## Comment on *The Lancet* Commission on pollution and health. In the control of ambient and household air pollution - how low do we need to go?

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The *Lancet* Commission on pollution and health is a robust call to arms. Stark in its warnings, but brimming with optimism, it emphasizes that pollution is the world’s greatest environmental threat to health, responsible for both 9 million deaths per year and a vast burden of non-communicable disability including respiratory, cardiovascular and intellectual impairment. Importantly, using data from the Global Burden of Disease, the Commission emphasizes that it is air pollution that results in a greater health burden than either water, soil or occupational exposures. Air pollution, combining both ambient and household air pollution (HAP), is responsible for 6 million deaths per year (with another 6 million from tobacco smoke) and this figure will increase if urgent measures are not taken. The most affected people will be the young and the old, especially in low and middle income countries (LMIC), but particularly in cities (55% global population) as 98% of urban areas globally fail accepted air quality standards.

The optimism in the Commission comes from 3 main messages – first, the solutions to air pollution are in large part known. There are good data from most of the world on sources of pollution and the effects of legislation in reducing impact. WHO guidelines suggest exposure limits to protect health, including both ambient and HAP levels. Second, the solutions are cost-effective. Using economic metrics including Willingness-to-Pay and analyses of the long-term cost of pollution, it is clear that pollution control does not in fact incur an economic cost but rather it offers a sound financial investment. In regions where air pollution control has been implemented large scale benefits have accrued. For example, in the USA, $30 benefit is estimated to have resulted from each $1 invested in air pollution control. The benefit has been seen in health, productivity and life expectancy. Third, the pathway to success is clearly laid out. Responsibility lies with government, international agencies, and civil society including health professionals – and there are examples of success starting with each.

The pathway to success is least clear, unfortunately, in the LMIC of Africa and Asia where biomass fuel use results in extraordinarily high levels of Household Air Pollution in 3 billion homes daily and current technology cannot achieve the WHO air quality limits. In the 3 years since *The Lancet* Commission Report on Respiratory Risks from HAP in LMIC was published (1), considerable new data have been generated regarding several of the key health outcomes described in the report. Despite a decreasing prevalence of the use of solid fuel for cooking in many low and middle-income countries, the actual number of people exposed to HAP is expected to be constant over the next decade due to the rise in global population (2). Acute lower respiratory illness (ALRI) in young children and chronic obstructive pulmonary disease (COPD) in adults remain two of the primary drivers of HAP-related burden of disease. The observational epidemiological evidence for the associations between exposure to HAP and both early childhood ALRI and COPD has been extensively reviewed (4-8) and judged by multiple investigators to be sufficiently strong that intervention trials have been designed and conducted to reduce exposures.

At the time of publication of *The Lancet* Commission report on Respiratory Risks from HAP in LMIC, only one report of a randomized controlled trial (RCT) of an improved biomass-fueled cook stove designed to reduce emissions had been published, the RESPIRE trial on early childhood ALRI in Guatemala (9). Subsequent to *The Lancet* Commission report, several RCTs of the efficacy of cleaner-burning biomass stoves for the prevention of childhood pneumonia have been conducted (10-13). The results of all of these studies have been presented at conferences, but the results of only two have been published to date (10, 11). The outcome of these studies has been clear, with little evidence that the distribution of cleaner-burning biomass stoves alone can directly lower the risk of early childhood pneumonia. Reduction in HAP to a level safe for children remains an important goal for which there is no immediate solution.

Recently, the results of a pooled analysis of Burden of Obstructive Lung Disease (BOLD) studies from 25 sites around the world involving over 18,500 adults and using a common questionnaire and high-quality post-bronchodilator spirometry question the prevailing wisdom that HAP exposure is an important risk factor for COPD (14). In this study, no association between self-reported use of solid fuel for cooking or heating and airflow obstruction was found, although chronic phlegm was more likely to be reported among those exposed for ≥20 years. Despite the strength of the outcome data in this study, a limitation is the self-reported nature of HAP exposure assessment. Another BOLD analysis showed that national COPD mortality rates were more strongly associated with restriction than obstruction measured by spirometry in BOLD study sites and that poverty was associated with spirometric restriction (15). The strong association of poverty, pollution and impaired lung function in the absence of the simple associations with ALRI and COPD previously anticipated (3) give validity to the Commission on pollution and health’s recommendation to review the available interventions in LMIC and assess both their ability to go to scale and potential impact.

The Commission on pollution and health identifies improved cooking stoves and cleaner fuels as important short and middle-term strategies to reduce HAP in the absence of definitive solutions. The Global Alliance for Clean Cookstoves, sponsored by the United Nations Foundation, has the ambitious goal of encouraging the distribution of 100 million clean cook stoves by 2020. An important gap in knowledge, however, is how much do emissions need to be reduced to have substantial health impact? The recent literature reviewed above can be interpreted as suggesting that there is insufficient intervention-based evidence to be certain about the answer to this question, for either early childhood ALRI or adult COPD. A four-country (Guatemala, India, Peru, Rwanda) RCT of a “clean” liquid petroleum gas (LPG) stove intervention is currently being conducted with a primary outcome of ALRI in children but spirometry in adults will not be included in this study. Even if the results of this trial show a positive effect of cooking with LPG, large-scale distribution of LPG in many LMIC is not likely to be feasible for many years and renewable energy solutions are to be preferred. In addition, emission reduction of cooking sources in isolation is unlikely to have major health impacts unless part of a comprehensive, affordable, and sustainable clean air strategy.

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