Original Article

Asthma and Allergic Disorders in Uganda: A Population-Based Study Across Urban and Rural Settings

Brooks W. Morgan, MSPH[a], Trishul Siddharthan, MD[a], Matthew R. Grigsby, MSPH[a], Suzanne L. Pollard, PhD[a], Robert Kalyesubula, MBBCh, MMed[b], Robert A. Wise, MD[a], Bruce Kirenga, MBBCh, MMed[b], and William Checkley, MD, PhD[a,c]   *Baltimore, Md; and Kampala, Uganda*

What is already known about this topic? Asthma and allergic disorders have been heavily linked to urbanization and associated lifestyle and environmental exposures. Unplanned urbanization in the form of periurban sprawl is increasing quickly in sub-Saharan Africa.

What does this article add to our knowledge? We use a population-based cohort of adults in urban and rural areas to compare the prevalence, risk factors, and population attributable fractions of allergic disorders, spotlighting the burden and causes of disease in Uganda.

How does this study impact current management guidelines? Asthma is not currently being diagnosed or treated appropriately in Uganda. Our data indicate that asthma and allergic disorders constitute a sizable health burden, requiring attention from hospitals and the Ministry of Health.

BACKGROUND: Allergic diseases are increasing in sub-Saharan Africa, but few studies have characterized the burden among adults.

OBJECTIVE: We conducted a study to evaluate the prevalence and risk factors of allergic disorders in urban and rural Uganda.

METHODS: We present a cross-sectional analysis of enrollment data from a population-based cohort study of adults aged ≥35 years in urban and rural Uganda. Sociodemographic and both lifetime and 12-month respiratory symptoms data were collected and spirometry was conducted following standard guidelines.

RESULTS: In 1,308 adults (median age 43.8 years and 52.3% female), we found an age-adjusted prevalence of 6.8% for asthma (9.8% urban, 4.3% rural; $P < .001$), 11.9% for allergic rhinitis (16.4% urban, 7.8% rural; $P < .001$), and 8.2% for eczema (9.9% urban, 7.8% rural; $P = .15$). Urbanization was the primary driver of asthma, accounting for 61.4% of cases (95% confidence interval [CI] 22.0% to 83.4%), and was the strongest risk factor for any allergic illness (odds ratio [OR] = 1.87, 95% CI 1.39-2.51). Parental asthma was not associated with allergic illness. Asthma was associated with a lower forced expiratory volume in 1 second (FEV_1) by 0.56 z scores (95% CI 0.33-0.80). We found a dose-response association between lower quintiles of the FEV_1/forced vital capacity ratio and both hospitalization (OR = 1.77, 95% CI 1.21-2.59) and impairment in daily activities (1.65, 1.20-2.27).

CONCLUSIONS: Asthma and allergic rhinitis were twice as prevalent in urban settings. Asthma was associated with greater impairment and worse lung function outcomes. We identified a high prevalence of allergic disorders in Uganda, which can be expected to increase due to urbanization and resultant exposures throughout early development.   © 2017 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2017;■:■-■)

https://doi.org/10.1016/j.jaip.2017.11.032

Asthma is a chronic respiratory disease characterized by airway inflammation, which causes difficulty breathing and affects more than 358 million people worldwide.[1] The prevalence of asthma is increasing quickly in low- and middle-income countries (LMICs) even as it declines in high-income countries, and the majority of

Abbreviations used
  ACQ- Asthma control questionnaire
  ATS- American thoracic society
  BMI- Body mass index
    CI- Confidence interval
  ERS- European respiratory society
 FEV_1- Forced expiratory volume in 1 second
  FVC- Forced vital capacity
  HIV- Human immunodeficiency virus
 LiNK- Lung function in Nakaseke and Kampala study
 LMIC- Low- and middle-income country
    OR- Odds ratio
  PAF- Population attributable fraction
 WHO- World Health Organization

deaths from asthma occur in LMICs.[1,2] Asthma and allergic disorders contribute significantly to morbidity, mortality, and economic burden, including both direct (monetary) and indirect (impaired productivity) costs.[2] Urbanization is one of the most important risk factors for allergic disorders, which can be explained in part by the adoption of poor nutrition, reduced physical activity, and environmental factors such as traffic and industry-related air pollution.[3-5] The prevalence of asthma is expected to rise in sub-Saharan Africa as rural to urban migration rapidly increases.[6]

Representative of this demographic transition, the urban population in Uganda grew from 800,000 in 1980 to 7.4 million in 2014.[7] This growth was largely unplanned, periurban sprawl, which increases exposure to ground and house allergens as well as air pollution from dust and traffic, all of which have been previously linked to increased asthma and allergic disorders in LMIC settings.[8-12] To date, there has been only 1 population-based study of respiratory disease among adults in rural Uganda, which focused on chronic obstructive pulmonary disease.[13] Data on the prevalence of allergic illness and risk factors are required to direct public health policy and medical treatment programs in Uganda.

We hypothesized that, based on previous literature and due to unplanned urban sprawl, asthma and other allergic disorders would be more prevalent in urban regions. To investigate this, we conducted a cross-sectional analysis of a population-based cohort study of urban and rural areas in Uganda. We also sought to identify risk factors and their population attributable fractions (PAFs) and document the prevalence of lifestyle impairment-related asthma outcomes and differences in care-seeking behavior between sites.

METHODS
Study setting

The study was carried out in 2 settings in Uganda with differing levels of urbanization. Kampala, the capital, has an estimated 416,000 households and a population of 1.5 million.[7] Nakaseke is a rural health district approximately 50 km north-northwest of Kampala that includes a central periurban community. Nakaseke comprises 43,000 households and 197,000 people.[7] Air quality in Kampala is poor, with a mean of 5.3 times the World Health Organization (WHO)-recommended level of daily particulate matter ($PM_{2.5}$), and is worse in industrial areas and residential neighborhoods with unpaved roads.[14] Although there are currently no published data on air quality in Nakaseke, it is a long distance from

major city centers (50 km from downtown Kampala and 14 km from the nearest highway).

Study design

Participants were enrolled in the Lung Function in Nakaseke and Kampala (LiNK) study, a population-based cohort study whose primary objective was to characterize the prevalence and risk factors for chronic respiratory diseases in adults in urban and rural settings of Uganda.[15] The study aimed to enroll 2,000 participants, 1,000 from each site. In participation with the Uganda Bureau of Statistics, we randomly selected 25 enumeration areas in each site using probability proportional to size sampling, as outlined by the WHO Expandable Programme on Immunization.[16,17] Within each of these enumeration areas, 1 adult was randomly sampled per household until 40 people were enrolled.

Inclusion criteria included age ≥35 years, full-time residency of the catchment area, and the ability to provide informed consent. Exclusion criteria included pregnancy, active pulmonary infection, active tuberculosis, and recent surgery. Trained field workers administered demographic and health surveys using tablet computers with Open Data Kit software (University of Washington, Seattle, Wash) before asking participants to perform spirometry. Consent, surveys, spirometry, and other tests were administered in Luganda, the local language. The study protocol was approved by the institutional review boards of the Johns Hopkins School of Medicine in Baltimore, Md, and both the Uganda National Council of Science and Technology and Mulago National Referral Hospital in Kampala, Uganda.

We developed a survey concerning asthma diagnosis and control, rhinitis, eczema, and certain risk factors. Spirometry was conducted using flow-based, portable spirometers (Easy-On-PC, ndd, Zurich, Switzerland). We calculated z scores for forced expiratory volumes using the National Health and Nutrition Examination Survey (NHANES) African American reference population.[18] Spirometry was conducted following American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines.[19] Tests were graded based on standardized guidelines for interpretation and quality control.[20]

Potential risk factors

Household size was defined by how many people, including the participant, live in their home. Exposure to biomass was defined as use of wood or charcoal for household cooking or heating. Unventilated cooking area was defined as a cooking space without a chimney or window that opens to the outside. Unimproved household water source was defined as using surface water or an unprotected well, or purchasing water from a tanker or cart. Unimproved household flooring was defined as sand, wood, or bare ground. Education was dichotomized into primary or less or greater than primary based on the highest level of school completed. In this area, completion of primary schooling equates to 7 years of education, whereas completion of secondary schooling equates to 13 years. Current smoking was defined as self-report of currently using any tobacco product, including cigarettes, cigars, and pipes. Personal history of human immunodeficiency virus (HIV) and tuberculosis were defined as self-report of ever being diagnosed with those conditions. Asthma in a family member was defined as self-report of a diagnosis of asthma in any member of the family, whereas parental asthma was specific to the mother or father. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2). Obesity was defined as BMI ≥30 kg/m^2.