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# Lead poisoning associated with malaria in children of urban areas of Nigeria

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## Abstract

The principal objectives of this study are to (a) investigate the prevalence of elevated blood lead levels (EBLLs) in children of three major cities of Nigeria with different levels of industrial pollution; (b) identify the environmental, social and behavioral risk factors for the EBLLs in the children; and (c) explore the association between malaria (endemic in the study areas) and EBLLs in the pediatric population. The study involved 653 children aged 2–9 years (average, 3.7 years). The mean blood lead level (BLL) for the children was $8.9 \pm 4.8\,\mu g/dL$, the median value was 7.8 μg/dL, and the range was 1–52 μg/dL. About 25% of the children had BLL greater than 10 μg/dL. There were important differences in BLLs across the three cities, with the average value in Ibadan ($9.9 \pm 5.2\,\mu g/dL$) and Nnewi ($8.3 \pm 3.5\,\mu g/dL$) being higher than that in Port Harcourt ($4.7 \pm 2.2\,\mu g/dL$). Significant positive associations were found between BLL and a child's town of residence ($p < 0.001$), age of the child ($p = 0.004$), length of time the child played outside ($p < 0.001$), presence of pets in a child's home ($p = 0.023$), but negatively with educational level of caregiver ($p < 0.001$). This study is one of the first to find a significant negative association between BLL and malaria in a pediatric population, and this association remained significant after controlling for confounding diseases and symptoms. The shared environmental and socio-demographic risks factors for lead exposure and *Plasmodium* (most common malaria parasites) infection in urban areas of Nigeria are discussed along with possible ways that lead exposure may influence the host response to infection with malarial parasites.
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## Introduction

Many children in Nigeria are burdened by the so-called neglected diseases or silent epidemics (Nriagu

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et al., 1996; Ehrenberg and Ault, 2005) of neglected populations. These diseases are said to be neglected because they are chronic, tend to affect the poor disproportionately, are not subject to compulsory reporting in most countries, and more importantly are not regarded as critical public health issues (compared to HIV/AIDS, tuberculosis, and malaria, for instance) by major aid donors and international organizations (WHO, 2003). They do not attract much attention from the media and public sector because they are not manifested as epidemiologic emergencies with high mortality rates. These diseases are largely ignored by the pharmaceutical industry because they are not a lucrative target that can support spending on research and development of specific drugs, vaccines and diagnostic tools (Trouiller et al., 2002; Ehrenberg and Ault, 2005). Although increasing attention is being paid to the neglected diseases of parasitic origin (such as lymphatic filariasis, soil-transmitted helminthiasis, schistosomiasis, onchocerciasis, leishmaniasis, African trypanosomiasis, Chagas disease, ectoparasitic skin infestations and parasitic zoonoses, etc.; WHO, 2003), the burden of morbidity associated with the increasing exposure of neglected populations in the developing countries to chemical pollutants in their environment has generally been ignored. One of the most prevalent and neglected diseases in Nigeria and most of the Sub-Saharan African countries probably is lead poisoning which has affected a large fraction of the childhood population because of the growing multiplicity of potential exposure routes. This point is illustrated by the fact that only three studies of childhood lead poisoning with limited sample sizes have been conducted in Nigeria (Nriagu et al., 1996; Pfitzner et al., 2000; Wright et al., 2005). The three studies were conducted in two medium cities (Jos and Kaduna) in northern Nigeria and, thus far, there has been no investigation of childhood lead poisoning in any of the major cities in the country. This study examines the inter-city and trans-cultural differences in lead exposure of the pediatric population in three of the largest metropolitan areas of Nigeria.

The disabilities created by lead poisoning (impaired mental and physical development, poor school performance, anemia, under-nutrition, infertility) represent a significant social, financial and health burden on the affected individuals, their families and communities (ATSDR, 1999; United Nations, 2005). Lead poisoning is the sixth most important contributor to the global burden of diseases measured in disability adjusted life years (DALYs), with Sub-Saharan African countries being predominantly responsible for the global DALYs (Pruss-Ustun and Corvalan, 2006). What has generally not received much attention in the scientific literature is the fact that lead poisoning can moderate the susceptibility of a child to parasitic diseases, including infections from vector-borne, food-borne, water-borne or soil-transmitted pathogens and that its overall contribution to the global DALYs may be considerably higher (Ogunseitan and Smith, 2001). In many urban areas of Nigeria, poverty, poor housing, high population densities and unsafe or inadequate living conditions, combined with inadequate sanitation and environmental pollution promote not only the spread of some communicable diseases but also can increase the children's vulnerability to lead. Co-incident lead poisoning and parasite infection among young children remain an unexplored public health problem in African countries. The objectives of this study are to (a) determine the prevalence of elevated blood lead levels (EBLLs) of children in three cities of Nigeria with different levels of industrial pollution; (b) identify the environmental, social and behavioral risk factors for the EBLLs in the children; and (c) explore the association between malaria and EBLLs in the study population. Although many parasitic diseases are endemic in Nigeria, *Plasmodium* infections (specifically malaria) are the most deadly (Snow and Marsh, 1998), hence the focus of this paper.

## Materials and methods

### Study population

The study participants were from three cities in different parts of Nigeria. Ibadan is located in southwestern region and is Nigeria's third most populous city, after Lagos and Kano. It is the capital city of Oyo State, and has an estimated population of 3 million people. The city is roughly divided into what could be called ancient Ibadan (a dense area of cluttered mud houses that is accessible mostly by foot-paths) and modern Ibadan (reflecting very lax local planning laws and a pilfering of architectural designs from all over the world). Nnewi is situated in the southeastern part of the country and is estimated to have 204,000 inhabitants. Although government records show about forty medium-scale industries, virtually all motor and motorcycle parts of all brands can be repaired or reconstructed in this city in make-shift cottage factories. Port Harcourt is located in the Niger Delta area of Nigeria and is the capital of Rivers State. Its population is estimated to be 1.3 million. Port Harcourt is the commercial center of the oil industry in the country. The three cities used in this study are culturally different with the Yorubas predominant in Ibadan, Igbos in Nnewi, while Port Harcourt consists of a heterogeneous mixture of many ethnic groups. All three cities are sprawling and overcrowded as building codes and zoning regulations are poorly enforced, and hence

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