

Abstract

Title: Air Pollution and its effect on mortality and pregnancy outcomes in Nairobi's slums

Authors: Egondi Thaddaeus and Muindi Kanyiva

Institutional Affiliation: African Population and Health Research Center & Umea University

Air pollution (both outdoor and indoor) is an important public health challenge especially in the developing world where legislation on emissions control is either weak or non-existent. With these countries preparing for industrial take off, outdoor air pollution will continue to remain important as it concerns the health consequences, owing to possibly higher levels of emissions. In these countries, majority of households rely on biomass derived fuels for cooking and heating that have been classified as highly polluting and have been shown to have deleterious effects on human health. Studies have documented the negative effects of both outdoor and indoor air pollution on health; however, there have been very few studies in Africa. The objectives of this study are to assess the perceptions and attitudes of people living in two informal settlements in Nairobi regarding their exposure to air pollution; estimate the effect of indoor air pollution on pregnancy outcomes and model the effect of air pollution on mortality in the two settlements. The study shall use mixed methods approach where a qualitative study will be done to look at the perceptions and attitudes of residents regarding air pollution. In addition to this, a panel study measuring levels of outdoor air pollutants shall be done. This will be done in such a way that seasonal variations are accounted for. To assess the effect of air pollution on pregnancy outcomes, a follow up study of pregnant women will be done and measurements of indoor air pollution levels will be done in their homes. The study is expected to take 12 months.

I. Introduction/Background

Most of the world's population growth is occurring in cities and towns of poor countries (Montgomery, Stren et al., 2004). These rapid, unplanned and unsustainable patterns of urban development make developing cities focal points for many emerging environment and health hazards (Health Effects Institute, 2004) which include ambient air pollution. The World Health Organization (WHO) estimates that 1.5 billion of urban dwellers face levels of outdoor air pollution that are above the maximum recommended limits (City Mayors Health). The air quality in urban areas is affected mainly by three types of pollution sources: releases from traffic, industry and domestic heating. The unpaved status of roads and burning of trash in open space increase the levels of particulate matter in the air especially in slum settings. Over the last few decades, traffic air pollutants raise most health concerns in urban areas due to increasing traffic congestion. The traffic air pollutants consist of fine particles, Sulphur dioxide (SO₂), nitrogen dioxide

(NO₂), ozone (O₃) and carbon monoxide (CO) (Jensen, 1999). Several published studies have indicated an association between air pollutants to a wide range of adverse health outcomes including chronic respiratory conditions, hospital admissions and mortality.

Similarly, indoor air pollution (IAP) has increasingly become a public health concern in developing countries (Bruce et al., 2000). Indoor air pollution is the presence of harmful gaseous and particulate pollutants within the home/working space and other indoor microenvironments. In households in the developing world, most of this pollution arises from the use of solid fuels for cooking and heating, mostly in poorly ventilated spaces using inefficient stoves. In addition, exposure to tobacco smoke is another important source of indoor air pollution. Most of the developing world is heavily dependent on biomass as a source of cooking and heating fuel. The prevalence of biomass use is estimated at 95% in the developing world and at 50% globally (Bruce et al., 2000, Bruce et al., 2002, Duflo et al., 2007). A large proportion of the population is therefore exposed to the harmful effects of pollutants released by burning of these fuels. In Kenya, the prevalence of households that use solid fuels is estimated at 17.5% in urban areas and 93.9% in rural areas while the prevalence of households with improved stoves is below 1% (World Health Organization, 2005b).

II. Problem Statement

Problem identification: This study seeks to answer the following questions: what are the perceptions and attitudes of people regarding exposure to air pollution? What are the effects of air pollution on cause- and age-specific mortality? What are the effects of air pollution on pregnancy outcomes?

Problem definition: The study of air pollution and its effect on mortality cuts across all age groups and gender. On the other hand, we shall follow up pregnant women residing in the two study communities who consent to take part in the study to study the effects of air pollution on birth weight and other pregnancy outcomes.

Problem Justification: The study of the effects of air pollution on mortality and pregnancy outcomes is important because studies in other contexts have shown that unborn babies, children and the elderly are the most vulnerable to the effects of air pollution. Mortality of the very young is a loss of future productive potential. In addition, estimates show that more and more people will live in urban areas where the levels of outdoor air pollution are on a scale beyond what is considered safe, and therefore unless evidence is produced and action taken, then we shall continue losing future generations. With regards to indoor air pollution and its effect on pregnancy outcomes, this study is important as it will inform policies and programs aimed at protecting the unborn and giving them a chance to be born healthy, assuring a healthy adulthood. Most of the studies on air pollution have been conducted in developed countries, and a number of studies have now been conducted in Asia as well (Health Effects Institute,

2004). The need remains for studies of cities of developing countries particularly in Africa, where characteristics of outdoor air pollution (e.g., air pollution level and mixture, transport of pollutants), meteorological conditions, and socio-demographic patterns may differ from those in developed countries. Also there is need for more studies looking at the effect of air pollution on pregnancy outcomes especially in developing countries where IAP often exceeds safe limits.

III. Review of Literature

The World Health Organization (WHO) estimates that 1.5 billion of urban dwellers face levels of outdoor air pollution that are above the maximum recommended limits (City Mayors Health). Quantifying the impact of air pollution on public health has gradually become a critical component in policy for the control of pollution. However, quantifying the magnitude of these health impacts pose considerable challenges owing to the limited availability of information on both effects on health and measurements on exposures to air pollution (Cohen, Anderson et al., 2004).

Nairobi, Kenya's Capital City, is typical of the fast growing cities in Sub-Saharan Africa (Kinney, Gichuru et al., 2011) with a resident population of about 3.2 million (Kenya National Bureau of Statistics, 2009). As other developing countries in Africa, Kenya has no air quality management and lacks data on air pollution, despite having the fastest growing urban population (Mulaku and Kariuki, 2001). Air pollution studies in Nairobi have shown that the levels of pollutants, especially particulate matter, are above WHO recommended levels in most parts of Nairobi City (Mulaku and Kariuki, 2001; Odhiambo, Kinyua et al., 2010; Kinney, Gichuru et al., 2011). Several studies on air pollution in Europe, America and Asia have shown consistent correlation between ambient particulate matter level and poor health outcomes (Pope, Dockery et al., 1991; Pope and Dockery, 1992; Pope, Thun et al., 1995; Morgan, Corbett et al., 1998; Gauderman, Avol et al., 2004). Although concentrations of pollutants are significantly different in these studies, most of the Particulate Matter (PM₁₀) levels in these studies are lower than those observed in Nairobi. The average PM₁₀ in Nairobi has been reported to be 236 µg/m³ with a range of 66.7 to 444.4 µg/m³ (Odhiambo, Kinyua et al., 2010) and the average Particulate Matter (PM_{2.5}) ranged from 50.7 to 128.8 µg/m³ (Kinney, Gichuru et al., 2011). There have been concerns about whether it is acceptable to extrapolate the concentration-response functions derived from studies in high-income settings to middle-and-low income ones (Smith and Akbar, 2003). Assessing and quantifying the effects of particulate matter concentrations on mortality rates in Nairobi would help to improve the knowledge base on the public health consequences of current air pollution levels in the city. Such knowledge can influence urgently needed policy solutions aimed at improving air quality and population health. However, presently little or no

information exists assessing the effect of outdoor air pollutant levels on health outcomes in Nairobi.

In addition to facing increasing levels of outdoor air pollution, women [and children] in sub-Saharan Africa and in many communities in the developing world, bear the greatest burden of the effects of indoor air pollution; given the disproportionate amount of time they spend cooking for the family (Duflo et al., 2007, Pogodina et al., 2009). Indeed women's exposure starts early in their life as many of them tend to start cooking in their teens or earlier (Ezzati et al., 2000). Therefore compared to male household members, females and young children are most vulnerable to the effects of biomass smoke. A study in Kenya that measured levels of particulate matter (PM) and carbon monoxide (CO) in the cooking place reported that females (16-50 years old) were exposed to average daily concentrations of PMs ranging from 2,795 to 4,898 $\mu\text{g}/\text{m}^3$ and CO levels in excess of 400 PPM (Ezzati et al., 2000, Ezzati et al., 2001). The WHO guidelines set the 24-hour mean exposure levels at 25 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and 50 $\mu\text{g}/\text{m}^3$ for PM_{10} and at 87 PPM of CO for 15 minutes (which is set for acute exposures as can occur with unvented cook stoves) or 6 PPM for 24 hours (World Health Organization 2006; World Health Organization 2010). Evidence points to similarities in composition between tobacco smoke and biomass smoke (Dary, O. (1981) and Behera, D. (1988) cited in (Boy et al., 2002)); meaning that individuals exposed to biomass smoke tend to be on almost similar risk profiles with tobacco smokers.

There is a dearth of studies on the effects of exposure to IAP on pregnancy outcomes especially in low- and middle-income countries where indoor air pollution levels usually exceed the WHO guidelines. More studies are needed to estimate the magnitude of IAP from biomass fuel use and tobacco smoke, and look at their effects on pregnancy outcomes in low- and middle-income countries. The study of pregnancy outcomes is important because they are strong predictors of new-born and infant health and low birth weight in particular has a bearing on subsequent health of an individual (Šrám et al., 2005). Research has shown that low birth weight, defined as weight below 2500g at the time of birth (World Health Organization, 1992), is linked to subsequent chronic illnesses, such as cardiovascular disease, type-2 diabetes and other illnesses, in adulthood (Šrám et al., 2005).

Many of the studies on exposure to IAP conducted in the developing world have not included actual measurement of exposure to air pollutants. Instead the use of proxy measures of exposure such as fuel and stove types are commonest (Mishra et al., 2004, Mishra et al., 2005, Kadir et al., 2010, Subramoney et al., 2010). It is therefore not

possible to assess how different levels of pollution affect health outcomes, which could be done when actual measurement of pollutant levels is available. This study will add to the body of knowledge and provide empirical evidence on the effects of air pollution on pregnancy outcomes and mortality. This study would be timely for Kenya, which is now progressing towards achieving the health Millennium Development Goals (MDGs).

IV. Research Objectives

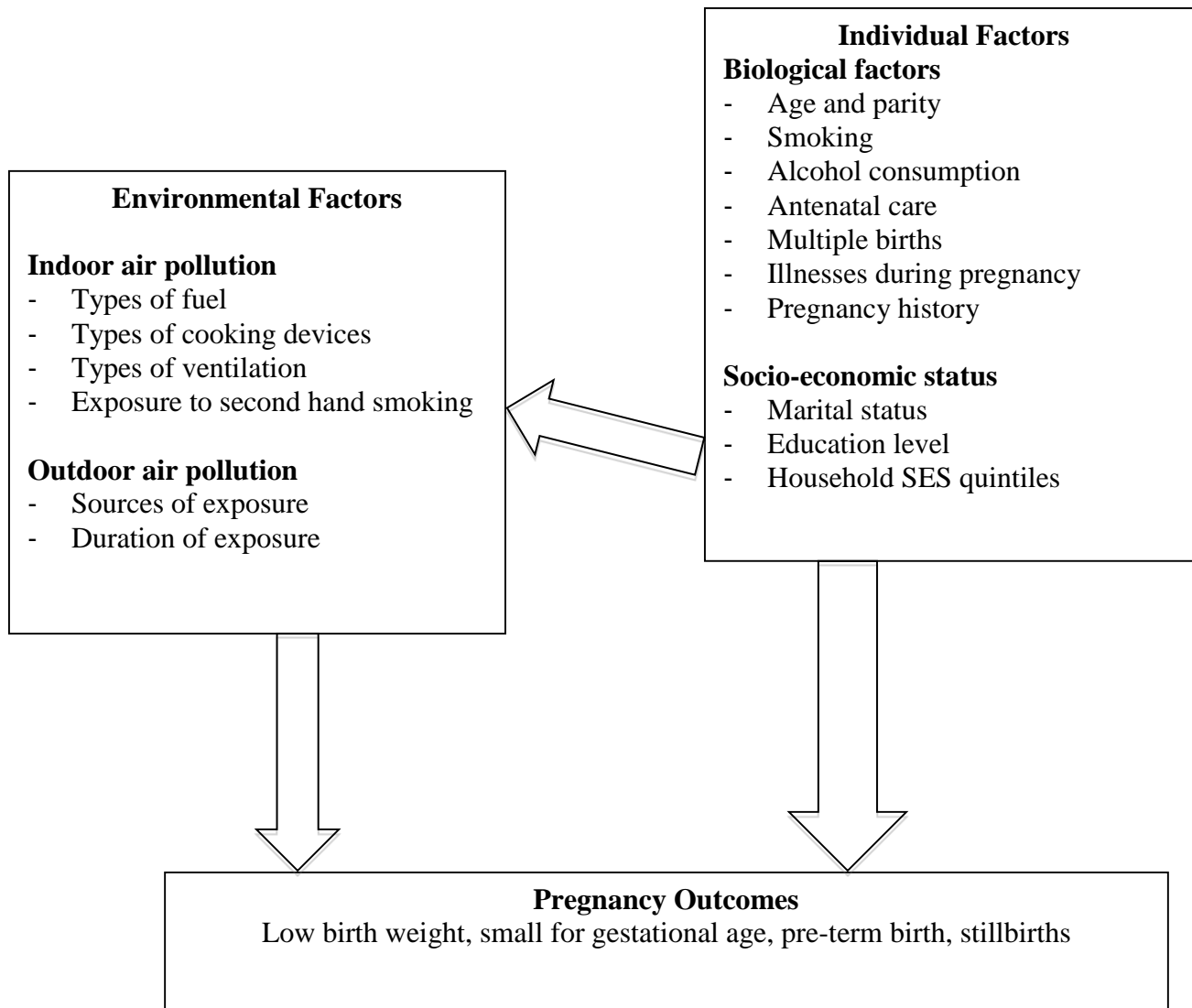
General: The aim of this study is to assess the air pollution status in Korogocho and Viwandani and its effect on mortality and pregnancy outcomes.

Specific: The specific objectives are to:

- explore the perceptions and attitudes of people living in two informal settlements in Nairobi regarding their exposure to air pollution;
- estimate the effects of indoor air pollution on pregnancy outcomes (birth weight and other outcomes) and
- model the effect of air pollution on mortality in the two settlements.

V. Conceptual Framework and Operationalization

The conceptual framework presented only addresses the relationship between air pollution and pregnancy outcomes. We postulate that environmental, biological and socio-economic factors influence pregnancy outcomes through complex pathways. Socio-economic factors also have an impact on the type of fuels and cooking devices used as well as housing conditions that affect levels of indoor air pollution.



VI. Hypotheses

VII. Study Design and Sampling Strategy

The study will involve both qualitative and quantitative approaches. The qualitative study will involve a total of eight focus group discussions with men and women living in Korogocho and Viwandani. In addition to this, outdoor air pollution will be measured as panel data to ensure seasonal variations are accounted for. This part of the study will only involve assessment by the measurement team who shall be carrying the measuring equipment. The study on indoor air pollution and pregnancy outcomes will be a prospective study of a cohort of pregnant women recruited during their first or early second trimester. They will be followed up until they deliver so that the birth weight of the newborn is taken. Measurement of indoor air pollution levels shall be done and other information on fuel and stove types used in the household collected. The study will be nested on an ongoing intervention study following up 600 pregnant women and providing nutritional counseling pre- and post-pregnancy for optimal child health.

VIII. Data Collection

Data collection will take place using structured questionnaires for the follow up study of pregnant women, while a register will be used to log in date, time and place where measurements of outdoor air pollution will have been done. An interview guide will be used for the qualitative study and this includes questions that elicit discussions among the invited participants. Focus groups will be convened in neutral venues within the communities where the respondents live to ensure all are free to give their views. Discussions shall be audio recorded to allow the research team to get a full account of the discussions after the sessions. The field team shall be trained on how to handle the air quality monitors to ensure proper data collection is done. Those conducting the interviews using the structured questionnaires will be trained on the content and mock interviews among the staff shall be done throughout the training to ensure all are comfortable with the instrument. A field based pilot study shall be done to ensure any issues pertaining to the instrument are addressed before actual field work begins and to also give the field team a chance to practice conducting the interviews in real field settings.

To ensure data collected are of good quality, the investigators shall together with the quality control team get a random sample of completed work and conduct spot-checks with the respondents. Any errors/inconsistencies shall be addressed with the concerned team member. In addition, sit-ins shall be done to observe how the interviewer introduces the study, the consent process and interviewing techniques. Lessons learned from different interviewers shall be shared with other teams.

For the focus groups, consent shall be obtained from each participant and they shall be informed of the audio taping of the discussions in advance. The outdoor air monitoring part of the study shall seek consent from the community gatekeepers mainly the chief and village elders of areas where measurements shall be taken. Individual consent shall be obtained from the pregnant women to be part of the study and consent shall be

sought of the women to be followed up at a later date. All data collected shall remain confidential and shall be stored in password protected computers at the APHRC offices. Audio tapes once transcribed shall be destroyed immediately.

IX. Data Processing and Analysis

Data collection for the quantitative study shall be done electronically using netbooks. This removes the need for data entry and therefore once data have been collected, the investigators shall obtain it for cleaning and analysis using Stata software. Descriptive analysis and multivariable regression analysis shall be applied as appropriate. Qualitative data shall be transcribed by the investigators and coded and thematic analysis conducted using Nvivo software.

X. Plan for Communicating Findings of the Study

The study results shall be disseminated to the study communities through community meetings while to get the results to those living beyond the study areas; we shall use media such as radio and television to discuss the findings. Dissemination to the international community shall be done through publication of papers in peer-reviewed journals. Several policy implications arise from this study: the control of emissions from vehicles and industries to reduce the amount of exposure to people. In addition, policies touching on maternal and child health will benefit from the findings from this study as shall policies on environmental health.

XI. Study Limitations and Risks

No risks are envisaged to arise from any of the components of this study. The main limitation of this study is the lack of sufficient air quality monitors especially for the indoor air pollution component. This has made the team to limit measurement of pollutant levels to one per household over the study period under the assumption that cooking fuels and stoves do not vary so much over a few months.

XII. Management and Organization of the Study

The study shall have three teams based on the three components: the qualitative team shall have two moderators and two note-takers with either taking the role of team leader during the period when the focus groups shall be convened. In the outdoor air pollution component, two field staff shall make up the team and they shall be supervised by the two investigators who shall act as the team leaders. The indoor air pollution component shall have two teams each having 8 interviewers and under the leadership of a supervisor. The research assistant on the larger study on which this component is nested shall provide coordination of the teams. The two investigators shall oversee the placement and retrieval of IAP monitors as well as uploading of data from the monitors.

XIII. Appendices and References

References

Boy E., Bruce N. & Delgado H. 2002. Birth weight and exposure to kitchen wood smoke during pregnancy in rural Guatemala. *Environmental Health Perspectives*, 110, 109-14.

Bruce N., Perez-Padilla R. & Albalak R. 2000. Indoor air pollution in developing countries: a major environmental and public health challenge. Bulletin of the World Health Organization, 78.

Bruce N., Perez-Padilla R. & Albalak R. 2002. The health effects of indoor air pollution exposure in developing countries. Protection of the Human Environment. Geneva: World Health Organization.

Cohen, A. J., Anderson, H. R., Ostro, B., Pandey, K. D., Krzyzanowski, M., Künzli, N., Gutschmidt, K., Pope C. Arden, r., Romieu, I., Samet, J. M. and Smith, K. R. (2004). Urban air pollution Comparative quantification of health risks: Global and regional burden of disease attributable to selected major risk factors Majid Ezzati, Alan D. Lopez, Anthony Rodgers and Christopher J.L. Murray. Geneva. World Health Organization. 1: 1353-1434.

City Mayors Health. "WHO calls for stronger cities to help prevent Asian health crisis." Retrieved 26 November 2011, http://www.citymayors.com/report/asian_health.html

Duflo E., Greenstone M. & Hanna R. 2007. Cooking Stoves, Indoor Air Pollution and Respiratory Health in Rural Orissa, India.

Ezzati M., Saleh H. & Daniel K. M. 2000. The Contributions of Emissions and Spatial Microenvironments to Exposure to Indoor Air Pollution from Biomass Combustion in Kenya. Environmental Health Perspectives, 108

Ezzati M. & Kammen D. M. 2001. An exposure-response relationship for acute respiratory infections as a result of exposure to indoor air pollution from biomass combustion in Kenya. Lancet, 358, 619–624.

Gauderman, J. W., Avol, E., Gilliland, F., Vora, H., Thomas, D., Berhane, K., McConnell, R., Kuenzli, N., Lurmann, F., Rappaport, E., Margolis, H., Bates, D. and Peters, J. (2004). The effect of air pollution on lung development from 10 to 18 years of age. The New England Journal of Medicine, 351(11): 1057-1067.

Health Effects Institute (2004). Health effects of outdoor air pollution in developing countries of Asia; a literature review, Boston, MA.

Jensen, S. S. (1999). A Geographic approach to modelling human exposure to traffic air pollution using GIS. PhD Thesis. Denmark, National Environmental Research Institute: 165.

Kadir M. M., McClure E. M., Goudar S. S., Garces A. L., Moore J., Onyamboko M. & Goldenberg R. L. 2010. Exposure of pregnant women to indoor air pollution: a study from nine low and middle income countries. *Acta Obstetrica et Gynecologica*, 89, 540–548.

Kenya National Bureau of Statistics (2009). Republic of Kenya Population and Census Survey, Ministry of Planning.

Kinney, P. L., Gichuru, M. G., Volavka-Close, N., Ngo, N., Ndiba, P. K., Law, A., Gachanja, A., Gaita, S. M., Chillrud, S. N. and Sclar, E. (2011). Traffic impacts on PM_{2.5} air quality in Nairobi, Kenya *Environmental Science & Policy*, 14: 369 - 378.

Mishra V., Dai X., Smith K. R. & Mika L. 2004. Maternal exposure to biomass smoke and reduced birth weight in Zimbabwe. *Annals of Epidemiology*, 14, 740-7.

Mishra V., Retherford R. D. & Smith K. R. 2005. Cooking smoke and tobacco smoke as risk factors for stillbirth. *International Journal of Environmental Health Research*, 15, 397 – 410.

Montgomery, M. R., Stren, R., Cohen, B. and Reed, H. E., Eds. (2004). *Cities transformed: demographic change and its implications in the developing world*. London, Earthscan.

Morgan, G., Corbett, S. and Wlodarczyk, J. (1998). Air-Pollution and Hospital Admissions in Sydney, Australia, 1990- 1994. *American Journal of Public Health*, 88(12): 1761 - 1766.

Mulaku, G. C. and Kariuki, L. W. (2001). Mapping and analysis of air pollution in Nairobi, Kenya. *International Conference on Spatial Information for Sustainable Development*, Nairobi.

Odhiambo, G. O., Kinyua, A. M., Gatebe, C. K. and Awange, J. (2010). Motor vehicles air pollution in Nairobi, Kenya. *Research Journal of Environmental and Earth Sciences*, 2(4): 178-187.

Pogodina C., Brunner Huber L. R., Racine E. F. & Platonova E. 2009. Smoke-free homes for smoke-free babies: the role of residential environmental tobacco smoke on low birth weight. *J Community Health*, 34, 376-82.

Pope, C., 3rd., Dockery, D. W., Spengler, J. D. and Raizenne, M. E. (1991). Respiratory health and PM₁₀ pollution-a daily time-series analysis. *American Review of Respiratory Disease*, 144(3): 668-674.

Pope, C. A., 3rd. and Dockery, D. (1992). Acute health-effects of PM10 pollution on symptomatic and asymptomatic children. *American Review of Respiratory Disease*, 145(5): 1123-1128.

Pope, C. A., 3rd., Thun, M. J., Namboodiri, M. M., Dockery, D. W., Evans, J. S., Speizer, F. E. and Heath, C. W., Jr. (1995). Particulate air-pollution as a predictor of mortality in a prospective-study of US adults. *American Journal of Respiratory and Critical Care Medicine*, 151(3): 669-674.

Smith, K. R. and Akbar, S. (2003). Health-damaging air pollution: a matter of scale. *Air Pollution and Health in Rapidly Developing Countries*. Gordon McGranahan and Frank Murray. Canada. Earthscan.

Sřrám R. J., Binková B., Dejmek J. & Bobak M. 2005. Ambient Air Pollution and Pregnancy Outcomes: A Review of the Literature. *Environmental Health Perspectives*, 113, 375–382.

Subramoney S., D'espaignet E. T. & Gupta P. C. 2010. Higher risk of stillbirth among lower and middle income women who do not use tobacco, but live with smokers. *Acta Obstetricia et Gynecologica*, 89, 572–577.

World Health Organization 1992. International statistical classification of diseases and related health problems, tenth revision. Geneva: World Health Organization.

World Health Organization 2005. World Health Survey Results for Kenya. World Health Survey. World Health Organization.

World Health Organization 2006. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: Global update 2005 Summary of risk assessment. Geneva: World Health Organization.

World Health Organization 2010. WHO guidelines for indoor air quality: selected pollutants, Bonn, Puncto druck+medien GmbH.

Appendices

Appendix 1: Questionnaires/Interview Guides

Qualitative guide into the enquiry of people's perceptions of exposure to air pollution

There will be 8 focus group discussions, separately for young adult males, females and older adult males and females. Young adults are defined as those aged between 18 and 29 while older adults will be 30 and above.

Each focus group will have 6-8 participants and two facilitators.

Objectives:

The study's objectives are to:

1. Understand the perceptions, attitudes and beliefs of individuals regarding air pollution.
2. Assess the communities' understanding of the health risks associated with air pollution.

Discussions

1. Let us discuss the broad issue of our environment- what does 'environment' mean to you? (Explore what the word environment means and let the participants discuss briefly on this).
2. What comes into our minds when we hear the term pollution of the environment?
 - a. Let the group discuss on any issue regarding the overall environment (air, water, land)
3. What comes into our minds when we hear the term 'risk'?
4. Let us discuss about the different types of air pollution we face in our day to day lives. Let us start with a discussion about the air outside for example on our way to work, to the market and other places outside our homes.
 - a. What do we think are the sources of pollution of the air outside our homes? (Moderator: list the mentioned sources of pollution on a flip chart- add the following if not mentioned: vehicle emissions, industrial emissions, dust, open fires used to burn trash, open air cooking, cigarette smoke; have the group discuss about the sources then rank them starting from the most important source of outdoor air pollution. Discuss why this is voted so.)
 - b. What do we feel should be done by individuals, communities and government to address any identified issues?
5. Now let us talk about the air within our homes.
 - a. What would we say are the sources of pollution of the air within our homes? (Moderator: List the mentioned sources of pollution on a flip

- chart- add the following if not mentioned: cooking stoves, cooking fuels, lighting fuels, poor ventilation, cigarette smoking in the house; then have the group discuss about the sources then rank them starting with the most important source of pollution. Discuss why this is voted as most important.)
- b. In addition discuss ventilation and how it is viewed e.g. windows or door open/closed when stove is on?
 - c. What are the possible steps that can be taken by individuals, communities and government to address any identified issues?
6. We are now going to discuss the air at our work place
 - a. What are the sources of air pollution in the places where we work? - list them on a flip chart and ask the group to rank the sources from the most important to the least important. Discuss why they have ranked them this way.
 - b. What do we think needs to be done by individuals, communities and government to address any issues identified?
 7. We will discuss the health risks arising from exposure to air pollution both in our homes, work place and in the outdoor environment.
 - a. In your opinion; what are the health problems associated with air pollution? (Discuss each problem regarding what they think is the role of air pollution in the occurrence of the mentioned problem).
 - b. Which of these are the most common problems experienced by people living in our communities?
 8. General question: if we came to put this instrument in your house (show photo of monitor and explain that it is used to measure the levels of pollutants in the air within the house); how would you feel? What do you think your neighbors will say to you if they learned that you are having this instrument in your house? What would the reaction be from other members of the community?

Ending the discussion

Thank the participants for answering all these questions and explain once more that their answers will help us understand their thoughts on exposures to and risks arising from air pollution. Also explain that there will be a report back to the community later on when all information has been gathered and analyzed.

1b: Questionnaire on IAP and pregnancy outcomes (See Excel Attachment)

Appendix 2

2a: Qualitative Guide in Kiswahili

Qualitative guide into the enquiry of people's perceptions of exposure to air pollution

There will be 8 focus group discussions, separately for young adult males, females and older adult males and females. Young adults are defined as those aged between 18 and 29 while older adults will be 30 and above.

Each focus group will have 6-8 participants and two facilitators.

Objectives:

Madhumuni ya huu utafiti ni:

1. Kuelewa vile watu wa jamii hii uhisi kuhusu uchafuzi wa hewa.
2. Kupata maoni kuhusu vile watu wa hii jamii huelewa na adhari za kiafya zinazotokana na uchafuzi wa hewa.

Discussions

1. Sasa tujadiliane kuhusu mazingira yetu. Je neon mazingira in maana gani kwetu?
(Explore what the word environment means and let the participants discuss briefly on this).
2. Nini kinachotujia kwa akili zetu tunaposikia juu ya 'uchafuzi wa mazingira'?
 - a. Kikundi kijadili kuhusu mazingira kwa jumla (hewa, maji na ardhi)
3. Nini kinachotujia kwa akili zetu tunaposikia neno 'adhari'?
4. Sasa tujadili kuhusu aina tofauti za uchafuzi wa hewa ambazo hutukumba katika maisha yetu ya kila siku. Tuanze na kuzungumza juu ya hewa iliyo nje kwa mfano huko njiani tukienda kwa kazi zetu, sokoni na mahali pengine popote palipo nje ya nyumba zetu.
 - a. Tunafikiri ni nini huwa inachafua hewa iliyo nje ya nyumba zetu?
(Moderator: list the mentioned sources of pollution on a flip chart- add the following if not mentioned: vehicle emissions, industrial emissions, dust, open fires used to burn trash, open air cooking, cigarette smoke; have the group discuss about the sources then rank them starting from the most important source of outdoor air pollution. Discuss why this is voted so.)
 - b. Tunafikiri ni nini watu binafsi, jamii na serikali wanaweza fanya ili kushughulikia mambo haya ambayo mmetaja?
5. Sasa tuingee kuhusu hewa iliyo ndani ya nyumba zetu.

- a. Tunaweza sema ni nini huchafua hewa ndani ya nyumba zetu? *(Moderator: List the mentioned sources of pollution on a flip chart- add the following if not mentioned: cooking stoves, cooking fuels, lighting fuels, poor ventilation, cigarette smoking in the house; then have the group discuss about the sources then rank them starting with the most important source of pollution. Discuss why this is voted as most important.)*
 - b. *In addition discuss ventilation and how it is viewed e.g. windows or door open/closed when stove is on?*
 - c. Tunafikiri ni nini watu binafsi, jamii na serikali wanweza fanya ili kushughulikia mambo haya ambayo mmetaja?
6. Sasa tutazungumza juu ya hewa katika sehemu zetu za kazi (ofisini, sokoni etc).
 - a. Ni nini huleta mchafuko wa hewa katika sehemu tunapofanya kazi? *(List them on a flip chart and ask the group to rank the sources from the most important to the least important. Discuss why they have ranked them this way).*
 - b. Tunafikiri ni nini watu binafsi, jamii na serikali wanweza fanya ili kushughulikia mambo haya ambayo mmetaja?
7. Tutazungumza juu ya adhari za kiafya ambazo huletwa na kuchafuliwa kwa hewa katika nyumba zetu, kazini na pia huko nje.
 - a. Kwa maoni yenu, ni shida zipi za afya ambazo huletwa na mchafuko wa hewa? *(Discuss each problem regarding what they think is the role of air pollution in the occurrence of the mentioned problem).*
 - b. Kati ya hizi mlizotaja, ni zipi ambazo ndio hupatikana sana na wakaazi wa huu mtaa wenu?
8. Tukiweka kifaa kama hiki kwa nyumba yako, utafikiria nini? Unafikiri majirani zako wakija jua kuna kifaa kama hiki kwako watasema nini? Na je watu wa hii jamii yako watakuchukuliaje wakigundua kuna hiki kifaa kwa nyumba yako?

Ending the discussion

Thank the participants for answering all these questions and explain once more that their answers will help us understand their thoughts on exposures to and risks arising from air pollution. Also explain that there will be a report back to the community later on when all information has been gathered and analyzed.

Appendix 3: Consent forms

3a: Individual Consent

AFRICAN POPULATION AND HEALTH RESEARCH CENTER

URBANIZATION & WELLBEING

Informed Consent Form

Study Title	Air pollution and its effect on mortality and pregnancy outcomes in Nairobi's slums
Investigator(s)	<ul style="list-style-type: none">▪ Thaddaeus Egondi▪ Kanyiva Muindi
Study Sponsor(s)	APHRC and Umea University
Collaborators	None

This Informed Consent Form has two parts:

- **Information Sheet (to share information about the study with you)**
- **Certificate of Consent (for signatures if you choose to participate)**

You will be given a copy of the full Informed Consent Form

Part I: Information Sheet

The African Population and Health Research Center and the School of Public Health, Umea University, are conducting a study in Korogocho and Viwandani on indoor and outdoor air pollution and how this affects mortality and pregnancy outcomes. This study will involve focus group discussions with groups of people residing in these communities. In addition there will be questions asked to pregnant women who shall be visited two times in the course of the pregnancy. We shall place small monitors in the homes of these women to measure the levels of Nitrogen Oxides, Carbon Monoxide, Particulate matter (dust and smoke particles). Outdoor air pollution will be assessed using handheld monitors around the community by a research officer on particular days. The outdoor air monitoring will be done for a total of 60 days staggered over the entire year. We are giving you this information because we would like you to participate in our research project. Should you have any questions or need more information regarding this project, do not hesitate to talk to one of the research team members working here or those in the head office.

Why is this Project Important? This study is important not only to the residents of the two communities but to residents in other parts of the city and the country. The information

we get from this study will be used by relevant arms of the government and other agencies to bring change to the policies concerning the environment and health particularly as concerns air pollution.

Who Can Participate?

The study is being conducted among women who are pregnant and who live within Korogocho and Viwandani. You are being invited to take part in this study because we feel you are the right person to give us information on exposure to air pollution, your experiences during the pregnancy and the subsequent outcome of the pregnancy.

Participation is Your Choice

Your participation in this research project is voluntary and should you decide not to take part, you or any member of your household will not be victimized in any way.

What Is Involved in this Project?

This study is part of a larger study and we shall visit women twice- during the first visit we shall collect information regarding cooking fuels and stoves that the household uses as well as the type of work you do. We then shall place a monitor in the house for 24 hours to collect information on the types and levels of pollutants found in the air inside the house. Upon delivery of the baby, we shall return to weigh the baby. In the course of the research, if there are questions you are not comfortable with, you can choose not to answer. You may also decide not to continue with the research if you choose to and this is okay. We however hope that you will take part in the project until its completion as we value your opinions. The questionnaire will take between 20 and 30 minutes of your time.

How long will the project last?

This study will go on for 12 months during which time you shall be visited twice.

What are the risks?

We do not envisage any risks arising from your participation in this research project.

What are the benefits?

You or any members of your family shall not receive any monetary or material benefits as a result of participating in this study; neither shall you or any member of your family incur any costs. The benefits arising from this study are expected to be to the community and the country in general as we envisage the results will inform policies and programs aimed at improving the state of air within the communities and the city.

How will we protect your information and confidentiality?

The research being done in the community may draw attention and if you participate you may be asked questions by other people in the community. We will not be sharing information about you to anyone outside of the research team. The information that we collect from this research project will be kept private. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will store the information on a password protected computer that is only accessed by the researchers. It will not be shared with or given to anyone outside of our project.

What will happen with the results?

The knowledge that we get from this research will be shared with you and your community before it is made widely available to the public. Each participant will receive a summary of the results. There will also be small meetings in the community and these will be announced. Following the meetings, we will publish the results so that other interested people may learn from the research.

Can I refuse to participate or withdraw from the study?

You do not have to take part in this research if you do not wish to do so. If you choose not to participate, you will not be victimized in any way. If you wish to stop participating in the study after you begin, you can stop at any time by telling someone on our project team

Who can I contact?

If you have any questions, you can ask anyone from our team now or later. If you have questions later, you may contact Thaddaeus Egondi, Telephone number: 4001000 or Kanyiva Muindi, Telephone number 4001000. If you have questions about your rights as a research participant, you may contact:

The Research Officer
AMREF Kenya
Wilson Airport, Lang'ata Road
Office Tel: +254 20 6994000
Fax: +254 20 606340
P.O Box 30125-00100
Nairobi, Kenya

Do you have any questions at this time?

Part II: Certificate of Consent

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant	
Signature of Participant	
DD/MM/YYYY	

If visually impaired, physically impaired, mentally impaired or illiterate

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print Name of Participant	
Thumb/Foot print of Participant	
Signature of Witness	
DD/MM/YYYY	

3b: Community consent

AFRICAN POPULATION AND HEALTH RESEARCH CENTER

URBANIZATION & WELLBEING

Informed Consent Form

Study Title	Air pollution and its effect on mortality and pregnancy outcomes in Nairobi's slums
Investigator(s)	<ul style="list-style-type: none">▪ Thaddaeus Egondi▪ Kanyiva Muindi
Study Sponsor(s)	APHRC and Umea University
Collaborators	None

This Informed Consent Form has two parts:

- **Information Sheet (to share information about the study with you)**
- **Certificate of Consent (for signatures)**

You will be given a copy of the full Informed Consent Form

Part I: Information Sheet

The African Population and Health Research Center and the School of Public Health, Umea University, are conducting a study in Korogocho and Viwandani on indoor and outdoor air pollution and how this affects mortality and pregnancy outcomes. This study will involve focus group discussions with groups of people residing in these communities. In addition there will be questions asked to pregnant women who shall be visited two times in the course of the pregnancy. We shall place small monitors in the homes of these women to measure the levels of Nitrogen Oxides, Carbon Monoxide, Particulate Matter (dust and smoke particles). The level of outdoor particulate matter in the community will be assessed using mobile monitors. We are giving you this information because we would like you to give consent of conducting our research in this community. We will seek individual consent from women who will be eligible to participate in the study and also from the head of household in taking air pollutants measurements in the house. Should you have any questions or need more information regarding this project, do not hesitate to talk to one of the research team members working here or those in the head office.

Why is this Project Important? This study is important not only to the residents of the two communities but to residents in other parts of the city and the country. The information

we get from this study will be used by relevant arms of the government and other agencies to bring change to the policies concerning the environment and health particularly as concerns air pollution.

What Is Involved in this Project? This study is part of a larger study and we shall visit women twice- during the first visit we shall collect information regarding cooking fuels and stoves that the household uses as well as the type of work you do. We then shall place a monitor in the house for 24 hours to collect information on the types and levels of pollutants found in the air inside the house. Upon delivery, we shall return to weight the baby. Outdoor air pollution will be assessed using handheld monitors around the community by a research officer on particular days. The outdoor air monitoring will be done for a total of 60 days staggered over the entire year.

How long will the project last?

This study will go on for 12 months during which time they will be visited twice.

What are the risks?

We do not envisage any risks arising from participation in this research project.

What are the benefits?

Participants or any member of their family shall not receive any monetary or material benefits as a result of participating in this study; neither shall they or any member of their family incur any costs. The benefits arising from this study are expected to be to the community and the country in general as we envisage the results will inform policies and programs aimed at improving the state of air within the communities and the city.

How will we protect information and confidentiality?

The research being done in the community may draw attention and if they participate they may be asked questions by other people in the community. We will not be sharing information about them to anyone outside of the research team. The information that we collect from this research project will be kept private. Any information about them will have a number on it instead of their name. Only the researchers will know what their number is and we will store the information on a password protected computer that is only accessed by the researchers. It will not be shared with or given to anyone outside of our project.

What will happen with the results?

The knowledge that we get from this research will be shared with you and your community before it is made widely available to the public. Each participant will receive a summary of the results. There will also be small meetings in the community and these will be announced. Following the meetings, we will publish the results so that other interested people may learn from the research.

Who can I contact?

If you have any questions, you can ask anyone from our team now or later. If you have questions later, you may contact Thaddaeus Egondi, Telephone number: 4001000 or Kanyiva

Muindi, Telephone number 4001000. If you have questions about your rights as a research participant, you may contact:

The Research Officer
AMREF Kenya
Wilson Airport, Lang'ata Road
Office Tel: +254 20 6994000
Fax: +254 20 606340
P.O Box 30125-00100
Nairobi, Kenya

Do you have any questions at this time?

Appendix 4: CVs

CV of Thaddaeus Egondi

Proposed Position in Project:	Principal Investigator		
Organisation:	African Population and Health Research Center		
Name of Staff:	Thaddaeus Egondi		
Profession:	Statistician		
Date of Birth:	20/04/1978		
Years with Organisation:	4 years		
Nationality:	Kenyan		
Membership in Professional Societies:	None		
Detailed Tasks Assigned in Project:	To oversee the overall activities of the proposed project and ensure the success of the whole project		
Education & Qualifications:			
Qualification	Awarding Institution	Country	Year
MSc Biostatistics	University of Hasselt,	Belgium	2006
MSc Applied Statistics	University of Hasselt	Belgium	2005
BSc. Statistics	University of Nairobi	Kenya	2003
Employment Record:			
From (year)	To (Year)	Position	Employer
2008	Date	Analyst/Biostatistician	African Population and Health Research Center (APHRC)
2006	2007	Data manager/Biostatistician	Optimizing Pediatric HAART clinical trial Project, Dept. of Pediatric, University of Nairobi
2003	2004	Data manager	CTL clinical trial Project, Dept. of Pediatric, University of Nairobi

Summary of research experience:

Thaddaeus Egondi has experience of data management and statistical analysis focused on the population and health issues. Previously he has worked with Pediatric HIV clinical trial research group at University of Nairobi.

Publications:

1. Lemkens N, Lemkens P, **Egondi TW**, Schrooten W, Jorissen M, Mertens R, de Raeve G, Preal R, Debruyne F.(2010). *Antibiotic use and doctor visits are reduced after adenotonsillectomy*. B-ENT. 6(4):239-43.
2. Ng N, Kowal P, Kahn K, Naidoo N, Abdullah S, Bawah A, Binka F, Chuc NT, Debpuur C, **Egondi T**, Xavier Gómez-Olivé F, Hakimi M, Hirve S, Hodgson A, Juvekar S, Kyobutungi C, Van Minh H, Mwanyangala MA, Nathan R, Razzaque A, Sankoh O, Kim Streatfield P, Thorogood M, Wall S, Wilopo S, Byass P, Tollman SM, Chatterji S. (2010). *Health inequalities among older men and women in Africa and Asia: evidence from eight Health and Demographic Surveillance System sites in the INDEPTH WHO-SAGE Study*. Global Health Action. 27; 3.
3. C. Kyobutungi, **T. Egondi**, A. Ezech. (2010). *The health and wellbeing of older people in Nairobi's slums*. Global Health Action. 27; 3.
4. R. Ndugwa, C. Kabiru, J. Cleland, D. Beguy, **T. Egondi**, E. Zulu, R. Jessor. (2010). *Adolescent Problem Behavior in Nairobi's Informal Settlements: Applying Problem Behavior Theory in sub-Saharan Africa*. Journal of Urban Health.
5. D. Wamalwa, C. Farquhar, E. Obimbo, S. Selig, D. Ngacha, B. Richardson, J. Overbaugh, **T. Egondi**, I. Inwani and G. Stewart. (2009). *Medication diaries do not improve outcomes with highly active antiretroviral therapy in Kenyan children: a randomized clinical trial*. Journal of the International AIDS Society, 12:8
6. J. Olenja, P. Godia, J. Kibaru, and **T. Egondi**. (2009). *Influence of Provider Training on Quality of Emergency Obstetric Care in Kenya*. Kenya Working Papers No. 3. Calverton, Maryland, USA: Macro International Inc.

Language proficiency:

Language	Speaking	Reading	Writing
English	Good	Good	Good

I (**Thaddaeus Egondi**) certify that the information provided here in is correct to the best of my knowledge as of (**17/08/2012**).

CV of Kanyiva Muindi

Proposed Position in Project:	Co-Principal Investigator
Organisation:	African Population and Health Research Center (APHRC)
Name of Staff:	Kanyiva Muindi
Profession:	Researcher
Date of Birth:	16 th April 1973
Years with Organisation:	9
Nationality:	Kenyan
Membership in Professional Societies:	International Society for Urban Health (ISUH); International Union for the Scientific Study of Population (IUSSP)
Detailed Tasks Assigned in Project:	I will be conducting the indoor air monitoring alongside the research team in the field. In addition, I will be in charge of quality control which involves visiting the teams and randomly spot-checking their work to ensure it is done ethically and correctly.

Education & Qualifications:

Qualification	Awarding Institution	Country	Year
MSc Public Health	The University of the Witwatersrand	South Africa	2006
BSc Fisheries	Moi University	Kenya	1997

Employment Record:

From (year)	To (Year)	Position	Employer
2002	Date	Research Officer	African Population and Health Research Center (APHRC)
1998	2000	Research Assistant	Various consultancies

Summary of research experience:

Kanyiva Muindi is currently pursuing her Doctoral training at the University of Umea. She has a wealth of research experience having started at APHRC as a field worker charged with collecting data in Nairobi's slums. She then later got her Master's training in Epidemiology and Biostatistics and upon her return she was charged with overseeing projects, designing study tools, training of data collection teams and

management and analysis of data collected. She has therefore hands-on experience in the research continuum right from the data collection to the analysis and dissemination of findings.

Publications:

Kimani, J.K., Ettarh, R., C. Kyobutungi C., B. Mberu and K. Muindi. Determinants for participation in a public health insurance program among residents of urban slums in Nairobi: results from a cross-sectional survey. BMC Health Services Research 2012, 12:66

Ousmane Faye, Baschieri A., Falkingham, J and Muindi K. (2011). Hunger and Food Insecurity in Nairobi's Slums: An Assessment Using IRT Models.

Ibisomi L., Gyimah S., Muindi K. and Adjei J. (2011). Ideal versus Actual: The contradiction in number of children born to Nigerian women.

Emina J, Beguy D, Zulu E, Ezech, A, Muindi, K, Elung'ata, P, Otsola, J, Yé, Y. Monitoring of Health and Demographic Outcomes in Poor Urban Settlements: Evidence from the Nairobi Urban Health and Demographic Surveillance System. J Urban Health. 2011; 88(0):200-218

Bocquier P, Beguy D, Zulu E, Muindi K, Konseiga A, Yé Y. Do Migrant Children Face Greater Health Hazards in Slum Settlements? Evidence from Nairobi, Kenya. Journal of Urban Health. 2011; 88(0):266-281.

Konseiga, A., Zulu, E., Bocquier, P., Muindi, K., Beguy, D. and Yé, Y. 2009. Assessing the effect of Mother's Migration on childhood mortality in the informal settlements of Nairobi. In "The Dynamics of Migration, Health and Livelihoods: INDEPTH Network perspectives". Edited by. Collinson M.A., Adazu, K., White, M.J., S.E. Findley. Ashgate. Aldershot.

Language proficiency:

Language	Speaking	Reading	Writing
English	Excellent	Excellent	Excellent
Kiswahili	Excellent	Excellent	Excellent

I Kanyiva Muindi certify that the information provided here in is correct to the best of my knowledge as of **17/08/2012**.

