Effect of household air pollution on pneumococcal carriage

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The burden of pneumococcal carriage and pneumonia is high in sub-Saharan Africa.[1] Pneumococcal conjugate vaccines were introduced in several lower-middle income countries (LMICs) in 2008 to address the high burden of pneumonia. Although the implementation of the pneumococcal vaccines has reduced the burden of nasopharyngeal carriage of vaccine-specific *Streptococcus pneumoniae* strains by 40–90% over 2–3 years (depending on the country and vaccine coverage), the prevalence of non-vaccine pneumococcal strains has increased.[2] Therefore, other tools that target risk factors for pneumococcal carriage and subsequent pneumonia, such as household air pollution, need to be adequately evaluated. This is an urgent task, as over 2·6 billion people are exposed to household air pollution worldwide. It is estimated that household air pollution from the burning of biomass and the inefficient use of fuel accounts for approximately 3·8 million premature deaths annually and approximately 45% of all pneumonia deaths in children aged younger than 5 years.[3] The mechanistic pathway linking exposure to household air pollutants with pneumonia is likely to be active infection by nasal pathogens as a result of impaired nasal mucociliary clearance, reduced immune response to respiratory infections, and disruption of the alveolar walls, as is also observed in chronic active and passive smoking.[4] However, there is little evidence that identifies the causal pathway that links household air pollution and pneumonia.

The study by Mukesh Dherani and colleagues,[5] published in *The Lancet Global Health*, is therefore an important addition to the literature in this regard. In their prospective observational study, the authors aimed to assess the effect of exposure to particulate matter $(PM)_{2·5}$, a common component of household air pollution, on the prevalence of nasopharyngeal carriage of *S pneumoniae* in a large sample of 485 Malawian children using a nested, prospective, observational study design. These children were recruited from the Child And Pneumonia Study, which assessed the effect of improved (a cleaner burning biomass-fuelled cookstove; intervention group) versus traditional (open fire cooking; control group) cookstoves on the incidence of pneumonia in children in Malawi. Dherani and colleagues[5] found that increased $PM_{2·5}$ exposure was significantly associated with the prevalence of nasopharyngeal *S pneumoniae* carriage (odds ratio 1·10 [95% CI 1·01–1·20], p=0·035). However, they also observed that the intervention had no significant effect on *S pneumoniae* carriage when compared with controls (1·36 [0·95–1·94]; p=0·093).

Few other studies have assessed the association between exposure to household air pollution and the prevalence of pneumococcal carriage in sub-Saharan Africa, but the results from these studies have been inconsistent, probably due to the use of different microbial carriage assessment methods, exposure indicators (eg, $PM_{2·5}$ *vs* carbon monoxide), exposure measurements (eg, personal *vs* ambient measurements), and interventions (eg, biomass fuel or liquefied petroleum gas).[6,7] For instance, the presence or absence of nasal *S pneumoniae* carriage was assessed using culture-based methods in the study by Dherani and colleagues[5] and using non-culture-based methods in the study by Carrión and colleagues.[7] The use of standardised methods, such as those developed by WHO, in subsequent studies will help when comparing datasets from different studies.

A balance between the health benefits of interventions to reduce household air pollution and contextual factors, such as the acceptability, availability, and perception of stoves, is crucial when selecting and distributing interventions. For instance, the Philips HD4012L stove used in the intervention group in the study by Dherani and colleagues[5] did not significantly reduce $PM_{2·5}$ exposure and was therefore less likely to confer health benefits, but it was accepted in the community where the study was done as a better stove than other traditional stoves during the transition to a cleaner cooking experience.[8] By contrast, the positive health effects expected from cleaner burning interventions (liquefied petroleum gas) were not observed in the Ghana randomised air pollution and health study[9] because the selected households that received the intervention were surrounded by households that primarily used biomass fuel and could have been exposed to biomas smoke from the neighbouring households. Additionally, in both studies done in Malawi[5] and Ghana,[9] participants used alternative biomass fuels even though households received an improved cookstove—a practice known as stove stacking—thus diluting the exposure reduction provided by the improved stoves. Fuels and stoves will have to be selected and delivered appropriately (eg, with the use of communication tools to encourage continuous use) to ascertain their maximal effects on health outcomes, such as reducing the prevalence of pneumococcal carriage and pneumonia. Existing interactive tools, such as the household air pollution intervention tool, provides guidance on the selection of household interventions to achieve health benefits in specific contexts.

For the **household air pollution intervention tool** see https://householdenergy.shinyapps.io/hapit3/

In conclusion, the study by Dherani and colleauges[5] is an important step in understanding the effect of $PM_{2·5}$ exposure on pneumococcal carriage. There are, however, additional key research needs, including: (1) identifying the mechanistic pathways linking exposure to household pollutants and pneumonia, such as respiratory immune modulation; (2) assessing household air pollution as a risk factor for other current viral infections, such as COVID-19; (3) identifying the effect of combining clean fuels and pneumococcal conjugate vaccine delivery and the cost-effectiveness of this approach; (4) examining the differential effects of these interventions on sex and other subgroups (eg, socioeconomic subgroups); and (5) showing the effects of community-wide delivery of stoves and effective fuels in maximising health benefits, as countries in LMICs scale-up access to these interventions, using the six measurable attributes of exposure, efficiency, convenience, availability, safety, and affordability.[10]

We declare no competing interests.

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