



Investigating the Influence of Quarry Mining Activities on Malaria Prevalence: A Community Based Survey in Ebonyi State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author LUO conceptualized the study. Authors LUO, PAA and ECE designed the study and wrote the protocol. All authors were involved in the literature searches. Authors COM and ENO did the statistical analyses, wrote the first draft of the manuscript and revised by author LUO. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the study was to investigate the influence of quarry mining activities on malaria prevalence in rural communities of Ebonyi state, Nigeria.

Study Design: A comparative cross sectional study design.

Place and Duration of Study: Rural communities of Ebonyi State southeast Nigeria between November 2011 and February 2012.

Methodology: Two rural communities in Ebonyi state, Nigeria were purposively selected for the study. One was renowned for its numerous quarry mining industries while the control group was a farming community. Total population study of the two communities were done. Data collection involved a pretested interviewer administered questionnaire and blood film examination for malaria parasites. Data analysis was done using Statistical Package for Social Science statistical software

version 20. Chi square statistical test of significance was used in the analysis and level of significance was determined by a p value of < 0.05 .

Results: A total of 342 respondents participated in the study, (206 in study group and 136 in control). A significantly higher proportion of respondents in the study group were aware of quarry mining activity in their community and the presence of abandoned quarry pits, ($p < 0.001$). Also, a higher proportion of children under 5 years and pregnant women in the study group experienced malaria in the past two weeks when compared with those in the control group, ($p < 0.001$) and a significantly higher proportion of respondents in study group were positive for malaria parasites when compared with the control group, ($p < 0.001$).

Conclusion: When compared to non-mining community, quarry mining significantly increased the prevalence of malaria. Also, pregnant women and children under the age of five years were the most affected groups in such areas. Bearing in mind that these mining activities are not regulated, there is need for adequate supervision and monitoring of all mining activities by responsible agents of government. There should also be intensification of malaria control efforts in such communities.

Keywords: Quarry mining; malaria; prevalence; Ebonyi State; Nigeria.

1. INTRODUCTION

Economic activities of inhabitants of an area can influence the pattern of diseases prevalent in the area [1]. Quarry mining is a major source of livelihood in Ebonyi state, Nigeria and the growing demand for limestone has led to the establishment of different scales of quarry industries in the state. Apart from satisfying the ever growing needs of a rapidly growing population for infrastructural development and urbanization, quarrying activities have helped to provide direct and indirect jobs for many people living in host communities.

Occupational activities like quarry mining alter the physical environment and allow disease causing pathogens or vectors to survive more freely than in other environments such that disease distribution is not uniform [2]. Environmental degradation and disease are some of the negative impacts of mining on the immediate community and poor environmental regulation in developing countries imply that these activities are carried out with little consideration of their health implications [1,3,4].

Malaria is one of the leading causes of death in sub-Saharan Africa, [5] and in Nigeria, it is holoendemic with a steady transmission throughout the year. [6] with approximately 97% of Nigerians at risk of the disease [7]. The preponderance of malaria and its variations in prevalence within geographic locations have been linked to differences in occupational activities that alter the physical environment [8,9,10]. Quarry mining is one of such occupational activity that alters the physical

environment and could create conditions that support malaria transmission [9,11]. For instance, water pits created by mining activities serve as a reservoir for mosquito breeding thereby increasing the risk of malaria and its transmission among mining communities [12,13].

Targeted community-based action for malaria control is required and although it is possible to say that malaria prevalence may be higher in mining communities there is little empirical evidence to support this relationship in Nigeria. A direct comparison of malaria morbidity pattern in mining and non-mining communities is therefore of relevance. This study was conducted to compare the malaria prevalence in quarry mining and non-quarry mining communities; and to identify the groups of people in these communities who are most-at-risk for malaria.

2. MATERIALS AND METHODS

2.1 Study Area

This study was undertaken in Ndiagu-Idaka and Umuezaka, two neighbouring communities in Ohaukwu Local Government Area of Ebonyi state, southeast Nigeria. Ebonyi state is the centre of stone crushing activities in southeast Nigeria. Ndiagu-Idaka is very rich in mineral deposits such as limestone and is renowned for its numerous quarry mining industries, many of which undertake unregulated quarry mining activities. The area attracts a lot of migrant workers who form their own quarrying settlements. Umuezaka community on the other hand is a farming community with mostly indigenous local dwellers.

2.2 Study Design

A comparative cross-sectional study design was adopted and two rural communities, Umuezeka and Ndiagu-Idaka were purposively selected. One community, Ndiagu-Idaka represented the mining community hence the study group while the other, Umuezeka represented the non-mining community (control group). Both communities were otherwise comparable in their socio-economic characteristics.

2.3 Sample Size and Sampling Technique

This study involved total population study of the two communities of adults aged 18 years and above. A meeting was scheduled between the political and traditional leadership of the two communities. After explaining to them the purpose of the study, they gave consent and assigned the Head of Department of Health in the Local Government Area to be part of the study. On agreed dates, each of the traditional rulers mobilized their community to a primary school compound. Two hundred and six (206) adults were mobilized in study group community while one hundred and thirty six (136) adults were mobilized for the control group. Everyone who attended and participated in the study responded to a pretested interviewer administered semi-structured questionnaire which was developed by the researchers. They also had blood collected for thin and thick smear for malaria parasites.

2.4 Data Collection and Management

Objective and subjective data collection methods were used. For the subjective method, a semi-structured questionnaire was used to collect information on respondents' demographics, their perception of malaria and malaria risks, episodes of malaria in their household and practice of malaria prevention strategies. The prevalence of malaria was objectively assessed through thick blood film examination for malaria parasites. By this method, 2 drops of blood was placed in the middle of a clean, grease free slide and mixed in a circular form to form a smear. This was allowed to dry properly and then stained with Giemsa stain. After allowing the stain to dry, the slide was examined under the microscope. Field staff were recruited and trained to administer the questionnaires, while blood samples were collected by experienced phlebotomists and examined for malaria parasites by trained medical laboratory scientists same day in the respective communities.

Completed questionnaires were first checked for completeness of information and appropriateness of recordings. Of the blood samples collected, (159) 77.2% in the quarry mining community and (125) 91.9% in the non quarry community were suitable and utilized for the study. Data was analyzed using SPSS statistical package version 20. Means and standard deviations were calculated for numeric variables while frequencies and proportions were calculated for categorical variables. Chi square statistical test of significance was used in the analysis and level of significance was determined by a p value of less than 0.05.

Malaria parasitaemia was recorded as either positive or negative. A positive result was interpreted as the presence of one ringed form of red blood cell in a field of view under X100 magnification of the light microscope. However, a malaria slide was declared negative when the microscopist has gone through 100 High Power Fields (HPF) and not find any parasite. The participants who were positive for malaria parasites were treated using Artemisinin Combination Therapies while all the participants including those who were negative for malaria parasites were given haematinics and anti-helminthics.

3. RESULTS

A total of 342 respondents participated in the study, 206 from the quarry mining community (study group) and 136 from the non-quarry mining community (control group). The mean age of respondents were 37.5 ± 17.9 years and 39.2 ± 16.9 years in study and control groups respectively. The rest of the findings are presented in Tables 1-4.

Table 1 shows the socio-demographic characteristics of respondents. Respondents in both communities were mostly females (study, 71.4% and control 89.7%) and married, (study, 67.9% and control 79.4%). Majority of respondents were resident in the communities (study, 95.6% and control, 99.3%), and had less than secondary education.

Table 2 shows the perceived effects of quarry mining in the community. A significantly higher proportion of respondents in the mining community were aware that quarry mining was taking place in the community, ($p < 0.001$) and also were aware of the presence of abandoned mining pits in their community, ($p < 0.001$).

Table 1. Socio-demographic characteristics of respondents

Variable	Study group n=206 N (%)	Control group n=136 N (%)	χ^2	p value
Gender				
Male	59 (28.6)	14 (10.3)	15.354	0.001
Female	147 (71.4)	122 (89.7)		
Marital status				
Never married	38 (18.5)	15 (11.0)	5.552	0.06
Married	140 (67.9)	108 (79.4)		
Separated/Divorced	28 (13.6)	13 (9.6)		
Educational attainment				
No formal education	74 (35.9)	48 (35.3)	1.508	0.974
Primary education	96 (46.6)	62 (45.6)		
Secondary education	28 (13.6)	21 (15.4)		
Tertiary education	8 (3.9)	5 (3.7)		
Resident in community				
Yes	197 (95.6)	135 (99.3)	FT	0.096
No	9 (4.4)	1 (0.7)		

FT: Fishers exact test

Table 2. Perceived effect of quarry mining on the environment

Variable	Study group n=206 N (%)	Control group n=136 N (%)	χ^2	p value
Aware of quarry mining activities in community				
Yes	199 (86.6)	2 (1.5)	305.96	<0.001
No	7 (3.4)	134 (98.5)		
Aware of abandoned quarry pits in community				
Yes	201 (97.6)	1 (0.7)	317.72	<0.001
No	5 (2.4)	135 (99.3)		
Number of observed pits with water in the community				
1-10 pits	181 (87.7)	0 (0.0)	FT	<0.001
11-20 pits	17 (8.3)	0 (0.0)		
≥20 pits	8 (3.9)	0 (0.0)		

FT: Fishers exact test

Table 3 shows the perception and practice of malaria prevention. Comparable proportion of respondents in both mining and non mining communities were aware of the beneficial effects of insecticide treated nets in the prevention of malaria, ($p=0.358$). However a higher proportion of households in study community had insecticide treated nets when compared with the non mining community and the difference in proportion was found to be statistically significant, ($p=0.048$).

Table 4 shows the prevalence of malaria in study and control groups. All the respondents in the quarry mining community perceived malaria to be common in their community while in the non mining community, 9.6% of the respondents had the same perception and this difference in proportions was found to be statistically

significant, ($p<0.001$). A significantly higher proportion of respondents in the mining community, (77.9%) experienced malaria in the two weeks preceding the study when compared with those in the non mining community and the difference in proportions was found to be statistically significant, ($p<0.001$). Also, higher proportions of children under five years and pregnant women in the mining community experienced malaria in the two weeks preceding the study when compared with those in the non mining community and this difference in proportions was found to be statistically significant, ($p 0.005$). A significantly higher proportion of respondents in the study community tested positive to malaria parasites on day of data collection when compared with those in the control community, ($p<0.001$).

Table 3. Perception and practice of malaria prevention

Variable	Study group n=206 N (%)	Control group n=136 N (%)	χ^2	p value
Perception of ITNs in malaria prevention				
Beneficial	192 (93.2)	130 (95.6)	0.854	0.358
Not beneficial	14 (6.8)	6 (4.4)		
Household ownership of ITN				
Yes	144 (69.9)	81 (59.6)	3.892	0.048
No	62 (30.1)	55 (40.4)		
Use of ITN by pregnant women and under 5 children previous night				
Yes	139 (67.5)	78 (57.4)	3.627	0.057
No	67 (32.5)	58 (42.6)		

ITN: Insecticide treated net

Table 4. Prevalence of malaria

Variable	Study group n=206 N (%)	Control group n=136 N (%)	χ^2	p value
Perceived frequency of malaria				
Very common	142 (68.9)	5 (3.7)	FT	<0.001
Common	64 (31.1)	8 (5.9)		
Not common	0 (0.0)	123 (90.4)		
Fever in household in past 2 weeks				
Yes	166 (77.9)	80 (55.6)	19.213	<0.001
No	40 (22.1)	56 (44.4)		
Household member with fever in past 2 weeks				
Under 5 years	91 (64.5)	39 (55.7)	10.552	0.005
Pregnant women	24 (17.0)	5 (7.1)		
Other family members	26 (18.4)	26 (37.1)		
Current episode of fever in household				
Yes	105 (50.9)	40 (29.4)	15.604	<0.001
No	101 (49.1)	96 (70.6)		
Malaria parasitaemia				
Positive	60 (37.8)	17 (13.3)	20.632	<0.001
Negative	99 (62.2)	108 (86.7)		

4. DISCUSSION

Respondents in the study community had a good level of awareness of quarry mining activity in their community and the presence of abandoned pits which were effects of quarry mining on the environment. Majority of them also felt that malaria was very common in their community and therefore perceived prevention strategies, such as use of insecticide treated nets as beneficial for controlling malaria. However, household ownership and use of insecticide treated nets was not as common. Several studies have reported lower malaria prevention practices

relative to knowledge and perception of risks and benefits [14,15]. Even though a number of individual and access factors have been linked to this outcome, less attention has been paid to the individual factors.

Findings from our study revealed that when compared to non-mining communities, quarry mining significantly increased the prevalence of malaria. The statistically significant finding in perceived occurrence of malaria, reported household episodes of fever currently and within the past two weeks, and malaria parasitaemia between quarry mining and non-quarry mining

communities to an extent demonstrate the linkage between quarry mining and malaria prevalence. The reported and observed presence of numerous abandoned quarry pits with water in the quarry mining community and the potential for them to constitute breeding sites for mosquitoes also explain the significantly higher prevalence of malaria in the community. This high prevalence of malaria in mining communities when compared with non mining communities has also been demonstrated from the result of a study in Ghana [16].

Even in quarry mining communities, pregnant women and children under-five years of age remain the most-at-risk groups of people for malaria. This implies that some of the health risks that result from the environmental degradation of quarry-mining are not limited to those who work at the sites but could impact on the health of communities as a whole. Malaria as a consequence of quarry mining goes beyond the ergonomics of fitting the machine to man, considering that it has population health effects. Quarry-mining is therefore a public health issue that should be given appropriate attention in order to ensure that malaria control efforts continue to yield sustained, significant and widespread results.

Mine site rehabilitation is a responsible social action. Closing former mine sites by identifying and correcting any safety hazards should include refilling quarry pits to return the land as close as possible to its natural state. Unregulated quarry mining activities often result in abandonment of pits in used up sites. Prioritizing and establishing mine site rehabilitation plans at the outset is necessary for ensuring environmental safety when mine sites are closed. Governments need to set environmental standards for regulating the activities of mining industries. While waiting for governments to come up with mine site rehabilitation policies, the national and state malaria control programmes need to target at-risk communities in the scale-up of malaria control interventions. Health services provided to such communities must take into account the priority health needs of the people.

5. CONCLUSION

When compared to non-mining communities, quarry mining significantly increased the prevalence of malaria. Also, pregnant women and children under the age of five years were the most affected groups in such areas. Bearing in

mind that these mining activities are not regulated, there is need for adequate supervision and monitoring of all mining activities by responsible agents of government. There should also be intensification of malaria control efforts in such communities.

ETHICAL APPROVAL

The research protocol was reviewed and approved by the Health Research and Ethics Committee of Federal Teaching Hospital Abakaliki, Ebonyi state, Nigeria. Permission to conduct the study was obtained from the State Ministry of Health and the community representatives. Verbal informed consent was obtained before collection of blood from members of the community and also before administering the questionnaires to respondents. Confidentiality was maintained by non-inclusion of self identifying characteristics in the data collection tool.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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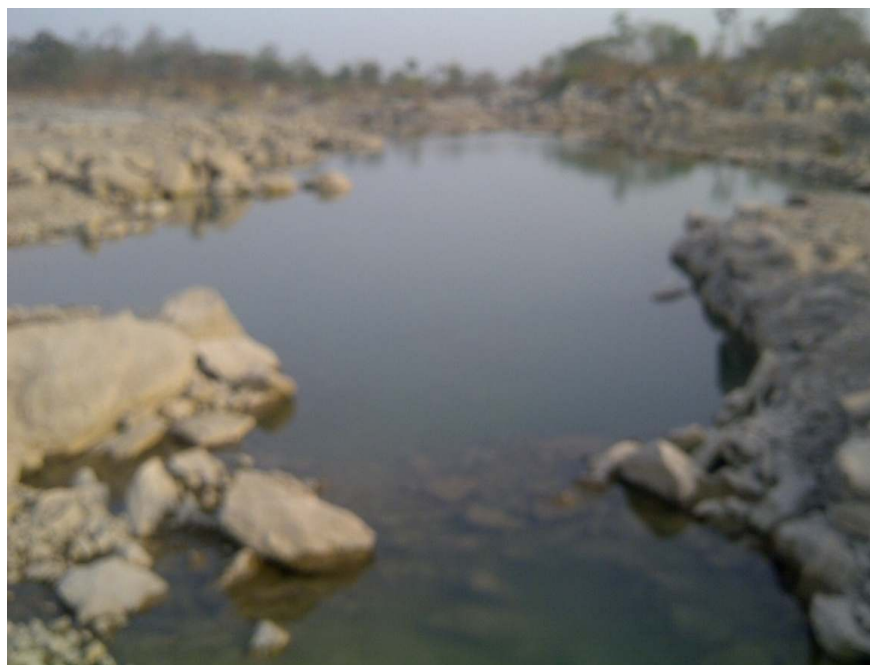
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APPENDIX

Pictures of Abandoned Mining Pits in Quarry Mining Community





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