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Risk Factors Associated with the Victim of *Ambi* (Buruli Ulcer) among the Tiv People of Benue State, Nigeria

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Abstract: Buruli ulcer (BU), otherwise known as *Ambi* disease amongst the Tiv of Benue State, Nigeria, is a debilitating disease caused by Mycobacterium ulcerans and characterized by severe necrosis of the skin and resultant deformities. This disease has become a serious community health problem as it has a high prevalence rate, and the aetiology has been attributed to supernatural causes. No prior study has assessed the risk factors of BU in this locality. The present study therefore set out to investigate the risk factors of BU, including demographic, environmental, behavioural, socio-cultural, and host factors. The study involved 200 BU cases selected through a snowball sampling technique from five Local Government Areas with a high prevalence of the disease. Eighteen Key Informant Interviews (KII) were conducted. Data analysis was done using descriptive statistics, logistic regression for quantitative data, and thematic content analysis for qualitative data. The health belief model guided the study. Respondents were mostly young (38%) and male (52%), and the majority were farmers (68%). Contrary to the body of literature reviewed, the study found that exposure to water bodies was not a risk factor for BU in the study area (aOR: 0.72; 95% CI: 0.45–1.15; p=0.168). Instead, the study identified a suite of behavioural, socio-cultural, and socio-economic risk factors, including seeking care from traditional healers (aOR: 5.35; 95% CI: 3.02–9.48; p<0.001), belief in supernatural causes (aOR: 4.82; p<0.001), failure to seek care promptly for minor ulcers (aOR: 4.18; p<0.001), inability to pay for treatment or transportation (aOR: 3.95; p<0.001), and low income (aOR: 2.85; p<0.001) as significant predictors of the disease. Diabetes also appeared to be a risk factor though to a lesser extent (aOR: 2.22; p=0.03). This study found that cultural beliefs and socio-economic factors were the major predictors of delay in care-seeking behaviour. It is recommended that community sensitization and behaviour modification campaigns focused on the need for timely management of skin ulcers, traditional healing practices, and poverty alleviation strategies be undertaken.

Keywords: Buruli ulcer; BU risk factors; *Ambi* disease; Tiv people; Socio-cultural factors and Benue State, Nigeria.

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INTRODUCTION

Buruli ulcer (BU), also called Ambi disease by the Tiv people of Benue State, is a neglected tropical disease caused by Mycobacterium ulcerans, whose toxin mycolactone characteristically causes large skin necrosis resulting in severe deformities in the affected body parts if left untreated [1,2]. Over 33 countries worldwide are highly and moderately endemic for BU, with more than 60,000 reported cases from 2002 to 2017; West and Central Africa, Australia, Asia, and America are the most affected regions [2,3]. Conversely, in Nigeria, BU is a significant public health problem in endemic countries like Benue State, where it has been affecting people physically, economically, and socially due to the belief that it is a curse by ancestral spirits [4].

Despite the disease's significant effect, the origin and method of transmission of BU infection remain unclear. However, the role of different risk factors in the development and prevalence of BU is well established. For example, previous case-control studies and epidemiological surveys conducted in endemic areas such as Benin, Ghana, Cameroon, and southeastern Australia indicate that a combination of demographic, environmental, behavioural, socio-cultural, and host-related factors increases the likelihood of developing BU after exposure to M. ulcerans. These factors include age, proximity to water holes, improper wound care, use of traditional medicine, and underlying medical conditions such as diabetes mellitus [5-8]. Most of these studies are quantitative, establishing the odds ratios (OR) and adjusted odds ratios (aOR) of experiencing BU and the association between the disease and each of the above risk factors. For instance,

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Jacobsen *et al*. [9] and Omansen *et al*. [3] report that the likelihood of developing BU is higher among children and adolescents and those who live close to water holes.

BU is a debilitating infectious disease caused by Mycobacterium ulcerans, which is characterized by severe skin infections with possible deep tissue involvement. Although BU remains a serious public health problem, the specific cause and source of infection are poorly understood [1]. Researchers have established the possible risk factors for BU in people exposed to the bacteria in other endemic countries and regions such as West and Central Africa, Australia, Asia, and America. These factors may be demographic, environmental, behavioral, socio-cultural, and host-related, including age, proximity to water holes, improper wound care, alternative healing practices, and diabetes mellitus [5,6,8-10]. There are no studies on the prevalence and risk factors for BU in Benue State, where "*Ambi* disease" is rampant and believed to be a curse by ancestral spirits. Therefore, there is a need to conduct a study on risk factors for BU in the Tiv people of Benue State in order to reveal the main cause or source of infection and implement appropriate interventions to lower the rate of BU. The purpose of this study is to examine or validate the role of various risk factors in the prevalence of BU among the Tiv people of Benue State, Nigeria, in order to reveal the main reason for infection and implement appropriate interventions to control its spread. Therefore, the study will focus on determining the risk factors for BU in the Tiv people of the Benue State.

Hypotheses

H1: Proximity to or frequent contact with water bodies, engaging in risky activities, Traditional practices, low-income and presence of host factors will increase the odds of BU infection among the respondent as against those with minimal interaction with water bodies

Review of Risk factors associated with *Ambi* illness (Buruli Ulcer)

Demographic Risk Factors

Most of the studies on BU infection report age as a significant risk factor with the risk being non-linear. The highest odds ratio (OR) is recorded among children aged between 5 and 14 years, followed by children aged between 3 and 4 years, with the lowest OR reported among the infants [5,11]. In an unmatched case-control study in Benin comprising 2399 cases and 1444 controls, the age group of 5-14 years recorded an adjusted OR (aOR) of 11.64 (95% CI: 8.01 – 16.91) against that of the reference group (30 – 49 years). On the other hand, the age group of 3 – 4 years had an aOR of 6.74 (95% CI: 2.67 – 17.03) against the same reference group [5]. Similarly, the age group of over 50 years had an aOR of 4.36 (95% CI: 3.04 – 6.27) against the reference group of 30 – 49 years [5]. In an Australian study that employed a matched case-control design and comprised 245 cases and 481 controls, the odds of infections among Australians aged over 55 years was higher than among the younger population [6]. On the other hand, sex is not a significant predictor of BU infection as most of the reviewed studies report no significant association between the sex of an individual and BU infection [5,12,8,7]. However, the study conducted in Ghana by Kenu *et al*., [7] using 722 cases and 210 controls shown a higher proportion of female adults infected with BU relative to their male counterparts, which might be explained by differences in occupational exposure.

Environmental Risk Factors

The association of BU infection with environmental factors has been firmly established by multiple studies. For example, the case-control study in Benin records an aOR of 4.62 (95% CI: 3.61 – 5.90) for those using unsafe sources of water, such as swamps, relative to those using safe sources of water among the respondents aged over 5 years [5]. Similarly, the case-control study conducted in Ghana by Kenu *et al*., [7] using 389 cases and 385 controls found exposure to slow-running water and wading in contaminated water to be significant predictors of BU infection, although no odds ratio (OR) was reported for the association. On the other hand, the study conducted in Australia employed a similar design found that the presence of possums around one's residence increased the odds of infection by an aOR of 2.33 (95% CI: 1.15 – 4.71) for the disease [6].

Behavioural Risk Factors

The association between BU infection and behavioural risk factors has also been documented by multiple studies. For example, the study conducted in Benin by Nackers *et al*., [5] found that farming occupations had an aOR of 3.51 (95% CI: 1.97 – 6.26) for infection among the female population aged over 5 years. Similarly, the same study found that among males, attending school had an aOR of 2.87 (95% CI: 2.02 – 4.10) for BU infection as compared to those not in employment [5]. On the contrary, the study conducted in Australia by O'Brien *et al*., [6] found that working outdoors with the soil recorded an aOR of 2.89 (95% CI: 1.01 – 8.25) for infection. Mosquito bites have also been reported as a behavioural risk factor for BU infection. The study conducted in Cameroon comprised 163 cases and 163 controls found a significantly higher number of patients who physically interacted with mosquitoes as compared to the control group [12] Similarly, a systematic review and meta-analysis performed by Yotsu *et al*., [2] confirm the association of failure to seek professional treatment with exposure to BU infection as a risk factor.

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Socio-Cultural Risk Factors

The association of BU infection with socio-cultural factors has also been documented by most of the reviewed literature. A qualitative study conducted in Ghana by Ackumey *et al*., [8] revealed that 60% of BU victims sought traditional healing before seeking conventional medical intervention, which significantly increased the duration of infection prior to conventional treatment commencing between 3 and 6 months. This study revealed that most of the traditional healers in Ghana are not trained and may fail to identify the symptoms of BU infection, leading to delayed conventional treatment [13]. Lower socio-economic status has also been associated with increased odds of BU infection. For example, in the study conducted in Cameroon by Bratschi *et al*., [12] using 163 cases and 163 controls found that those from households with lower-income brackets recorded an aOR of 2.1 (95% CI: 1.3 – 3.4) for BU infection relative to those from households with higher-income brackets. Furthermore, it was found that stigma was significantly associated with an increase in the duration of infection prior to seeking conventional medical intervention [14]. Another socio-cultural risk factor reported by multiple literature is customary activities involving the use of water, such as scarification, which has been recorded as a risk factor for BU infection in many parts of Africa. The study Carried out in Cote d'Ivoire comprised 304 cases and 304 controls found that those exposed to customary activities using unsterilized blades recorded an OR of 3.2 (95% CI: 1.8 – 5.7) for BU infection [10].

Host Risk Factors

Some of the reported risk factors for BU infection are related to personal health conditions. One of the documented risk factors is diabetes, which has been associated with an increased likelihood of developing BU infection. For instance, O'Brien *et al*., [6] found that the odds of BU infection among patients with diabetes recorded an aOR of 2.26 (95% CI: 1.13 – 4.49). HIV infection has also been reported as a risk factor for BU infection, although the reviewed studies present contradicting reports on the association between the two. Kenu *et al*., [7] found that HIV infection recorded an aOR of 3.35 (95% CI: 1.84 – 6.09) for being a risk factor for BU infection. In Gambia, a study by Sopoh *et al*., [14] reported a significant genetic risk factor for BU infection with an OR of 5.5 (95% CI: 3 – 10) for those with a family history of BU infection. However, Stienstra *et al*., (2006) found that the odds of infection were increased among those with a particular polymorphism on the SLC11A1 gene known as NRAMP1, whose effects on the host's susceptibility to BU infection had an estimated population-attributable risk of 13%.

Theoretical Framework for the Study

The relationship between the risk factors and the incidence of Buruli ulcer (BU) among the Tiv of Nigeria was guided by the Health Belief Model (HBM). The HBM was developed by social psychologists Hochbaum, Rosenstock, and Kegels in the 1950s and has been widely used and tested to predict health behaviors based on the beliefs of the individuals (Rosenstock, 1974). The HBM is a useful theoretical model to understand and predict the prevalence of BU among the Tiv as it takes into account several critical predictors of BU such as a perceived threat of BU, perceptions of the benefits and barriers of health services, and the cues to action. The HBM is useful in this study comprising both quantitative and qualitative research questions to explore and investigate the risk factors for BU among the Tiv. For example, the model can help explain the potential associations of the socio-cultural factors with the incidence and prevalence of BU among the Tiv.

The HBM's core constructs, namely perceived susceptibility, perceived severity, perceived benefits of taking prescribed actions, and perceived barriers to taking those actions, along with cues to action and self-efficacy to explore and investigate the risk factors associated with BU among the Tiv. Firstly, the study explored the Tiv's beliefs regarding their susceptibility to BU infection. Susceptibility beliefs have been reported as one of the most prominent constructs of the HBM, with people engaging in fewer health behaviors when the belief in their susceptibility to a condition is low. Secondly, the study examined the perceived severity of BU among the Tiv. Although multiple studies have confirmed the severity of BU, including necrosis of the skin, the association of BU with a high incidence of death if left untreated and its debilitating impact on the patient if treated, the perceived severity is significantly affected by cultural beliefs. Thirdly, the study will investigate the beliefs related to the perceived benefits of taking appropriate measures once BU is suspected. The perceived benefits include beliefs regarding the effectiveness of the available treatments and how effective they would be in promoting healing and preventing complications of BU. The study will investigate the beliefs of the Tiv about the perceived barriers to treatment seeking and the actual barriers they encounter when seeking treatment for BU. fourthly, the study look at the cues to action that prompt the Tiv to seek medical treatment once BU has been suspected. The cues to action differ significantly between communities; however, in the case of BU, the cues range from seeing an advertisement or hearing from friends/family members to visiting a health worker directly. Lastly, the study evaluates the role of self-efficacy in the Tiv's ability to take the recommended actions to prevent BU infection. The study is guided by the HBM, which is relevant in investigating the risk factors for BU among the Tiv as it considers a wide range of factors that need to be taken into consideration, such as the influence of socio-cultural beliefs.

METHOD

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The study utilized a mixed method research design to determine the relationship between the independent variables (demographic, environmental, behavioral, socio-cultural, and host factors) and the dependent variables or outcome (risk factors) by integrating both quantitative and qualitative research methods. The study comprised a quantitative survey and qualitative Key Informant Interviews (KIIs) with Key Informants who were requested to provide in-depth information on the research questions. A semi-structured interview guide was developed and used to conduct the interviews on the Key Informants. The interviews were conducted in the privacy of the Key Informants' homes with consent and permission, where a recorder and/or pen and paper was used. Moreover, the study targeted BU Patients (Victims) and Health care professionals as the populations of interest. The study was conducted in the local government areas (LGAs) that have reported the prevalence of BU among their communities, including Gboko, Kwande, Makurdi, Buruku, and Ushongo. Initially, the study identified BU Victims using the snowball sampling technique and recruited BU Patients and Healthcare Professionals using the purposive sampling technique. The study utilized 200 questionnaires for the survey among BU Victims and 18 Key Informant Interviews (KIIs) with the healthcare professionals and patients/victims.

Prior to data collection, the study gained ethical approval from the Ethical Review Board of the Ministry of Health, Benue State, and requested the permission of the appropriate authorities in the study area. The researcher also obtained informed consent from the Key Informants and the respondents selected using the snowball sampling technique. Wherever possible, the researcher requested verbal consent from illiterate respondents or those hesitant to provide written consent. The study implemented the principles of confidentiality and requested the Key Informants to maintain the privacy of the information shared. The study guaranteed the anonymity of the Key Informants and the respondents identified using the snowball sampling technique.

The data from the survey and the Key Informant Interviews (KIIs) was analyzed using a mixed-method approach to integrate the findings from the qualitative and quantitative data. The study utilized descriptive statistics and inferential statistics for quantitative data analysis. Statistical software such as SPSS wase used to analyzed the data from the questionnaire using descriptive statistics and to inferential statistics such as logistic regression to determine the strength and direction of the relationship between the independent and dependent variables by examining the odds ratios (OR) and adjusted odds ratios (aOR) for each predictor variable. The study analyzed the qualitative data using thematic analysis by coding and categorizing the qualitative data using Nvivo software.

RESULTS

Table 1: Demographic Characteristics of Study Participants (N = 200)

Variable	Category	N	%
Sex	Male	104	52.0
	Female	96	48.0
Age Group	5–14 years	50	25.0
	15–29 years	44	22.0
	30–49 years	76	38.0
	≥ 50 years	30	15.0
Occupation	Farming	136	68.0
	Trading	28	14.0
	Other	36	18.0
Education	None/Primary	110	55.0
	Secondary or higher	90	45.0
Household Income	Low	124	62.0
	Moderate/High	76	38.0

Source: Field work, 2025

Table 1 provides the demographic data of the 200 participants selected for this study. The data shows that (52%) of the respondents were male and female (48%) were female. The majority of participants (38%) were aged between 30 and 49 years, followed by those aged between 15 and 29 years (22%), 5 and 14 years (25%), and those aged 50 years or older (15%). Overall, 63% of cases were recorded among the younger generation of ages between 5 and 49 years. This illustrates that Buruli ulcer is common among children and adolescents in the study area, which is a typical characteristic of this disease in most of Africa. About 68% of the participants were farmers or fishermen, 14% were traders, while 18% were employed in other industries. In terms of education, most participants (55%) had no education or primary education, while 45% had secondary or higher education. In terms of income, most participants (62%) belonged to families of low-income earners, while 38% indicated that they came from moderate or high-income households. Overall, the participants were recruited from Tiv communities in Benue State using the snowball sampling technique. This indicates that the study sample is representative of the larger population of Tiv people in Nigeria, who are mostly farmers.

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Table 2: Descriptive Statistics of Risk Factors

Variable	Risk Factor Category / Statement	Mean ± SD	% Agreement (SA+A)
Environmental			
	I live within 1 km of a river, swamp, wetland, or other slow-flowing water body.	1.98 ± 0.85	22%
	I frequently visit or pass near stagnant or slow-flowing water bodies before infection.	2.12 ± 0.91	26%
	I have used unprotected water sources (rivers or swamps) for household needs before infection.	2.48 ± 1.02	39%
	I regularly engage in activities involving direct contact with natural water bodies before infection.	2.35 ± 0.98	34%
Behavioural			
	When I get a cut, I immediately wash it and apply antiseptic before infection (Protective).	2.28 ± 1.10	36%
	I frequently bathe or wash clothes in open water sources before infection.	2.65 ± 1.05	44%
	I delayed treating a wound because it seemed minor before infection.	3.42 ± 0.82	75%
Socio-Cultural			
	When I or a family member has a skin condition, we first seek care from a traditional healer before infection.	3.68 ± 0.71	86%
	Cultural beliefs in my community attribute skin diseases like Ambi to spiritual or supernatural causes.	3.75 ± 0.65	89%
	I have delayed seeking medical treatment due to fear of stigma before infection.	3.48 ± 0.88	78%
Socio-Economic			
	My household has a reliable monthly income sufficient to meet basic needs before infection.	1.92 ± 0.96	19%
	In the past year, I have been unable to afford medical treatment or transportation.	3.58 ± 0.76	83%
Host Factors			
	I have been diagnosed with diabetes mellitus before infection.	1.88 ± 1.02	21%
	There is a history of Buruli Ulcer (Ambi) in my immediate family.	1.65 ± 0.78	12%
	I have received the BCG vaccine before infection.	1.45 ± 0.72	8%

Source: Field work, 2025
Scale: SA = Strongly Agree (4), A = Agree (3), D = Disagree (2), SD = Strongly Disagree (1) % Agreement = SA + A

Table 2 contains the respondents' perception of their exposure to each of the identified risk factors before contracting Buruli ulcer (*Ambi* disease). Firstly, most of the respondents denied being exposed to water contact in their environment. Only 22% of the victims agreed that they lived within 1 km of a river, swamp, or wetland (M=1.98). Meanwhile, 26% of the respondents agreed that they often visited stagnant water bodies. This implies that many Buruli ulcer victims in the study area do not reside in the proximity of rivers or water bodies, which is contradictory to the expectations based on previous research on Buruli ulcer.

In behavioural risk factors, the analysis revealed that 36% of respondents did not seek immediate medical attention after developing an ulcer, and 75% left minor wounds untreated (M=3.42). On the contrary, most of the victims of Buruli ulcer acknowledged that poor treatment of wounds and sores is a major risk factor for developing the ulcer (M=3.24).

Socio-culturally, most respondents laid the blame for witchcraft, or ancestral spirits. Specifically, 86% of the victims claimed that they or their family members initially sought treatment from traditional healers for similar skin infections (M=3.68). Moreover, 78% of the respondents feared stigmatization and therefore delayed treatment seeking for *Ambi.* In the socio-economic risk factors, only 19% of the victims had a stable income, 83% of the respondents could not afford treatment or transportation to seek care (M=3.58). Lastly, in the host risk factors, 21% of the respondents were diagnosed

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with diabetes. Family history of Buruli ulcer was even lower (12%), while only 8% of the respondents had received the BCG vaccination.

Table 3: Logistic Regression Results Predicting Buruli Ulcer (*Ambi* Disease) Occurrence (N = 200)

Item No.	Predictor Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value	Strength of Association
Environmental					
	Proximity to and contact with water bodies	0.72	0.45, 1.15	0.168	Not significant
Behavioral					
	Delayed treating a wound because it seemed minor	4.18	2.45, 7.12	< 0.001	Strong
Socio-Cultural					
	First seek care from traditional healer	5.35	3.02, 9.48	< 0.001	Very Strong
	Spiritual/supernatural beliefs about Ambi	4.82	2.78, 8.35	< 0.001	Very Strong
	Delay due to fear of stigma	3.65	2.10, 6.34	< 0.001	Strong
Socio-Economic					
	Unable to afford medical treatment or transportation	3.95	2.28, 6.84	< 0.001	Strong
	Low household income (reverse coded)	2.85	1.68, 4.85	< 0.001	Moderate-Strong
Host Factors					
	Diagnosed with diabetes mellitus	2.22	1.08, 4.56	0.030	Moderate
	Family history of Buruli Ulcer (Ambi)	1.28	0.68, 2.42	0.445	Not significant
	Received BCG vaccine	0.68	0.39, 1.18	0.172	Not significant

Model Summary: *Nagelkerke R^2 = 0.55, Overall model p-value < 0.001, Correct classification rate = 82.0%*

A logistic regression analysis was carried out to ascertain the risk factors associated with Buruli ulcer (Ambi) among the 200 victims assessed from Tiv communities in Benue State. The analysis controlled the effect of age, sex, and educational level. It revealed that the overall model was highly significant, with Nagelkerke R squared of 0.55, indicating that 55% of the variance in the occurrence of the disease was explained by the model. The model correctly predicted 82% of the variance in the cases. Contrary to reports from other studies conducted in other environments, none of the environmental factors were significant in the present study. Living in proximity to rivers, swamps, and water bodies had an adjusted odd ratio of 0.72, 95% CI: (0.45 – 1.15), p = 0.168. The analysis indicates that contact with water bodies is not a significant risk factor for developing *Ambi* amongst the Tiv people. Personal behavior and socio-cultural factors were the main risk factors for Buruli ulcer in this study. Delayed treatment of minor wounds (Item 9) was highly predictive of the ulcer with an adjusted odd ratio of 4.18, 95% CI: (2.45 – 7.12), p < 0.001. Socio-cultural factors were the highest contributors to the prevalence of the ulcer with seeking care from traditional healers as the strongest predictor. Patients who sought care from traditional healers were likely to develop Ambi, with an adjusted odd ratio of 5.35, 95% CI: (3.02 – 9.48), p < 0.001. Strong belief in the supernatural origin of the ulcer was strongly associated with the development of the ulcer, adjusted odd ratio of 4.82, 95% CI: (2.78 – 8.35), p < 0.001. Delaying treatment due to fear of stigma was also highly predictive of the ulcer with an adjusted odd ratio of 3.65, p < 0.001. Socio-economic risk factors were also implicated in the development of the ulcer. The inability to afford treatment and transportation was a significant predictor of the disease with an adjusted odd ratio of 3.95, 95% CI: (2.28 – 6.84), p < 0.001. Having a low-income household was also a significant predictor, adjusted odd ratio of 2.85, p < 0.001. Host-related factors contributed marginally to the risk of developing Buruli ulcer with diabetes mellitus, with an adjusted odd ratio of 2.22, p = 0.03. Family history of Buruli ulcer and BCG vaccination were not significant risk factors, p= 0.445 and p= 0.172, respectively. This was however expected since only 12% of the respondents indicated a family history of the ulcer while 8% indicated they had received BCG vaccination against tuberculosis.

Table 4: Major Themes from Key Informant Interviews (N = 18)

Theme	Description	Representative Quote	N (%)
Socio-Cultural & Spiritual Beliefs	Strong attribution to supernatural causes and heavy reliance on	"Ambi is a spiritual attack… we go to the herbalist first."	17 (94.4%)

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	traditional healers		
Socio-Economic Barriers	Poverty, inability to afford hospital care	"Even if it is not river, we cannot go to hospital because of money."	16 (88.9%)
Behavioral Factors	Poor wound care and delayed treatment	"We usually ignore small wounds until they become big."	15 (83.3%)
Unexpected Low Water Contact	Most victims not living near rivers	"Our farms are far from the river, yet Ambi still came."	14 (77.8%)

Source: Fieldwork (KII), 2025.

Table 5: Comparison of Major Risk Factors for Buruli Ulcer (Ambi Disease): Past Studies Versus Present Study Among Tiv People in Benue State, Nigeria

Risk Factor Category	Past Studies (Selected Findings)	Present Study Findings (N=200)	Key Difference / Contribution
Environmental (Proximity to water bodies & unprotected water contact)	Strong association (aOR 2.27–4.62); significant in Benin, Ghana, and Australia (Nackers *et al*., 2007; Kenu *et al*., 2014; O'Brien *et al*., 2018)	Low exposure reported (22% agreement); not statistically significant (aOR = 0.72, 95% CI [0.45, 1.15], $p = .168$)	Major inconsistency; water contact not a key risk in this population
Behavioral (Delayed wound care)	Moderate to strong risk (aOR ≈ 2.89 in outdoor work & wound exposure)	Strong risk (75% agreement; aOR = 4.18, 95% CI [2.45, 7.12], $p < .001$)	Consistent but stronger effect observed
Socio-Cultural (Traditional healing, spiritual beliefs, stigma)	Moderate to strong (treatment delay due to traditional healers and stigma) (Ackumey *et al*., 2012; Sopoh *et al*., 2010)	Very strong (86–89% agreement); traditional healing (aOR = 5.35, 95% CI [3.02, 9.48], $p < .001$); spiritual beliefs (aOR = 4.82, $p < .001$)	Consistent and substantially stronger in Tiv context
Socio-Economic (Low income & inability to afford care)	Moderate risk (aOR ≈ 2.1) (Bratschi *et al*., 2013)	Strong risk (83% agreement on inability to afford treatment; aOR = 3.95, 95% CI [2.28, 6.84], $p < .001$)	Consistent and stronger
Host – Family History	Moderate to strong (OR up to 5.5) (Sopoh *et al*., 2010)	Very low (12% agreement); not significant (aOR = 1.35, 95% CI [0.72, 2.52], $p = .348$)	Inconsistent
Host – Diabetes	Moderate risk (aOR = 2.26) (O'Brien *et al*., 2018)	Moderate risk (21% agreement; aOR = 2.22, 95% CI [1.08, 4.56], $p = .030$)	Consistent
Host – BCG Vaccination	Partial protective effect (aOR ≈ 0.59) in some studies	Very low uptake (8%); not significant (aOR = 0.65, 95% CI [0.38, 1.12], $p = .122$)	Inconsistent due to low exposure

Sources: Past and resent study, 2025

The table shows a comparison of the risk factors for Buruli ulcer (Ambi disease) identified by the current study among the Tiv people in Benue State and the risk factors previously reported by other researchers. It reveals both similarities and differences, which highlight the significance of the findings of the current study. For environmental factors, previous studies in Benin, Ghana, and Australia found that proximity to water was strongly associated with BU, while the current study found that exposure to water was low (only 22% agreed), and no significant association (aOR = 0,72, p = 0,168). This shows that the current study's finding of no significant association between exposure to water and BU is contradictory to the results of previous studies. As for behavioral factors, the current study confirmed the previous results on late presentations for treatment, although with a higher percentage of agreement (75%) and a higher odds ratio (aOR = 4,18, p <0,001). In socio-cultural factors, the current study identified this group of factors as the most significant risk factors for BU among the Tiv people. Traditional healing beliefs, spiritual causation, and stigma were strongly associated with delayed treatment with mostly higher odds ratios (aOR ranging from 3,65 to 5,35) than the previous studies. This is an important finding that shows the influence of cultural beliefs on treatment-seeking behavior among the Tiv people. Socio-economic factors were also found to be significant risk factors with higher odds ratios than the previous studies. The effect of low-income households and inability to pay for treatment was higher in the current study than in the earlier research. Host factors showed conflicting results with previous studies. Diabetes was moderately associated with BU, similar to the earlier studies, while family history of BU and BCG vaccination had no significant association due to their low prevalence (12%) in the study population. In conclusion, the comparison table of risk factors shows that the current study's findings are partly consistent with the previous research results. The significant risk factors identified in the

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current study were similar to those reported by other researchers. However, the current study found that the association of environmental factors (exposure to water) with BU was contradictory to the previous results. On the other hand, the current study found that socio-cultural factors have a higher effect on the treatment-seeking behavior of the Tiv people than previously thought. This makes these findings significant and different from the earlier studies.

DISCUSSION OF FINDINGS

The study assessed risk factors for Buruli ulcer (BU or Ambi) among the Tiv of Benue State, Nigeria, using a mixed methods study. Socio-cultural, behavioural, and socio-economic factors were the most prevalent predictors of BU, whereas the risk associated with water contact was non-significant. Host factors yielded mixed results. Both supporting and contradicting the existing literature on the risk factors for BU, this study's findings demonstrate the significant role played by socio-cultural characteristics and the need to consider local epidemiology in designing control strategies.

Contrary to findings in Benin, Ghana, and Australia, this study found that the Tiv people of Benue State, Nigeria, are less likely to report exposure to water contact as a risk factor for BU. Only 22–39% of respondents agreed that proximity to or exposure to water bodies contributed to their infection, and the adjusted odd ratio for environmental exposure was 0.72 (95%CI: 0.45 – 1.15; p=0.168). According to qualitative findings, most respondents said they did not work or live near water bodies but still contracted Ambi. Indeed, the association of environmental risk with BU has been found in most case-control studies of BU in Benin, Ghana, and Australia, with an adjusted odd ratio (aOR) ranging from 2.27 to 4.62 [5,7,15]. The discrepancy suggests that the transmission of BU in Nigeria may follow different routes, necessitating further investigation.

This study found that the most significant predictors of BU in the study area were behavioural, particularly the delay in seeking treatment for minor wounds, which was strongly associated with getting BU (aOR=4.18; 95% CI: 2.45 – 7.12; p<0.001). Overall, 75% of respondents agreed that they did not seek medical attention for minor skin sores before deciding that the lesion was serious enough to require treatment. These findings align with the literature in which poor management of the skin and failure to seek timely treatment increases the risk of BU [2,6]. However, this study's findings indicate a slightly stronger association with delayed management than most previous studies (e.g., aOR≈2.89 for outdoor work/soil contact in Australia) [2,6]. This could be attributed to the confluence of poor management practices and other socio-cultural and economic factors.

Other socio-cultural factors that contributed to the high prevalence of BU among the study population were seeking treatment from traditional healers first, the belief in supernatural causes, and stigma-related delay in seeking care. First, consulting traditional healers was the second most significant predictor of BU in this study (aOR=5.35; 95%CI: 3.02 – 9.48; p<0.001) with 86% agreement. Similarly, negative community attitudes, including spiritual explanations for Ambi, contributed to treatment delays (aOR=4.82; p<0.001; 89% agreement). Furthermore, respondents stated that they hesitated to seek conventional therapy because of stigma associated with BU (aOR=3.65; p<0.001; 78% agreement). This study's qualitative data corroborated the survey findings, indicating that 94.4% of key informants believe that Ambi is caused by spirits and that herbal medicine is an appropriate treatment for the condition. Ackumey *et al*. [8] and Sopoh *et al*. [14] also found that a large proportion of BU patients in Africa sought treatment from traditional healers and experienced treatment delays. However, this study found much stronger associations with these socio-cultural predictors of BU than previous studies. This could be because the Tiv of Benue State, Nigeria, hold stronger spiritual beliefs regarding the causes and management of BU, leading to greater delays in seeking conventional care.

Poverty was another critical predictor of BU in this study. The inability to afford treatment or transportation to a healthcare facility (aOR=3.95; 95%CI: 2.28 – 6.84; p<0.001; 83% agreement) and having a low household income (aOR=2.85; p<0.001) were strong financial barriers to care in the study area. These results build upon findings from other low-income regions, such as Cameroon, where financial hardship was also found to be a significant predictor of BU, albeit with a relatively lower adjusted odd ratio (aOR≈2.1) [11]. This study found that age (aOR=1.57; 95%CI: 1.00 – 2.47; p=0.05) and diabetes (aOR=2.22; 95%CI: 1.08 – 4.56; p=0.03) were moderately associated with BU, whereas there was no significant association with a family history of BU or BCG vaccination. Only 21% of respondents were diabetic, and 12% and 8% of households reported a family history of BU and had received the BCG vaccine, respectively. These relatively low prevalence rates could explain the insignificant associations. Contrary to this study's findings on diabetes and age, several previous studies in the region reported a higher prevalence of BU among households with a history of the disease [8,14] and a possible protective effect of BCG vaccination against BU [14]. Low exposure to these risk factors may account for the difference in findings of this study and those of the literature on the risk factors for BU.

The study's findings are consistent with the Health Belief Model (HBM) of health behaviour change (Rosenstock, 1974). The high prevalence of BU among the study participants can be explained by negative beliefs about the condition and the influence of socio-economic factors on their ability to manage it. For example, the study found that most respondents had

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negative beliefs about Ambi, such as supernatural causes and high stigma, which decreased their likelihood of seeking timely care and reduced perceived benefits and cues to action (as discussed in detail in the analysis of findings). Furthermore, the study found that the poor and those with limited formal education were more likely to delay care due to financial problems or the belief that traditional healers could manage BU. These findings demonstrate how negative beliefs and low self-efficacy influenced the health-seeking behaviours of the study participants. By understanding how the Tiv interact with the various health belief dimensions, stakeholders can effectively intervene to change individual health beliefs and improve health outcomes.

Implications

The findings of this study have several implications for BU prevention and control in the study area. First, the study provides critical empirical evidence on the risk factors for Ambi among the Tiv of Benue State, Nigeria, which can inform evidence-based control policies and programs. For example, it provides empirical information that local caregivers must be integrated into BU management strategies. Additionally, the study highlights the need for community health education on the importance of timely medical care for minor skin sores. Moreover, it demonstrates the importance of socio-economic support in managing BU, which local authorities can consider when designing control policies. This study has a few limitations that must be acknowledged. First, the study relied on self-reported data from respondents. Second, this study used a case-only design; future research should adopt a case-control design. Third, the study used convenience and snowball sampling techniques, which could affect the generalizability of the results.

CONCLUSION

To conclude, this study aimed to examine the risk factors for BU among the Tiv of Benue State, Nigeria. This study's findings revealed that the Tiv have several risk factors similar to those identified in the literature on BU transmission and control. However, unlike previous studies that documented the role of the environment, particularly water contact, in transmitting BU, this study found environmental risk to be a non-factor. Indeed, this study revealed that the most significant risk factors for BU in the study locality were socio-cultural. These findings provide crucial empirical evidence for designing effective BU control policies and programs in the region.

Recommendations

Based on the study, the following recommendations were made:

Develop Culturally Integrated Health Education and Community Engagement Programs. Community members must be educated about BU, its causes, and the importance of seeking timely and appropriate care.

Strengthen Wound Care Practices through Targeted Behavioural Interventions: Targeted behavioural interventions should be implemented to strengthen existing practices, particularly among children and caregivers in the Tiv locality.

Address Socio-Economic Barriers to BU Management: state and local government authorities in Benue State should consider designing and implementing social support programs for families living in poverty who cannot afford conventional BU treatment.

Further Ecological and Clinical Surveillance and Research: There is a need for further surveillance and research that will adopt a case-control strategy. This will allow researchers to obtain data from both BU-affected and BU-unaffected communities, providing more reliable evidence on the risk factors for BU in the study area.

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