

The significance of early-life prevention of COPD in sub-Saharan Africa: findings from the FRESH AIR UGANDA survey

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Abstract

Chronic obstructive pulmonary disease (COPD) is globally one of the major non-communicable diseases (NCDs). COPD is also among the NCDs that are increasing worldwide, with the poorest and most vulnerable communities most affected. For decades, tobacco smoke (including second-hand smoke or passive exposure) has traditionally been seen as the primary cause of COPD. In Africa and other low-income settings, biomass exposure is probably the most important risk factor for COPD. In Western communities, where COPD is mainly due to tobacco smoking, the disease becomes clinically apparent particularly in the fourth and fifth decade of life because the pathological events that lead to COPD develop slowly over a long period of time. It is plausible that where biomass smoke exposure starts early in life, even prenatally, that COPD can develop much earlier. The prevalence of COPD in people younger than 40 years is not known because most surveys have included people 40 years or older. The FRESH AIR survey included people above the age of 30 years. Results show that the prevalence of COPD among adults aged 30–39 years was 39% (38% in men and 40% in women). COPD surveys among young people in sub-Saharan Africa are urgently needed. Education programmes to raise awareness and knowledge of the risk of COPD in general, and early-life COPD in particular, are needed.

Introduction

Chronic obstructive pulmonary disease (COPD) is globally one of the major non-communicable diseases (NCDs), and an important contributor to the global burden of disease in people older than

40 years.¹ COPD is also among the NCDs that are increasing worldwide, with the poorest and most vulnerable communities most affected.^{2,3} In 2010, COPD was the fourth highest cause of death globally and it was expected to become the third by 2030. In 2014, the World Health Organization (WHO) reported that COPD is now the third leading cause of mortality, and has surpassed the combined mortality of tuberculosis, HIV/AIDS and malaria in sub-Saharan Africa.⁴

For decades, tobacco smoke (including second-hand smoke or passive exposure) has traditionally been seen as the primary cause of COPD, affecting more than 200 million people worldwide. These estimates, however, were based on data from studies conducted in industrialised countries.⁵ The major prevalence studies were particularly conducted among participants above the age of 40 years living in urban areas.^{6–8}

It is now recognised that a substantial proportion of COPD cases (up to 20%) can not be explained by exposure to tobacco smoke, particularly in low- and middle-income countries (LMICs). During the last decade, other risk factors have been found to be associated with the development of COPD, such as indoor and outdoor pollution, environmental exposures, untreated asthma and tuberculosis, as well as dietary and genetic factors.^{9–12} In Western communities, where COPD is mainly due to tobacco smoking, the disease becomes clinically apparent especially in the fourth and fifth decade of life. This is because the pathological processes that lead to COPD are slow and accumulate over time. In biomass smoke-related COPD, exposure starts much earlier in life, and often even in prenatally. This early exposure means that long durations of exposure can be attained in early life, hence COPD caused by biomass smoke exposure can occur early in life. In addition, growing attention is being given to the fact that early life disadvantages could predispose the young individuals to a higher risk of developing COPD in adult life as well.^{10–13} The FRESH AIR Uganda survey is one of the very few COPD surveys that has specifically included people younger than 40 years. It is hoped that these findings will stimulate research into COPD among the young, allowing design of preventive interventions in early life.

FRESH AIR Uganda

In 2012, a prospective cross-sectional survey (FRESH AIR Uganda) was performed among a representative sample of 588 participants above the age of 30 years on the prevalence of COPD and its risk factors in a rural district of Masindi in Uganda.¹⁴ Pre- and post-bronchodilator spirometry was per-

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formed by well-trained local healthcare workers working at the different health centres of Masindi district. The survey used the lower limit of normal threshold, i.e. participants below the fifth percentile of the predicted FEV₁/FVC ratio (forced expiratory volume in one second/forced vital capacity) as the defining criterion of COPD instead of the fixed ratio FEV₁/FVC<0.7, to avoid under-diagnosis in young participants and over-diagnosis in elderly participants.^{15,16}

Among adults above the age of 30 years, we found a prevalence of spirometry-based COPD of 16% (53% women). The prevalence was unexpectedly high among adults aged 30–39 years: 39% (38% men and 40% women). Among the participants with COPD, 44% of the men and 8% of the women were current smokers; their mean age was 40 and 52 years respectively (in the group aged 30–39 years, 65% of men and 5% of women were current smokers). In addition to tobacco smoking, almost 95% of the participants were exposed to smoke caused by biomass fuel use.¹⁴

Discussion

The findings of this survey indicate that a high proportion of COPD patients are younger than the universally accepted 40 years. Why would COPD develop in young people in Sub-Saharan Africa? What should be done?

Indoor air pollution

While the development of COPD is multifactorial, indoor air pollution arising from biomass fuel use is probably the most important risk for COPD in LMICs.¹⁷ Around three billion people, most of them living in LMICs, rely on the use of open fires and simple burning of biomass fuels (wood, animal dung, crop residues, straw and charcoal) for cooking and heating. The smoke produces high levels of household air pollution with a range of health-damaging pollutants. These include significant amounts of particulate matter, of which the smallest particles (mean aerodynamic diameter of particles <2.5 µg, PM_{2.5}), can penetrate deep into the lungs to the alveolar spaces.^{11,12} Household air pollution often affects the poorest households that are unable to afford clean, efficient cooking practices. In most countries of sub-Saharan Africa, women have the responsibility for domestic cooking, and most are exposed to biomass smoke each day, as well as the young children and the sick who spend more time indoors or around cooking fires.

Early life events and impact on lung growth

A second explanation for the high prevalence of COPD in sub-Saharan countries may be related to early-life events. In normal lung development, airway branching is complete by the first trimester of pregnancy.¹⁸ Alveoli develop by a different process and are present at birth, increasing during childhood.¹³ Lung volume and airflow continue to increase as the thorax grows; lung growth ceases in young adulthood (by the end of adolescence in women and by the mid-20s in men) and lung function remains constant for about 10 years (plateau phase); thereafter lung function slowly decreases.^{13–19} It is already known that early-life events leading to low birth weight, increase the risk of developing COPD.²⁰

When a pregnant woman is cooking, the exposure to biomass smoke affects her baby: this is associated with low birthweight, and reduced lung function of the infant soon after birth.²¹ Thereafter, young children are exposed to these high levels in the first years of their lives, as they remain close by their mother during cooking (infants often carried on the back of their mother), causing poor lung growth and reduced development of the lungs during childhood.^{11,12} Biomass smoke also induces respiratory infections among young children, strongly associated with a decline in lung function in later life.²² Exposure to household air pollution accounts for more than half of deaths to childhood pneumonia in children under five years of age.¹² The reduced lung function due to biomass smoke exposure among children continues during life, and could result in a lower plateau at young adulthood, having a lasting effect into adulthood, and thus substantially increasing COPD risk.¹⁹

Facing the variety of COPD risk factors in sub-Saharan Africa

A person living in a rural area of sub-Saharan Africa has lifelong exposure to a variety of risk factors for the development of COPD during all stages of life: perinatal factors (maternal exposure to biomass smoke, low-birth weight, and pre-term birth), childhood exposure (respiratory tract infections, exposure to indoor biomass smoke, childhood asthma, second-hand smoking, occupational exposures, poor nutrition, and kerosene lamps), and adult exposure (occupational exposures, agricultural smoke, indoor biomass smoke, cigarette smoking, second-hand smoking, kerosene lamps, and outdoor air pollution). Outdoor air pollution is a growing problem, especially in cities.^{23,24} Tobacco smoke also exacerbates the detrimental effect of biomass smoke.^{17,25} There is an inverse relationship between socioeconomic status and male smoking prevalence.²⁶ Socioeconomic indicators such as poverty are also associated with poor access to healthcare, poor nutrition, low birth weight, exposure to indoor and outdoor air pollution, poor living conditions and water supply/sanitation, causing ill health effects, and therefore increasing the risk of developing COPD.^{26–29} The influence of socioeconomic factors is complex: more research is needed to identify these partly modifiable, and at the same time independent, risk factors.^{27,28,30}

Educational programmes

Most people (communities, healthcare professionals, and policy-makers) are unaware of the damage caused by biomass smoke. Lung health education programmes offer the potential to teach people about the problem of biomass smoke exposure and allow those at greatest risk, including pregnant women and young children, to change their cooking traditions and apply behavioral changes to the exposure of household air pollution. A cascading and sustainable 'train-the-trainers' module, such as is being run by the FRESH AIR Global Bridges project in the Masindi area of Uganda, offers an example of how this education may be carried out. Educational materials developed by local health workers have now been approved by the Ministry of Health in Uganda.^{1,2}

Conclusion

A silent growing epidemic of COPD, starting at younger ages,

seems to be developing in sub-Saharan Africa. This applies particularly to communities living in rural areas, an often neglected group of people. Although tobacco smoking remains an important cause of COPD, almost all are exposed to biomass smoke and this interacts with other risk factors such as early-life respiratory infections, tuberculosis, low birth weight, poverty, and malnutrition. Although prevention of COPD can be achieved to some extent by smoking cessation, reduction of the exposure to the other risk factors should be a major public health goal for LMICs, and should start early in life. Public awareness and control of the household environment are important steps in preventing respiratory diseases. While research on the effects of biomass smoke is increasing, additional research is needed into the benefits of prevention and reductions of exposures at a community level. Researchers, policy-makers and government, stakeholders, health professionals, and communities will have to work together to control the growing burden of COPD, and start prevention and intervention programmes.

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