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Review Article

Stop normalizing poverty: How can African children achieve their true lung health potential?

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ABSTRACT

The British Thoracic Society (BTS) launched a Global Health Group in 2019 in partnership with the Pan African Thoracic Society. This paper reports the third of a series of BTS Winter Meeting global lung health symposia addressing lung health in African children in the context of poverty. In this report, we summarize the two presentations included in the symposium. The first talk, by Refiloe Masekela, focused on the legacy of poor lung health across generations providing an overview of factors known to be important in child respiratory health. The second talk, by Kevin Mortimer, summarized the evidence to date on intervention studies of clean cookstoves and child lung health.

Keywords: Socioeconomic determinants, Air pollution, Interventions, Lung function trajectories, Poverty

INTRODUCTION

The British Thoracic Society (BTS) launched a Global Health Group in 2019 in partnership with the Pan African Thoracic Society (PATS).[1] The Group proposes a symposium for the BTS winter meeting each year and offers a summary of this for the Journal of PATS. The first symposium, in February 2021, addressed five major respiratory exposures/diseases in Africa: air pollution, childhood pneumonia, post-TB lung disease, asthma, and chronic obstructive pulmonary disease (COPD).[2] The second symposium in December 2021 focused on chronic respiratory diseases in low-income and middle-income countries (LMICs).[3] This third symposium in November 2022 tackled lung health in African children in the context of poverty. This manuscript is not a comprehensive review of the literature but a reflection of the proceedings of the symposium.

THIS STORY STARTED LONG, LONG AGO: THE LEGACY OF POOR LUNG HEALTH ACROSS THE GENERATIONS

Lung health can be defined as the ability to lead a good quality of life, free of infections, and exposures that could limit the lung's capacity to breathe. In this definition, it is clear that for one to attain maximal lung capacity and thus health, there are a multitude of factors that can set one on a lung health trajectory from the intrauterine period.[4]

In pulmonary medicine, an individual's lung capacity has been intimately linked to ethnicity with this being rooted in colonial history and racism.[5,6] Unfortunately, lung health disparities

have not been viewed through a lens of socioeconomic, environmental, and other factors that are known to influence lung capacity.[7,8] Lung health is determined before a baby even takes its first breath from the intra-uterine environment. Factors such as epigenetics are beyond the scope of this review.[9]

Intrauterine environment

Maternal health including maternal nutrition (vitamins and trace elements), maternal weight, intrauterine exposures to tobacco smoke and air pollution, access to prenatal supplements, and stress can all impact the intrauterine environment that the fetus is exposed to.[10-16] All these factors may result in a neonate who is small for gestational age and has lower lung capacity. The Generation R study which followed up over 5600 maternal child pairs found that fetuses with intrauterine growth restriction had lower forced expiratory volume in one second and forced vital capacity z-scores compared to normal sized fetuses.[17] However, there was no association between fetal lung restriction and asthma. The GRAPHS study conducted in Ghana found that babies born to mothers with high exposure to carbon monoxide had evidence of increased minute ventilation and respiratory rate as well as evidence of airway obstruction on infant lung function testing.[18] Maternal tobacco smoke is also well described as an important cause of intrauterine fetal lung restriction and is associated with wheezing in the first few years of life. Prenatal stress has also been found in birth cohorts in Africa to be associated with airway obstruction in infants.[19]

Air pollution

Poor air quality in Africa is a public health emergency and is associated with a number of poor health outcomes. With increasing urbanization of populations, Africa is set to have more than 80% of its population living in urban by 2050, where outdoor air pollution levels are known to be higher. Pollution sources and ubiquitous indoor pollution from biomass fuel use are almost universal.[20] The early studies on the impact of air pollution on lung health have shown that in normal healthy children, increasing black carbon in alveolar macrophages is associated with lower lung function.[21] Similar findings in women in Malawi found higher levels of black carbon in alveolar macrophages of women using traditional biomass fuel cook stoves compared to those using cleaner biomass cookstoves.[22] Exposure to tobacco smoke was found to be associated with an almost two-fold risk of tuberculosis (TB) infection in a systematic review.[23] Maternal smoking was also found in a large analysis of the ISAAC phase III data in 28 261 adolescents in African centers to be associated with severe asthma.[24]

TB

Recently, there has been increasing recognition that TB has implications on lung health even in those with microbiological conversion and seeming cure. Post-TB lung disease is an entity now well-described in adults.[25] A recent paper from a cross-sectional comparative study in the Gambia found that children who had previous TB had spirometry evidence of restrictive lung disease when compared to children living in the same household without the previous TB.[26]

Human immunodeficiency virus (HIV) infection

Sub Saharan Africa has the highest rates of HIV infections worldwide. Exposure to HIV infection in utero is associated with an increased risk of respiratory tract infections as well as opportunistic infections. In the Drakenstein Child Health Study, high maternal HIV viral load was associated with increased lung clearance index and increased risk of airway obstruction at age 2 years.[27] A recent study of infants with the early initiation of antiretroviral therapy found evidence of obstructive lung diseases on plethysmography at age 10 years with high total lung capacity and residual volumes.[28]

IN THE BEGINNING, THERE WAS FIRE: BUT IS THIS THE "KILLER IN THE KITCHEN" OR JUST SMOKE AND MIRRORS?

Household air pollution due to the combustion of dirty-burning fuels for cooking, heating, and lighting in and around the home has been estimated to cause between 2 and 4 million deaths/year.[29,30] Pneumonia in young children and COPD and cardiovascular disease in adults are the main diseases associated with morbidity and mortality due to household air pollution.[29,30] Clean cookstoves and fuels have been promoted as solutions to household air pollution that would improve health and save lives.[31]

In 2009, Romieu *et al*. reported the findings of a household-level randomized controlled trial of a chimney biomass-burning cookstove with a chimney versus continuation of traditional cooking methods on lung health in 552 women and 668 children in rural Mexico.[32] A major finding was poor adherence to the intervention. No statistically significant effect was seen on lung function decline in women or acute lower respiratory tract infections (ALRIs) in children in intention to treat analyses.

In 2011, Smith *et al*.[33] reported the findings of a household-level randomized controlled trial of a biomass-burning cookstove with a chimney versus continuation of traditional cooking methods on physician-diagnosed pneumonia in 518 children <19 months old in rural Guatemala (RESPIRE). No statistically significant effect was seen on the primary outcome in the intention to treat analysis.

In 2012, Hanna *et al*.[34] reported the findings of a household-level randomized controlled trial of a biomass-burning cookstove with a chimney versus continuation of traditional cooking methods on multiple health and other outcomes in adults identifies as primary cooks from 2651 households in rural India. No statistically significant effect was seen on the primary outcome in intention to treat analyses.

In 2016, Tielsch *et al*.[35] reported the findings of a cluster randomized step-wedge controlled trial of a biomass-burning cookstoves versus continuation of traditional cooking methods on ALRI in 5254 children under the age of 3 years in rural Nepal. No statistically significant effect was seen on the primary outcome in intention to treat analyses.

In 2017, Mortimer *et al*.[36] reported the findings of a community level cluster randomized controlled trial of two biomass-burning cookstoves versus continuation of traditional cooking methods on pneumonia in 10,750 children under the age of 5 years in rural Malawi (CAPS). No statistically significant effect was seen on the primary outcome in intention to treat analyses.

In 2017, Alexander *et al*.[37] reported the findings of a household level randomized controlled trial of an ethanol-burning cookstove versus wood- or kerosene-burning cookstoves on blood pressure in 324 pregnant women in urban Nigeria. No statistically significant effect was seen on the systolic blood pressure in the intention to treat analysis.

In 2019, Kirby *et al*.[38] reported the findings of a community level cluster randomized controlled trial (174 clusters; 1582 households) of an environmental home-based intervention package including a biomass-burning cookstove with a chimney versus continuation of traditional cooking methods on caretaker reported acute respiratory infection in children in Rwanda. This trial did find a statistically significant effect on the primary outcome in the intention to treat analysis with a prevalence ratio of 0.75, 95% CI 0.60–0.93, $P = 0.009$.

In 2021, Jack *et al*.[39] reported the findings of a household-level randomized controlled trial (1414 pregnant women) of liquefied petroleum gas (LPG) burning cookstoves versus biomass burning cookstoves versus continuation of traditional cooking methods on birthweight and physician-diagnosed severe pneumonia in the 1st year of life in rural Ghana (GRAPHS). No statistically significant effect was seen on these primary outcomes in intention to treat analyses.

In 2021, Checkley *et al*.[40] reported the findings of a household-level randomized controlled trial of an LPG burning cookstove versus continuation of traditional cooking methods on blood pressure, lung function, and respiratory symptoms in 180 women in rural Peru. No statistically significant effect was seen on these primary outcomes in intention to treat analyses.

In 2022, Clasen *et al*.[41] reported the findings of a household-level randomized controlled trial of an LPG burning cookstove versus continuation of traditional cooking methods on birthweight of 3061 live births in Guatemala, India, Peru, and Rwanda (HAPIN). No statistically significant effect was seen on the primary outcome in intention to treat analyses.

These ten clinical trials conducted across diverse settings/countries, with a range of cookstove/fuel interventions on several different indicators of health, are broadly consistent in finding no statistically significant effects on the primary health outcomes of interest.

It is, therefore, time to accept that the introduction of clean cookstoves and fuels in place of traditional cooking methods is not an effective (or cost effective) solution for improving human health and saving lives based on current clinical trial evidence. It is important that the search continues for effective solutions for improving human health, where household air pollution and other problems of poverty are common. It is also important that while this search continues, stretched health budgets are used wisely and on interventions that are proven to be clinically and cost-effective.

CONCLUSION

Lung health in LMICs is affected by multifaceted problems starting from intrauterine stage and continues during their childhood growth. Poverty is a major risk factor for lung disease affecting the normal growth and development of children growing up in LMICs. There are opportunities for LMIC policy and decision makers to work on strategies to improve lung health for their children through health education, vaccination, appropriate nutrition, prevention of risk factors, and promotion of interventions to maximize healthy lung development in children, rather than normalizing poverty. The evidence from randomized clinical trials of cleaner cookstoves/fuel interventions does not support their use as effective or cost-effective interventions for improving child lung health. It is important that limited child health budgets are used wisely on proven effective and affordable approaches to achieve optimal lung health in the early life and across the life course.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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