

RESIDENTIAL PROXIMITY OF MUNICIPAL WASTE DUMPSITES AND INCREASED RATE OF HOSPITALIZATION FOR MALARIA

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ABSTRACT

Epidermological studies suggest that there may be an association between environmental exposure to waste dumpsites and malaria. The aim of this study was to test the hypothesis that residential proximity to waste dumpsites results in increased rates of hospitalization for malaria in children between the ages of 1 and 5 years in New Market Neighborhood in Owerri. After analysis with statistical tools, it was found that there was a significant increase in the incidence and rate of hospitalization among children living in proximity to the waste dumpsite.

INTRODUCTION

The continued function and survival of any human society is dependent, to a significant degree, on its adaptability, resilience, and vulnerability to environmental events (Young & Berkout, 2006). As globalization accelerates the rate and spatial scale of human environment interaction, the distinction between natural and man-made disasters becomes blurred (Pezzoli, Turkey, Sarahia, & Mirander, 2007).

In Nigeria, solid waste management has remained one of the greatest challenges of urban municipalities, gulping about 10 to 20% of their annual budgets (FEPA, 1999). This is partly because their phenomenal population and spatial growth is not coupled with the provision of waste treatment and disposal facilities.

Consequently, urban residents have dumped their waste indiscriminately on open spaces, undeveloped plots, and roadsides. There is great anxiety about environmental risks associated with poor waste management in the country. Increasingly, the public is becoming aware of environmental issues such as the potential hazards to health resulting from disposal of a wide range of wastes (Gatrell & Lovett, 1995; Sheldon & Smith, 1995). Goren and Hellman (2001) argue that exposure to even low levels of pollution can aggravate health problems, especially among the most vulnerable groups. Other authorities posit that waste dumps could provide conditions in which disease vectors are able to persist and reproduce, although this depends on waste constituents, environmental conditions, age of the dumps, and operating practices (Swan, Crook, & Gilbert, 2002).

Malaria is among the leading causes of death in Nigeria and many countries of the sub-Saharan Africa, where the protozoan *Plasmodium falciparum* species, which produces the most severe symptoms, is most predominant (Afolabi, 2006). This parasite is transmitted by the bite of an infected female *Anopheles* mosquito from where it enters into the bloodstream and travels to the liver, where it grows and multiplies in a period of 8 days to several months and even years. The fight against malaria has long been mainly reactive as people wait and do nothing until they come down with the disease. According to Ikhisemoge (2006) about 200 million cases of malaria occur worldwide annually, and between 100 and 200 million die; more than 75% of these deaths occur in children in the sub-Saharan Africa. With her large population, there is little doubt that quite a large proportion of these deaths occur in Nigeria.

The incidence of malaria generally increases more rapidly among vulnerable groups, especially neonates and children. There is limited evidence to suggest that the breeding and multiplication of mosquitoes on waste dumps can lead to increases in the incidence of malaria.

This study examines the health effect of a waste dump on the population living close to it. It tries to establish whether there is a strong link between pathological zones created by waste dumpsites and incidence of malaria, and whether the proximity to waste dumps has a significant influence on the rate of hospitalization of children due to malaria disease.

MATERIALS AND METHODS

Study Area

The study area is located in the southwestern fringe of Owerri Municipal in a relatively new and fast growing neighborhood called New Market. The study area was chosen for several reasons.

First, the neighborhood is well-delineated from other residential zones in Owerri Municipal by natural and man-made features. In fact, it is bounded in the south through southwest by the Otamiri river and in the East by Emmanuel

College's premises, all running parallel to a major transportation route (Douglas Road), and in the north by Royce Road. Its location is therefore distinctly bounded and so interesting for such a study. Second, although some commercial activities are practiced along the streets and major roads bordering the area, the zone is mainly residential, with a very high population density. The final reason is the willingness of residents to cooperate with anything that has to do with the dumpsite, because of its high nuisance value within the neighborhood.

However, as a result of a lack of waste collection systems in this neighborhood, residents in the area found it most convenient to dump their waste on an undeveloped piece of land a few meters from the nearby Otamiri stream, which, in fact, serves as a source of water supply to many communities downstream (Nekede, Ihiagwa, Obinze). Refuse has been dumped on this site for more than 15 years, on a surface area approximately 6 hectares in size, 5 meters high, and uncovered. Nearly 30 tons of waste are dumped here daily. Waste components mainly include metals (beverage cans, ferrous materials), used papers, rags, plastics, and organic materials (food remnants, dead and green leaves). A large quantity of decaying fruits and vegetables (oranges, tomatoes, etc.) was found on the dumpsite. All these materials provide a conducive environment for the *Anopheles* mosquitoes to breed in troops. The area surrounding the dumpsite is highly urbanized and mainly used for mixed residential houses made of bungalows and high-rises not exceeding two floors. The closest buildings are located at a distance of 15 meters from the dumpsite which shows proper integration of the dumpsite within the neighborhood.

Study Population

It is not easy to embark on an epidemiological study relating to waste and health of a population in an environment fraught with a paucity of data. Surrogate techniques were therefore adopted to get as near the actual situation as possible. It was, therefore, considered necessary to select households by a measure of at-risk population density around the dumpsite. The study population are mainly traders, civil servants, and artisans (welders, electricians, etc.) who live and practice their professions within the area. The total population of the neighborhood is 18,563 according to the 2006 population census.

From this population, which fell within a Census Enumeration Zone (CEZ), a sample of 224 families having children between 1 to 5 years of age was randomly selected using House Enumeration Numbers. This age range of children was chosen as they constitute the most vulnerable group, especially for malarial disease. The choice of families was validated through field visits. A mini-survey was conducted among these families to ascertain their socio-economic status (income, education, feeding), housing conditions, and, especially, to verify the use or non-use of mosquito-treated nets among family members. The Enumeration Numbers were used as family code numbers in the study since locational data are

less problematic than diagnostic code data (Peace & Mazumder, 2007). For example, a family may be coded as OW-9943. If the family had three children that fell within the study age group, then the numberings were OW-9943(1), OW-9943(2), and OW-9943(3), corresponding with the ascending order of the age of the children. A total of 860 subjects were thus coded ($n = 860$) for the study.

Assessment of Exposure

The study considered one measure of exposure to malaria infection, namely, the distance between subjects and the dumpsite. A 200-meter cordon zone was carefully delineated, with 430 subjects (Zone A), while the remaining subjects of the same number were in Zone B, which was in the same neighborhood but beyond 500 meters from the dumpsite. These two zones are separated from each other by Royce and Nekede Roads. Zone B may be likened to a “clean or control” zone.

During the survey, parents were given special folders to enable any consulting pediatrician or medical doctor to indicate the illness treated when any of the subjects fell sick (one for each child) for purposes of the study. A total of 658 parents followed the instructions and made their folders available after a period of 11 months. This number was reduced to 602 subjects, half in each zone. Verifications were later made in the various hospitals where the children were treated. Most of those who did not participate either relocated to other places or could not afford to pay for consultations and drugs, and resorted to other methods of treatment when their children fell sick.

Statistical Analysis

Given the limited sample size, three age groupings of the children were made (< 1 year, 2-3 years, and 4-5 years) based on the distribution of their ages within the population. To neutralize the effect of variables such as housing conditions, income of parents, housing density, and feeding a logistic model was used. The exposure measures among subjects and total sample population were made using logistic regression (for malaria and hospitalization rates).

Because of the limited sample size, the odd-ratios (ORs) were not adjusted for potential confounders. Regression ANOVA and chi-square tests were used to compare differences between the zones. Coefficients were calculated using the Spearman rank-order correlation test. Data was analyzed by SPSS for Windows 10.0.

RESULTS

Sample Characteristics

The descriptive information focused mainly on the socio-economic status of the parents (income, education) as well as some variables on the children (age, feeding, etc.). The average age of the children was 2.8 years and approximately

half of the total sample were males. There was equal representation of both sexes in the two zones.

All families had lived in their apartments for more than 3 years, showing that the majority of the subjects had been exposed since birth. The average educational level of parents was the West African School Certificate (6 years of secondary or high school education), with an average monthly income level of 15,500 Naira (US\$120). The average household consists of five persons, residing in a concrete dwelling of three rooms. Rooms were properly ventilated with sufficient doors and windows. None of the families used mosquito nets. The highest number of children within the study age group per family was three while the least was one.

Exposure Characteristics

The study revealed the prevalence of malaria among subjects in the two zones investigated (see Table 1).

Among the total sample of $n = 602$, there were 452 reported cases of malaria among the subjects within the study period of 11 months. Of this total, 66.3% were treated in Zone A ($d < 200$ meters) and 8.9% in Zone B ($d > 500$ meters). Out of the reported cases, 88.2% occurred within Zone A while 11.8% in Zone B. Medical notes revealed that the infected subjects showed symptoms of the disease (high fever, body weakness, loss of appetite, etc.). Results of their blood analyses also indicated that each of these infected children had plasmodium, though with different degrees of infection. Each of the affected children also spent a minimum of 1 day in the hospital while the highest incidence of malaria was recorded within the months of October 2006 (13.9%) and the least in February 2007 (5.7%). About 100 serious cases of malaria were reported with a total hospitalization period of 1,174 days with an average of 2.7 days per subject. Also, 27% of subjects in Zone A suffered double episodes, with the duration of the illness ranging between 3 to 5 days. Only 2% of subjects in Zone B suffered double episodes of the disease. Unfortunately, there were 19 (4.2%) reported cases of death resulting from malaria which occurred among children between the ages of 2 and 4 years old, all occurring in Zone A (see Table 2).

Malaria incidence decreased with age (the younger being the more vulnerable to the disease), and was significantly higher among subjects living around the dumpsite. The rate of hospitalization was highest among children between the ages of 2 and 3 years, indicating that this group was the most vulnerable.

Also, the rate ratio (RR) was significantly higher (6%) among subjects in Zone A than those in Zone B (0.76%). However, this ratio decreased with age in both zones. There was no significant difference in the rate of hospitalization between sexes in the sample.

The overall results showed that children living within the 200 meters distance from the dumpsite (Zone A) are 3.5 times more likely to suffer from malaria than those living beyond 500 meters distance (Zone B), the less exposed area.

Table 1. Cases of Malaria among New Market Residents in Proximity to Waste Dumpsite

Months	No. of children treated for malaria		Serious cases		No. of deaths		Duration of hospitalization (total days)		Total alive	
	No.	%	No.	%	No.	%	No.	%	No.	%
October 2006	63	13.9	13	2.9	2	0.4	182	15.5	61	13.5
November 2006	51	11.2	9	1.9	1	0.2	131	11.2	50	11.1
December 2006	45	9.9	11	2.5	2	0.4	126	10.7	43	9.5
January 2007	39	8.6	18	3.9	2	0.4	108	9.2	37	8.2
February 2007	26	5.7	7	1.5	3	0.6	61	5.2	23	5.1
March 2007	38	8.4	5	1.1	5	1.1	73	6.2	33	7.3
April 2007	34	7.5	8	1.8	1	0.2	82	6.9	33	7.3
May 2007	47	10.4	11	2.5	—	—	131	11.2	47	10.4
June 2007	33	7.3	10	2.2	2	0.4	112	9.5	31	6.9
July 2007	41	9.1	3	0.7	—	—	77	6.6	41	9.0
August 2007	35	7.7	5	1.1	1	0.2	91	7.8	34	7.5
	452	100.0	100	22.1	19	4.2	1174	—	433	95.8

Table 2. Number of Subjects Treated for Malaria in Zones A and B ($n = 602$)

Months	Zone A (<200m)		Zone B (>500m)		Total	%
	No treated (F)	%	No treated	%		
October 2006	57	12.6	6	1.3	63	13.9
November 2006	47	10.3	4	0.8	51	11.1
December 2006	40	8.8	5	1.1	45	9.9
January 2007	36	7.9	3	0.6	39	8.6
February 2007	23	5.0	3	0.6	26	5.7
March 2007	32	7.0	6	1.3	38	8.4
April 2007	27	6.0	7	1.6	34	7.5
May 2007	43	9.5	4	0.8	47	10.3
June 2007	29	6.4	4	0.8	33	7.2
July 2007	35	7.7	6	1.3	41	9.0
August 2007	30	6.6	5	1.1	35	7.7
	399	88.3	53	11.7	452	100.0

Relationship between Distance from Dumpsite and Hospitalization

The rate of hospitalization correlated positively with distance from dumpsite. The Spearman correlation coefficient calculated between rate of hospitalization and distance from dumpsite in Zone A was -1.12 ($p < .05$) and was adjusted for other factors that may contribute to the disease. This negative correlation indicated that proximity to waste dump exposes children to the hazards of malaria infection. Similarly, the correlation coefficient of 0.105 ($p < 0.05$) in Zone B indicated that a long distance from dumpsite lowers exposure to the disease.

DISCUSSION

The results obtained from this study suggest that young children are vulnerable to environmental diseases such as malaria. They also indicate that the level of vulnerability is a function of the level of exposure and distance to the source of disease.

It was observed that the peak period of malaria infection corresponded with months of climatic transition with low rainfalls, which encouraged the

breeding of *Anopheles* mosquitoes on the waste dump. This corroborates Tibbetts (2007), who observed that mosquitoes and the diseases they carry, including malaria, are especially sensitive to temperature changes. Tibbetts and Epstein (2005) also maintained that warm temperatures accompanying draughts accelerate the maturation of viruses, and that when water sites shrink, mosquitoes concentrate in the same place, enhancing the transmission of the viruses they carry.

If the drop in the rate of infection in June 2006 corresponded with months of high rainfall, when these vectors lay their eggs in humified waste dumps, the low value recorded in the month of February 2007 may be attributed to the chilling effect caused by the Harmattan wind, when all the children were properly covered against cold, which consequently protected them from mosquito bites.

There are reasons to argue that proximity to the waste dump increased the incidence of malaria and high rates of hospitalization among children living in the New Market neighborhood:

1. Residents indicated during our survey that the incidence of malaria before the appearance of the waste dump in the area was minimal.
2. The accumulation of waste provided a breeding ground for mosquitoes that vector this disease.
3. The exposure route was only through mosquito bites among a population group that was highly vulnerable and less mobile.

Overall, our results show that the growing health disparities that result from poverty and inadequate infrastructure and service provision in our urban areas raise serious concerns about environmental justice (Pellow & Brulle, 2005; Thomas, Mitchell, & Williams, 2006). The scale and complexity of diseases arising from poor handling of refuse makes municipal solid waste management an obvious priority. Children living in urban low-income and minority neighborhoods often are at greater risk of exposure to environment-based hazards than other groups (Tillett, 2007).

CONCLUSION

This study adds to the evidence that exposure to environmental pollutants can contribute to compromised health and pathology of related diseases (Henning, Reiterer, & Majkova, 2005; Needham, Barr, Caudill, Pirkle, Turner, & Osterloh, 2005). There were several risk factors for malaria for which we did not control (diet, use of net and insecticides, latent period) which are confounders when their frequencies in the sub-population are associated with exposures. Despite these limitations, we argue that if we find such clear elevations in the rates of malaria incidence and hospitalization among our subjects, when our exposure assessment is so crude, the real relationship between malaria and proximity to waste dumps may likely be stronger. Nonetheless, the case study shows that accumulations of solid waste in proximity to residential

areas provides pathways that are associated with etiology of many chronic diseases including malaria. There is a great need to further explore the waste-malaria paradigm in environmental health studies with the view to developing new strategies for intervention and prevention of this disease (Spivey, 2007). Ultimately, the promotion of urban cleanliness and effective management of municipal waste may be the most sensible strategies to “Roll Back Malaria” in Nigeria in the years ahead.

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