure to wetlands is socioeconomic status of disease endemic dwellers. The objective of this study is to identify associations of some perceived risk factors for the development of BU. A total of 62 case positive subjects were matched against 138 controls from the 3 systematically selected endemic communities to determine their level of perceived risk factors to the disease. Regression analysis among endemic population revealed that apart from marital status, no age group, gender, educational level, occupation, religious belief nor knowledge of BU was perceived to predispose people living in endemic area to the development of BU as compare to the reference group for each variable. There was correlation between those who are married with BU compared to the single (OR = 2.8, 95% CI = 1.1-7.1; p = 0.026). Multivariate analysis on perceived knowledge of the disease, perception of socioeconomic status and perceived occupational hygiene among endemic community dwellers revealed no association of risk to developing BU. Present study has revealed that perception of the general risk factors among people in endemic region seems to differ from the risk factors from literature.

Key words: Buruli ulcer, *M. ulcerans*, perception, endemic, risk factors

INTRODUCTION

Buruli Ulcer (BU), caused by *Mycobacterium ulcerans* infection, has become one of the most rapidly emerging diseases in West Africa in recent decades (Webb *et al*., 2009). The disease is characterized by an indolentnecrotizing of skin, subcutaneous tissue and occasionally bones. This mycobacterial disease is poorly understood and has emerged dramatically since the 1980's, reportedly coupled with rapid environmental changes to the landscape. Notable contributing factors for BU outbreak include deforestation, eutrophication, dam construction, irrigation, farming (agricultural and aquaculture), mining and habitat fragmentation. BU is a disease found in rural areas located near wetlands (ponds, swamps, marshes, impoundments, backwaters) and slow-moving rivers, especially in areas prone to flooding (Walsh *et al*., 2008). Cases have been reported from at least 32 countries in Africa (mainly West), Australia, Southeast Asia, China, Central and

South America and the Western Pacific (Merritt *et al*., 2010). A number of cases have been reported in non-endemic areas of North America and Europe as a sequel to international travel (Ezzedine *et al*., 2009). When treatments are delayed often in West Africa where due to lack of adequate knowledge about the disease they are normally reported late, infections could lead to ulcerated lesions (Muelder, 1992). The exact mode of transmission is not fully known and attempts to culture the *M. ulcerans* bacterium directly from the environment in recent times have chalked very little success. Rural isolation may mean that national surveillance systems do not immediately detect the appearance of new outbreaks. Affected populations may believe that there is no effective medical treatment for the disease, which discourages them from seeking assistance (Aujoulat *et al*., 2003). Case control studies have suggested that farming activities close to rivers in endemic areas are a risk factor for Buruli Ulcer (Marston *et al*., 1995) but for farmers involved in subsistence agriculture, avoidance of riverine areas is difficult. A recent study from Ghana has suggested that swimming in rivers may also be an independent risk factor (Aiga *et al*., 2004). Although, there have been reports of a seasonal distribution in BU cases related to rainfall-influenced patterns of village water body usage and by season in South Eastern Australia, other studies have not shown this relationship. Recording monthly trends for BU cases over a 3-year period in Benin, Sopoh *et al*. (2007) found consistent average monthly BU case occurrence, without an apparent seasonal trend. However, country-wide data can obscure local variation in climate and the issue of seasonal trends needs to be more closely investigated at the local level. The unknown incubation period for BU, which may vary from 2 weeks to 7 months (Johnson *et al*., 2005) and this development makes it difficult to analyze seasonal factors with the occurrence of the disease. Socioeconomic impact when data from Ghana was analysed revealed huge economic burden on affected countries. When the gross domestic product per capita (Ghana) in 1998 was estimated at USD $399.41 (http://ucatlas.ucsc.edu/query "php Retrieved October 11, 2007" the cost of surgical excision of a large ulcer, including 3 months' inpatient expenses, transportation, food and income lost was USD $783. Even in Cameroon, when treatment is provided at no cost, financial impact has been reported to be as high as 25% of yearly household income (Grietens *et al*., 2008). By comparison, the medication cost of an 8 week course of rifampin streptomycin is USD $10 (Etuaful *et al*., 2005). The key to this potential reduction in morbidity and economic burden lies in the detection of the disease in the early pre-ulcerative stages. At this level, antimicrobial therapy is most likely to decrease the extent of surgical intervention and shorten recovery time. Public disease perception and health seeking factors contributing to delayed presentation for treatment of BU are complex. Principal among them is misconceptions regarding the cause of BU disease and this often does not go without perceived role of sorcery, reliance on traditional medicine as first line therapy, fear of or lack of confidence in western treatment and financial concerns (Renzaho *et al*., 2007). Surveys exploring public knowledge and perception of the disease have been valuable in elucidating these factors and represent a useful tool in designing and assessing the success of public health. Recent works using surveys as research instrument has demonstrated the fact that people have information about a situation. They do not always seem to reflect in their knowledge level as good number of those interviewed for such surveys emanate from the different background. This seem to rate their knowledge level between average and low in terms knowledge. The underlying reasons for this could well be their sources of information. It is possible that the friends, who were the sources of information themselves had very little knowledge and understanding beyond the mentioning of the technologies therefore, little or no education went on (Buah, 2011). The main

objective of this study was to identify associations of some behavioral risk factors risk as perceived by people in BU communities in hopes of better elucidating transmission modes for control.

MATERIALS AND METHODS

Study area and population: The site of the study, the Amansie West District in the Ashanti Region of Ghana, is one of the greatest number of reported cases of Buruli ulcer of the 18 districts in the region (Amofah *et al*., 1995) and the second greatest number in the country (Amofah *et al*., 2002). The district is a typical tropical rain forest area of 1,320 km^2 with an estimated total population of 130,000 in 135 communities (2000 census). It is approximately 60 km southwest of Kumasi, the Ashanti regional capital. As one of the least developed districts in the country, infrastructure and socioeconomic conditions are poor (Asiedu and Etuaful, 1998). Within the district, the majority of Buruli ulcer-endemic communities are located in the south along the two rivers, the Offin and the Oda. Tontokrom is the most heavily affected community in the district with an estimated prevalence of 22%. In addition to St. Martin's Catholic Hospital located in Agroyesum, which has been providing Buruli ulcer patients within and outside the district with curative services since 1993 there are four government health centers and one private clinic in the district.

Case definition: A case positive variable refers to individuals who has been clinically diagnosed of BU in the past but has been treated and discharged with varying degrees of contractual deformities. Case negative variables also refer to study subjects with no previous history of BU. A community was considered endemic if a case had been identified in the public health center in the past three years. A community that is not listed in the health center records in association with a case of Buruli Ulcer, was considered non-endemic.

Study design: A case-control study was used to assess perceived behavioral pattern related risk factors for BU. A comparative study based on endemic verses non-endemic was also carried out as part of the study. To assess the prevalence of selected risk factors for some chronic disease and the association of these risk factors with socio-demographic variables, a cross sectional study was conducted in a representative sample of adults aged 40 years or more in the district of selected district (Kumar *et al*., 2011).

Data collection: Surveys has been employed in recent times to investigates perception and the use of this instrument has been employed not only to forecast the out-come of scientific research but aid in decision-making (Recha *et al*., 2008). To obtain data on perceived behavioral patterns among individuals in study area, questions about general awareness of disease, knowledge of possible mode of transmission, domestic hygienic behavior, other household members' infection, occupational hygiene, remedy seeking behavior and the presence of small scale mining activity (popularly known in community as Galamsey) were considered. Study was conducted between September 2009 and September 2010. Both qualitative and quantitative data were collected from the participants using focus group discussion and structured questionnaire (Kudi *et al*., 2007). With the help of structured interviews and focus groups discussion, BU cases positives and controls were conducted during home visits with questionnaires. Individuals who felt reluctant to continue with the interview were excluded from the study. Akan, the local language in Ashanti Region, was used for interviews. The questionnaires were filled out by the interviewers during the interview. Repeated home visits were

made until all the target interviewees were covered by the study. Sixty-two positive case and 138 controls were selected by systematic sampling based on verbal treatment record of having been clinically diagnosed of BU in the past and has been treated, with visibly different degrees of contractual deformities from three systematically selected endemic communities (Yakasakrom, Bonsaaso and Tontokrom, all from the Amansie West district, Ghana). Two hundred study participants were also randomly selected from three systematically selected non-endemic communities (Yawhemekrom, Manso Akropong and Manso Mim) from the same district as controls and were matched against 200 respondents from the endemic communities.

Data analysis: While Chi-square test was used to test for significance between categorical variables. Logistic regression was used to determine the extent to which significant variables predicted a number of health related study including high blood pressure in underground miners (Afoakwah and Owusu, 2011). Multivariate logistic regression model has been used to adjust most (if not all) risk estimates for covariates in earlier research for most case control studies (Mathew *et al*., 2009). Questionnaire responses were manually entered using Microsoft Excel and analysis of data was performed with employing univariate and multivariate logistic regression analysis. Analysis was limited to matched sets containing BU positive case with answered questions on control subjects. Variables that attained significance at a p value<0.05 were selected were retained from results of univariate analysis and confirmed using multivariable analyses. The chi-square test was used to examine associations between dichotomous variables where study participants in endemic area were matched with an equal number of participants in non-endemic. Two-tailed tests were used, with p<0.05 considered significant (Odeyinka *et al*., 2007).

RESULTS

When perceived behavioral pattern related questions that affect BU based on location was stratified with age category, it was revealed that the proportion of subjects who fall within the age group 16-20 were significantly higher (p = 0.0017) among the endemic area (15%) as compared to the non-endemic area (5.5%). The adult population (i.e., age>50 years) was more common among the non-endemic area as compared to the endemic area as shown in Table 1. There are about two times more female in the endemic area as compared to the non-endemic area (OR = 1.7; p = 0.0062). Majority of the subjects from the endemic area were single, divorced and have attained at least primary education (Table 1). Most of them were unemployed with fewer proportions engaging in farming activity. There are about seven times more 'galamsey' operators in the endemic area as compared to the non-endemic area from this study (Table 1). However, Logistic regression analysis using respondent's demographic data when stratified among the studied population revealed that apart from marital status, no age group, gender, educational level, occupation, religious belief nor knowledge of BU is perceived to predispose people living in endemic area to the development of BU as compare to the reference group for each variable. Those who are married are perceived to be at about 3 times at risk of developing BU as compared to the single (OR = 2.8, 95% CI = 1.1-7.1; p = 0.026). There was a strong correlation between those who were divorced and the widowed as compared to the singles, respectively (OR = 4.1, 95% CI = [1.1-15.5]; p = 0.033 and OR = 5.5, 95% CI = [1.0-37.3]; p = 0.04) as shown in Table 2.

When the perception of study respondents was stratified based on location, it revealed that there was no association with perception whether or not a member of ones' household has suffered BU in the past as shown in Table 1. Perception of general knowledge of the disease was common among

Table 1: Respondents demographic data, group at risk, knowledge of BU and possible mode of transmission of study respondents stratified by location

Variable	% Total (400)	% Endemic (200)	% Non-endemic (200)	p-value	Odds Ratio (OR)
Age					
6-15	7 (1.7)	6 (3.0)	1 (0.50)	0.0566	6.1
16-20	41 (10.2)	30 (15.0)	11 (5.5)	0.0017	3.1
21-50	247 (61.7)	132 (66.0)	115 (57.5)	0.0803	1.4
>50	105 (26.2)	32 (16.0)	73 (36.5)	0.0001	0.3
Sex					
Male	167 (41.7)	70 (35.0)	97 (48.5)	0.0062	0.6
Female	233 (58.2)	130 (65.0)	103 (51.5)	0.0062	1.7
Marital status					
Married	262 (65.5)	105 (52.5)	157 (78.5)	0.0001	0.3
Single	74 (18.5)	61 (30.5)	13 (6.5)	0.0001	6.3
Divorced	26 (6.5)	20 (10.0)	6 (3.0)	0.0045	3.6
Widow	24 (6.0)	10 (5.0)	14 (7.0)	0.3997	0.7
Separated	14 (3.5)	4 (2.0)	10 (5.0)	0.1026	0.4
Educational level					
Never	96 (24.0)	48 (24.0)	48 (24.0)	1	1
Primary	97 (24.2)	74 (37.0)	23 (11.5)	0.0001	4.5
JSS/Primary	158 (39.5)	54 (27.0)	104 (52.0)	0.0001	0.3
SSS/Sec	44 (11.0)	20 (10.0)	24 (12.0)	0.5227	0.8
Tertiary	8 (4.0)	4 (2.0)	4 (2.0)	1	1
Occupation					
Unemployed	53 (13.2)	42 (21.0)	11 (5.5)	0.0001	4.5
Farming	246 (61.5)	104 (52.0)	142 (71.0)	0.0001	0.4
Hunting	3 (0.75)	2 (1.0)	1 (0.5)	0.5622	0.6
Govt. worker	6 (1.5)	4 (2.0)	2 (1.0)	0.4107	2
Trading	31 (7.7)	12 (6.0)	19 (9.5)	0.1905	0.6
Apprentice	12 (3.0)	6 (3.0)	6 (3)	1	1
Gal. Operator	35 (8.7)	30 (15.0)	5 (2.5)	0.0001	6.9
Others	14 (3.5)	0 (0.0)	14 (7.0)	0.0001	0.1
Knowledge of BU					
Yes	389 (97.25)	196 (98.0)	193 (96.5)	0.359	1.777
No	11 (2.75)	4 (2.0)	7 (3.5)	0.0654	2.852
Possible mode of transmission					
Water	85 (21.2)	58 (29.0)	27 (13.5)	0.0002	2.6
Food	2 (0.5)	0 (0.0)	2 (1.0)	0.1563	0.2
Soil	22 (5.5)	4 (2.0)	18 (9.0)	0.0021	0.2
Person to person	8 (2.0)	6 (3.0)	2 (1.0)	0.1531	3
Others	18 (4.5)	18 (9.0)	0 (0.0)	0.0001	40.6
Don't know	265 (66.2)	114 (57.0)	151 (75.5)	0.0001	0.4
Group at risk					
Children	79 (19.7)	48 (24.0)	31 (15.5)	0.0328	1.7
Women	28 (7.0)	19 (9.5)	9 (4.5)	0.05	2.2
Men and children	115 (28.7)	16 (8.0)	99 (49.5)	0.0001	0.1
Men and women	18 (4.5)	9 (4.5)	9 (4.5)	1	1
Women and children	132 (33.0)	80 (40.0)	52 (26.0)	0.0029	1.9

OR: Odds ratio, CI: Confidence Interval, p: p-value, aOR: Adjusted Odds ratio, SSS: Senior Secondary School, JSS: Junior Secondary School, D/K: don't know. Parenthesis under Odds ratio column represents confidence intervals of each group whiles all other parenthesis within the main table represents the various percentages

Table 2: Demographic data, perception of knowledge of BU, group at risk and possible mode of transmission of study respondents in endemic area

Variables	% Total (200)	% BU (62)	% NoBU (138)	OR (95% CI)	p-value	OR (95% CI)	p-value
Age (years)							
15-Jun	6 (3.0)	1 (1.6)	5 (3.6)	0.4 (0.1-3.9)	0.465	1.2 (0.1-12.7)	0.878
16-20	30 (15.0)	8 (12.9)	22 (15.9)	0.8 (0.3-2.0)	0.637	1.2 (0.4-3.4)	0.685
21-50	32 (16.0)	12 (19.4)	20 (14.5)	1		1	
>50	132 (66.0)	41 (66.1)	91 (68.9)	1.3 (0.-63.0)	0.486	0.9 (0.3-2.5)	0.812
Sex							
Male	70 (35.0)	16 (25.8)	54 (39.1)	1		1	
Female	130 (65.0)	46 (74.2)	84 (60.9)	1.8 (1.0-3.6)	0.0451	1.4 (0.7-3.1)	0.352
Marital status							
Married	105 (52.5)	37 (59.7)	68 (49.3)	2.8 (1.3-6.1)	0.011	2.8 (1.1-7.1)	0.026
Single	61 (30.5)	10 (16.1)	51 (37.0)	1		1	
Divorced	20 (10.0)	9 (14.5)	11 (8.0)	4.2 (1.412.7)	0.012	4.1 (1.1-15.5)	0.033
widow	10 (5.0)	5 (8.0)	5 (3.6)	5.1 (1.220.9)	0.024	5.5 (1.0-3.3)	0.04
Separated	4 (2.0)	1 (1.6)	3 (2.2)	1.7 (0.218.1)	0.66	2.1 (0.2-26.5)	0.555
Educational level							
Primary	74 (37.0)	19 (30.6)	55 (39.9)	0.1 (0.0-1.2)	0.068	0.2 (0.0-1.9)	0.144
JSS/primary	54 (27.0)	18 (29.0)	36 (26.1)	0.2 (0.0-1.7)	0.132	0.3 (0.0-3.2)	0.306
SSS/sec	20 (10.0)	8 (12.9)	12 (8.7)	0.2 (0.0-2.5)	0.226	0.5 (0.0-5.7)	0.556
Tertiary	4 (2.0)	3 (4.8)	1 (0.7)	1	1		
Never	44 (22.0)	13 (21.0)	31 (22.5)	0.1 (0.0-1.5)	0.101	0.5 (0.0-5.7)	0.14
Others	4 (2.0)	1 (1.6)	3 (2.2)	0.1 (0.0-2.7)	0.178	0.1 (0.0-1.8)	0.475
Occupation							
Farming	104 (52.0)	36 (58.1)	68 (49.3)	0.5 (0.1-3.9)	0.533	0.2 (0.0-1.9)	0.167
Hunting	2 (1.0)	1 (1.6)	1 (0.7)	1.0 (0.0 29.8)	1	1.4 (0.0-50.8)	0.839
Unemployed	42 (21.0)	12 (19.4)	30 (21.7)	0.4 (0.1-3.2)	0.386	0.2 (0.0-2.2)	0.201
Gov't. worker	4 (2.0)	2 (3.2)	2 (1.4)	1		1	
Trading	12 (6.0)	4 (6.5)	8 (5.8)	0.5 (0.1-5.0)	0.554	0.2 (0.0-2.9)	0.257
Apprentice	6 (3.0)	2 (3.2)	4 (2.9)	0.5 (0.0-6.6)	0.6	0.2 (0.0-3.6)	0.254
galamsey operator	30 (15.0)	5 (8.1)	25 (18.1)	0.2 (0.0-1.8)	0.148	0.1 (0.0-1.1)	0.059
Religion							
Catholic	55 (27.5)	19 (30.6)	36 (26.1)	1			
Methodist	30 (15.0)	11 (17.7)	19 (13.8)	1.1 (0.4-2.8)	0.845	1.1 (0.4-3.0)	0.914
Presby	8 (4.0)	2 (3.2)	6 (4.3)	0.6 (0.1-3.4)	0.595	0.8 (0.1-5.5)	0.853
Penticost	12 (6.0)	2 (3.2)	10 (7.2)	0.4 (0.1-1.9)	0.239	0.3 (0.1-2.0)	0.236
Charistmatic	46 (23.0)	15 (24.2)	31 (22.5)	0.9 (0.4-2.1)	0.837	0.9 (0.3-2.2)	0.782
Islam	8 (4.0)	3 (4.8)	5 (3.6)	1.1 (0.2-5.3)	0.87	1.2 (0.2-6.4)	0.844
Traditionalist	2 (1.0)	1 (1.6)	1 (0.7)	1.9 (0.1-32.0)	0.658	1.5 (0.1-27.1)	0.797
not affiliated	39 (19.5)	9 (14.l5)	30 (21.7)	0.6 (0.2-1.4)	0.234	0.8 (0.3-2.1)	0.595
Knowledge of BU							
Yes	196 (98.0)	61 (98.4)	135 (97.8)	1		1	
No	4 (2.0)	1 (1.6)	3 (2.2)	0.7 (0.1-7.2)	0.794	0.5 (0.0-5.7)	0.547
Possible mode of transmission							
Water	58 (29.0)	18 (29.0)	40 (29.0)	0.2 (0.0-1.5)	0.111	0.2 (0.0-2.2)	0.187
Soil	4 (2.2)	3 (4.8)	1 (0.7)	1		1	
Others	6 (3.0)	3 (4.8)	3 (2.2)	0.1 (0.0-1.5)	0.106	0.2 (0.0-2.5)	0.203
person to person	18 (9.0)	5 (8.1)	13 (9.4)	0.3 (0.0-5.3)	0.437	0.5 (0.0-8.5)	0.625

Table 2: Continued

Variables	% Total (200)	% BU (62)	% NoBU (138)	OR (95% CI)	p value	OR (95% CI)	p value
D/K	114 (57.0)	33 (53.2)	81 (58.7)	0.1 (0.0-1.4)	0.089	0.1 (0.0-1.6)	0.116
Group at risk							
Men	19 (9.5)	7 (11.3)	12 (8.7)	1		1	
Children	48 (24.0)	15 (24.2)	33 (23.9)	0.8 (0.3-2.4)	0.661	0.6 (0.2-2.2)	0.467
Women	16 (8.0)	6 (6.7)	10 (7.2)	1.0 (0.3-4.1)	0.968	0.8 (0.2-3.4)	0.721
Men and children	9 (4.5)	1 (1.6)	8 (5.8)	0.8 (0.2-3.0)	0.733	0.7 (0.2-2.9)	0.598
Men and women	19 (9.5)	6 (9.7)	13 (9.4)	1.4 (0.3-6.9)	0.701	1.6 (0.3-9.1)	0.574
All	9 (4.5)	4 (2.9)	5 (3.6)	0.7 (0.2-2.0)	0.492	0.7 (0.2-2.3)	0.602
Women and children	80 (40.0)	23 (37.1)	57 (41.3)	0.2 (0.0-2.1)	0.185	0.2 (0.0-1.9)	0.152
Possible mode of transmission							
Water	58 (29.0)	18 (29.0)	40 (29.0)	0.2 (0.0-1.5)	0.111	0.2 (0.0-2.2)	0.187
Soil	4 (2.2)	3 (4.8)	1 (0.7)	1		1	
Others	6 (3.0)	3 (4.8)	3 (2.2)	0.1 (0.0-1.5)	0.106	0.2 (0.0-2.5)	0.203
Person to person	18 (9.0)	5 (8.1)	13 (9.4)	0.3 (0.0-5.3)	0.437	0.5 (0.0-8.5)	0.625
D/K	114 (57.0)	33 (53.2)	81 (58.7)	0.1 (0.0-1.4)	0.089	0.1 (0.0-1.6)	0.116

both endemic and non-endemic communities. Fifty eight (29.0%) of the people in endemic region perceive water to be a possible mode of transmission compared to twenty seven (13.5%) in the non-endemic region and this was significant (p = 0.0002). Whiles ninety-nine (49.5%) study participants in the non-endemic region perceived men and children as group at risk of developing BU compared to sixteen (8.0%) of the people in endemic area (p = 0.0001); 80 out of 200 (8.0%) of the people in the endemic area rather perceived men and children to be at risk compared to their non-endemic counterparts, fifty two (26.0%) (p = 0.00029). Fewer proportions of study subjects in the endemic area (2.0%) perceived soil to be a possible source of Mycobacterium ulcerans infection compared to subjects in non-endemic area (9.0%) as shown in Table 1. Multivariate regression analysis when run for subjects in endemic area also demonstrated that neither one's perceived knowledge of BU nor perceived group of people at risk were associated as risk factor variables for developing BU as shown in Table 4. Women and men however in endemic community were perceived to be about 2 times at risk (OR = 1.4, 9.5%, CI (0.3-6.9), p value = 0.701) of developing BU compared to their reference group though this was not significant.

Analysis of perceived socioeconomic status of the people stratified by location revealed that, a greater proportion of children in the study population in endemic areas (43.5%) go to farm barefooted compared to their non-endemic counterpart (8.5%) and this perception was significant (p = 0.0001). However, the perception among the people concerning wearing of "Charlie wote"(a type of bathroom slippers which is used out-doors by people of low economic status) to school among children in the study population was more common in endemic communities (19.0%) as compared to those in the non-endemic regions (7.0%) as shown in Table 3. One hundred and thirty five (67.5%) of the study subjects in the endemic community perceived children play barefooted in open fields and dusty compound compared ninety three (46.5%) of study participants in non-endemic area (p = 0.0001). Ninety one (45.5%) of the people in endemic region perceived children

Table 3: Respondents' perception of group at risk, remedy seeking behavior, domestic and occupational hygiene in endemic community

Variables	% Total (200)	% BU (62)	% No BU (138)	OR (95% CI)	p-value	OR (95% CI)	p-value
Group at risk							
Men	19(9.5)	7(11.3)	12(8.7)	1		1	
Children	48 (24.0)	15 (24.2)	33 (23.9)	0.8 (0.3-2.4)	0.661	0.6 (0.2-2.2)	0.467
Women	16 (8.0)	6 (6.7)	10 (7.2)	1.0 (0.3-4.1)	0.968	0.8 (0.2-3.4)	0.721
men and children	9 (4.5)	1 (1.6)	8 (5.8)	0.8 (0.2-3.0)	0.733	0.7 (0.2-2.9)	0.598
men and women	19 (9.5)	6 (9.7)	13 (9.4)	1.4 (0.3-6.9)	0.701	1.6 (0.3-9.1)	0.574
All	9 (4.5)	4 (2.9)	5 (3.6)	0.7 (0.2-2.0)	0.492	0.7 (0.2-2.3)	0.602
women and children	80 (40.0)	23 (37.1)	57 (41.3)	0.2 (0.0-2.1)	0.185	0.2 (0.0-1.9)	0.152
Household suffered BU before							
Yes	118 (59.0)	34 (54.8)	84 (60.9)	0.8 (0.4-1.4)	0.423	0.9 (0.5-1.8)	0.792
No	82 (41.0)	28 (45.2)	54 (39.1)	1			
What do children wear on feet to farm							
charle wote	10 (5.0)	4 (6.5)	6 (4.3)	0.290.5-7.6)	0.327	1.3 (0.2-7.2)	0.743
wellington boot	87 (43.5)	22 (35.5)	65 (47.1)	1		1	
Tawoto	16 (8.0)	7 (11.3)	9 (6.5)	2.3 (0.8-6.9)	0.138	1.9 (0.6-6.6)	0.295
Barefoot	16 (8.0)	6 (9.7)	10 (7.2)	1.4 (0.7-2.8)	0.326	1.3 (0.6-2.8)	0.54
Others	71 (35.5)	23 (37.1)	48 (34.8)	1.8 (0.6-1.4)	0.317	2.4 (0.7-8.5)	0.167
What do children wear on feet to school							
Camboo	74 (37.0)	27 (43.5)	47 (34.1)	1.3 (0.7-2.6)	0.452	1.3 (0.6-2.8)	0.519
Others	38 (19.0)	8 (12.9)	30 (21.7)	2.3 (0.3-17.1)	0.429	2.6 (0.3-23.3)	0.388
Charlie	9 (4.5)	2 (3.2)	7 (5.1)	0.6 (0.2-1.5)	0.282	0.6 (0.2-1.7)	0.339
Barefoot	75 (37.5)	23 (37.1)	52 (37.7)	1		1	
Sandals	4 (2.0)	2 (3.2)	2 (1.4)	0.6 (0.1-3.4)	0.603	0.6 (0.1-3.8)	0.607
Do children play barefooted							
Yes	135 (67.5)	40 (64.5)	95 (68.8)	0.8 (0.4-1.6)	0.507	0.7 (0.3-1.4)	0.301
No	55 (27.5)	19 (30.6)	36 (26.1)	1		1	
Don't know	10 (5.0)	3 (4.8)	7 (5.1)	0.8 (0.2-3.5)	0.78	0.6 (0.1-3.2)	0.581
Do children play barefooted							
Yes	91 (45.5)	26 (41.9)	65 (47.1)	0.7 (0.4-1.3)	0.29	0.6 (0.3-1.2)	0.176
No	89 (44.5)	32 (51.6)	57 (41.3)	1		1	
Don't know	20 (10.0)	4 (6.5)	16 (11.6)	0.4 (0.1-1.4)	0.178	0.3 (0.1-1.3)	0.114
What do women wear on feet to farm							
wellington boots	6 (3.0)	2 (3.2)	4 (2.9)	1			
Charlie	131 (65.5)	39 (62.9)	92 (66.7)	0.8 (0.1-4.8)	0.852	1.6 (0.2-11.4)	0.657
Tawoto	27 (13.5)	10 (16.1)	17 (12.3)	1.2 (0.2-7.6)	0.865	1.9 (0.2-15.9)	0.539
Barefoot	16 (8.0)	6 (9.7)	10 (7.0)	0.7 (0.1-4.8)	0.688	1.0 (0.1-9.6)	0.98
Others	20 (10.0)	5 (8.1)	15 (10.9)	1.2 (0.2-8.7)	0.857	5.7 (0.5-60.9)	0.152
Do Galamsey operators wear any protective							
Yes	80 (40.0)	25 (40.3)	55 (39.9)	1.0 (0.5-1.9)	0.955	1.2 (0.6-2.5)	0.583
No	94 (47)	29 (46.8)	65 (47.1)	1		1	
Don't know	26 (13.0)	8 (12.9)	18 (13.0)	1.0 (0.4-2.6)	0.994	1.3 (0.4-3.9)	0.628
Do they have contact with soil							
Yes	178 (89.0)	55 (88.7)	123 (89.1)	1			
No	6 (3.0)	2 (3.2)	4 (2.9)	1.1 (0.2-6.3)	0.899	1.4 (0.2-8.6)	0.733
Don't know	16 (8.0)	5 (8.1)	11 (8.0)	1.0 (0.3-3.1)	0.977	1.2 (0.3-4.1)	0.826
Observed symptoms							
Nodules	158 (79.0)	51 (82.3)	107 (77.5)	1.0 (0.2-5.4)	0.957	1.6 (0.2-10.4)	0.643
Swells	16 (8.0)	5 (8.1)	11 (8.0)	0.9 (0.1-6.7)	0.926	1.9 (0.2-16.9)	0.581

Table 3: Continued

Variables	% Total (200)	% BU (62)	% No BU (138)	OR (95% CI)	p-value	OR (95% CI)	p-value
Skin infections	4 (2.0)	1 (1.6)	3 (2.2)	0.7 (0.0-11.3)	0.779	0.8 (0.0-16.5)	0.865
open sores	16 (8.0)	3 (4.8)	13 (9.4)	0.5 (0.1-3.8)	0.473	0.9 (0.1-8.6)	0.894
Hospital	6 (3.0)	2 (3.2)	4 (2.9)	1		1	
What to do with BU							
Self-medicate	8 (4.0)	4 (6.5)	4 (2.9)	2.4 (0.6-9.8)	0.234	3.1 (0.6-15.3)	0.161
Relatives	10 (5.0)	4 (6.5)	6 (4.3)	1.6 (0.4-5.8)	0.492	1.5 (0.4-6.0)	0.592
Hospital	182 (91.0)	54 (87.0)	128 (92.8)	1		1	

Table 4: Respondents' perception of remedy seeking behavior, domestic and occupational hygiene in endemic community stratified by location

Variable	% Total (400)	% Endemic (200)	% Non-endemic (200)	p-value	OR (Odds ratio)
What do children wear on feet to farm					
Charlie wote	114 (28.5)	87 (43.5)	27 (13)	0.0001	4.933
wellington boot	17 (4.25)	10 (5.0)	7 (3.5)	0.11	0.5952
Tawoto	165 (41.25)	16 (8.0)	149 (74.5)	0.0001	0.0001
Barefoot	104 (26.0)	87 (43.5)	17 (8.5)	0.0001	8.288
What do children wear on feet to school					
Camboo	236 (59)	74 (37.0)	162 (81.0)	0.0001	0.1378
charlie wote	52 (13)	38 (19.0)	14 (7.0)	0.0004	3.116
Barefoot	21 (5.25)	14 (7.0)	7 (3.5)	0.1166	2.075
Sandals	91 (22.75)	74 (37.0)	17 (8.5)	0.0001	6.322
Do children play bare footed					
Yes	228 (57.0)	135 (67.5)	93 (46.5)	0.0001	2.4
No	144 (36.0)	55 (27.5)	89 (44.5)	0.0004	0.5
Don't know	28 (7.0)	10 (5.0)	18 (9.0)	0.1169	0.5
Children barefooted for water					
Yes	140 (35.0)	91 (45.5)	49 (24.5)	0.0001	2.6
No	222 (55.5)	89 (44.5)	133 (66.5)	0.9707	1
Don't know	38 (9.5)	20 (10.0)	18 (9.0)	0.7331	1.1
What do women occasionally wear on feet in the house					
W. boots	28 (7.0)	14 (7.0)	14 (7.0)	1	1
Charlie	246 (61.5)	123 (61.5)	123 (61.5)	1	1
Tawoto	72 (18.0)	36 (18.0)	36 (18.0)	1	1
Barefoot	31 (7.7)	18 (9.0)	13 (6.5)	0.3498	1.4
Others	23 (5.7)	9 (4.5)	14 (7.0)	0.2829	0.6
Do they wear protective cloths?					
Yes	84 (21.0)	80 (40.0)	4 (2.0)	0.0001	32.3
No	200 (50.0)	94 (47.0)	106 (53.0)	0.0489	1.4
Don't know	103 (25.7)	26 (13.0)	90 (45.0)	0.0001	0.2
Do they have contact with soil?					
Yes	315 (78.7)	178 (89.0)	137 (68.5)	0.0001	3.7
No	7 (1.7)	6 (3.0)	1 (0.5)	0.0566	6.1
Don't know	88 (22.0)	26 (13.0)	62 (31.0)	0.0001	0.3
Observed-symptom?					
Nodules	250 (62.5)	158 (79.0)	92 (46.0)	0.0001	4.4
Swells	17 (4.2)	16 (8.0)	1 (0.5)	0.0002	17.3
Skin Infections	8 (2.0)	4 (2.0)	4 (2.0)	1	1
Open Sores	33 (8.25)	12 (3.0)	21 (10.5)	0.0002	0.2

Table 4: Continued

Variable	% Total (400)	% Endemic (200)	% Non-endemic (200)	p-value	OR (Odds ratio)
Hospital	35 (8.75)	6 (3.0)	29 (14.5)	0.0001	0.2
Others	67 (16.7)	4 (2.0)	63 (31.5)	0.0001	0.1
What to do with BU?					
Self-Medicate	46 (11.5)	8 (4.0)	38 (19.0)	0.0001	0.04
Relatives	19 (4.75)	10 (5.0)	9 (4.5)	0.8142	1.1
Hospital	335 (83.7)	182 (91.0)	153 (76.5)	0.0001	0.2

go for water barefooted compared to forty seven (24.5%) of the people in non-endemic community and this was significant (p = 0.0001). Eighty (40.0%) of the people in endemic area perceived there are small scale activities in their community, with majority (89%) of them not wearing any protective cloth during their operation compared to four people in non-endemic area 4(2.0%) (OR = 32; p = 0.0001).

However, when the perception of the socioeconomic status of the people in the endemic communities was analysed with a logistic regression model, it revealed that there was no association of this perception in terms of risk factor to the developing BU as shown in Table 4.

In assessing their response to symptom of possible BU infections based on location, one hundred and fifty eight (79.0%) of the people in endemic area perceived the appearance of a nodule in the skin as possible BU infection compared to ninety two (46%) in the non-endemic area and this was significant (p = 0.0001). However, thirty eight (19.0%) of the people in the non-endemic area perceive people in their community will self-medicate on suspecting a possible BU infection compared to eight (4.0%) of the people in endemic area as shown in Table 3. Perception of occupational hygiene among subjects in the endemic area when stratified based on whether or not galamsey operators had some protective covering when going under-ground there by exposing other parts of their body to the soil by a multivariate analysis revealed no risk factor association with BU (Table 4). Stratification of the perceived possible observed symptoms and perceived remedy seeking behavior of study subjects in endemic area revealed that, neither of the two have an association of risk factors for BU. People in endemic community perceived people who resort to self-medication on suspecting a possible BU infection to be about 3 times at risk of developing BU (OR = 2.4, 95% C.I. (0.6-9.8), p = 0.234) compared to their reference group as shown in Table 4.

DISCUSSION

This is the first case-control study to describe some perceived behavioral practices associated with risk factors for BU in some selected communities in Amansie west district, Ghana. In recent times, the use of perceptive study as a tool has been useful to forecast the threat of some disease among some health professionals (Udoh and Oku, 2010).Our data show that BU was not perceived to be associated with age, gender, educational level, occupation and this is in contrast to previous studies by Aiga *et al.* (2004) which status that there are no risk factors for BU with respect to age and gender women and children <15 years are sometimes vulnerable. This is not surprising because our data were collected based on perception through a questionnaire and this cannot measure accurately the true variation in environmental contacts and health-related behaviors, and there is a possibility of recall and social desirability biases. However, when perceived behavioral pattern related questions that affect BU based on location was stratified with age category, it was revealed that the proportion of subjects who fall within the age group 16-20 were significantly higher (p = 0.0017) among the endemic area (15%) as compared to the non-endemic area (5.5%).

The adult population (i.e., age >50 years) was more common among the non-endemic area as compared to the endemic area. Results from this study also suggested that there are more children between ages 16-20 in endemic areas who were available for the study. This is also not surprising because at this age, the younger population are more independent and roam freely in the environment, with most of the disease endemic dwellers usually scantily clothed, which increases exposure to a contaminated environment. These associations are consistent with earlier research carried out by Aiga and a group of researchers (Aiga *et al*., 2004). Molecular studies has also confirmed that M. ulcerans is present in some water, mud, fish, aquatic insects and snails from swamps in regions endemic for BU (Johnson *et al*., 2005). Multivariate analysis from the study using logistic regression revealed that married people in endemic area are perceived to be at about 3 times at risk of developing BU as compared to the single (OR=2.8, 95% CI =1.1-7.1; p=0.026). There was a strong correlation between the divorced and the widowed as results of the analysis revealed there were perceived to be at about 4 and 6 times at risk of developing BU as compared to the singles, respectively (OR=4.1, 95% CI=(1.1-15.5); p=0.033 and OR=5.5, 95% CI=[1.0-37.3]; p=0.04) and this perception was in discord to results of earlier works Aiga *et al*. (2004). Logistic regression model from this study revealed both perceived general knowledge of BU in endemic community and different category of people as shown in Table 2 were not associated with the development of BU (Jacobsen and Padgett, 2010). The former was not a surprise because reports from previous work has shown that, in absence of effective tools to control BU, current control strategies are aimed at reducing the prolonged suffering, disabilities and socioeconomic burden associated with the disease. At the annual meeting of the WHO Global BU Initiative (GBUI) held in Geneva, Switzerland, on 14-17 March 2005, various control strategies were agreed upon and that included early detection of cases at the community level, adequate information, education and communication among health workers as well as members in endemic communities. Other strategies were training of health workers and village health workers among others (Johnson *et al*., 2005). This has created enough awareness of the disease among inhabitants of endemic area. However, the perception of no apparent association of BU with age and sex is in consistent with other studies (Raghunathan *et al*., 2005) While multivariate analysis revealed no difference in perceived knowledge of the disease compared to the reference group, majority of the people in the endemic communities perceive water to be a possible mode of transmission, they however, do not perceive this observation as risk factor for BU and this results is consistent with research carried out by Fyfe and a group of researchers in a work published in 2010 (Fyfe *et al*., 2010). It is worthy of notice that one characteristic of the disease is its apparent association with bodies of water worldwide (Muelder, 1992). Personal observation during visits to the study area has revealed that, most parts of the endemic area is located in the swampy banks along the slow-flowing Offin River (in addition to many others) and some of its tributaries and this may have informed the decision of study participants. Recently, there has been the identification of *M. ulcerans* in certain water insects raising the possibility of water related agents as a possible mode of transmission of the disease and this confirms results from these portions of the work (Van der Werf *et al*., 1999). Socio economic status has been an important tool in elucidating a number of health related studies including hyperglycemia on plasma copper and zinc in pregnancy complicated with diabetes mellitus and the results have been helpful in mapping out control strategies (Ugwuja *et al*., 2010). In the light of this, socio economic status of the people was analysed and the multivariate analysis demonstrated no perceived association with the development of BU in endemic area and this is inconsistent with previous studies (Asiedu and Etuaful, 1998). This was not surprising because, focus group

discussion in one of the endemic communities revealed that, though study participants perceive one could have BU with possible contact with wetlands, they do not perceive this as a threat. This was what a participant had to say walking barefooted in water related terrain could be dangerous in terms of contracting BU, children always remove their foot ware crossing streams. The main rationale behind carrying out this study was the perception that different behavioral patterns with regards to occupation as well as domestic practices (socio economic status) among individuals in endemic regions could contribute to ones risk of developing BU. Data analysis emanating from this study has demonstrated that greater proportion of children in the study population from endemic areas were perceive to belong to people of low socioeconomic status (go to farm barefooted) compared to their non-endemic counterpart. However, people in endemic communities do not perceive this to be a risk factor for the disease. Again focus group discussions organized in some of the sampling communities revealed these among many others "I suspect walking barefooted with exposed feet to wetlands, swampy and riverine condition is a risk of developing BU, I am not too worried to see a child walking barefooted in endemic community, since is only destiny that could make one have infection" This perception among people in the disease endemic area is inconsistent with previous studies and is quite disturbing because activities that take place near water bodies, such as farming, soil profile disturbances among others also act as risk factors and with the wearing of protective clothing and bootie perceived to reduce the risk of the disease (Portaels *et al*., 2008). Majority of the study population in the endemic community perceive the presence of small scale mining operations popularly known as "galamsay" in their community compared to non-endemic study participants and there was the overwhelming perception that these small scale miners did not ware any protective cloths when going underground hence greater parts of their bodies was perceived to be in contact with the soil. Focus group discussion and in-depth interview conducted during the study by selected study participants had it that," there were no cases of BU until the emergence of the local mining activities in Tontokrom, an endemic community in the district. Cases of BU escalated when many of the inhabitants resorted to galamsey as the second most popular occupation after farming in Tontokrom leading to major endemic foci. These indigenous small scale miners went underground with a greater parts of their bodies exposed to the disturbed soil profile as they perceive their dug holes within which they conducted their activities was hot and they only way they found comfort whiles digging was wearing only small panties". However, a result of this study has showed that, people in endemic areas do not perceive this trend as a risk factor for developing BU and this observation is inconsistent with previous studies (Johnson *et al*., 2005) where *M. ulcerans* were detected from soil in Australia using Real Time Polymerase Chain Reaction technology.

Consistent with other studies, Merritt *et al*. (2010) give assessment of the perception of response to possible BU infections has revealed that, a greater majority of respondents in the study population in the endemic community perceive an emergence of a nodule on the skin as a possible symptom for BU. This may be due to the fact that, continuous education among community members on the harmful effects of the disease and the visible deformities that has characterized infection with accompanying amputation has generated enough awareness. Only few people in endemic area were perceived to self-medicate on suspension of a possible BU infection. Though perceived self-medication by people in endemic areas were about 3 times at risk compared to people who were perceive to visit the hospital, this perception was not significant. Consistent with previous studies (Sopoh *et al*., 2007) logistic regression revealed no association perceived of people who would self-medicate to the development of BU.

CONCLUSION

The goal of this study was to identify whether the perception of risk factors for developing BU differ by location and whether or not this perception could predispose an endemic dweller to the development of the disease and to use this information to examine likely modes of transmission for *M. ulcerans*. There do not appear to be significant differences in perceived risk of disease by sex, knowledge of the disease, household exposure to *M. ulcerans,* socioeconomic status of the people or perceived remedy seeking behavior people in endemic region. Results from this study have revealed that though there appears to be general knowledge of the perception of risk factors among people in the study area, they do not perceive these to predispose them to possible BU infection and this is a worrying trend. The fact still remain that, the socioeconomic burden and loss through Buruli ulcer are contributing to a vicious cycle of poverty in the disease endemic areas. It is recommended education ought to be intensified on risk factors for the disease among endemic dwellers to alter some aspect of current perception of risk factors for BU.

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