

Institution:

UNIVERSITY OF LIVERPOOL

Unit of Assessment:

UOA2 - Public Health, Health Services and Primary Care

Title of case study:

Household Air Pollution from Global Inequalities in access to clean energy: Improving Prevention strategies to Maximise Health Gain

1. Summary of the impact

The University of Liverpool (UoL) team at the WHO Collaborating Centre for Policy Research on Social Determinants of Health (Liverpool WHO CC) has made a leading, internationally recognised contribution to addressing the adverse health consequences of household air pollution, a problem responsible for an estimated 4 million premature deaths among 2.8 billion of the world's poorest people. Impacts include (i) generating global awareness of a hitherto poorly recognised problem through defining the disease burden, (ii) leading development of new WHO Guidelines on the issue, (iii) providing key evidence for intervention and policy studies in low-income countries and (iv) helping to formulate strategy for global initiatives to address the problem.

2. Underpinning research

The Liverpool WHO CC team has made a leading contribution to quantifying the Global Burden of Disease (GBD) from Household Air Pollution (HAP), with Nigel Bruce (Professor in Public Health, 1993 – present) co-chairing the HAP expert group for the GBD 2010 study, and Daniel Pope (Snr Lecturer; 2003 – present) leading systematic reviews assisted by Debbi Stanistreet (Snr Lecturer; 1997 – present) and Mukesh Dherani (Senior Research Fellow; 2006 – present). They estimated that 2.8 billion people globally rely on traditional solid fuels (wood, dung, coal, etc) and simple stoves for cooking [1] leading to levels of HAP (particulate matter - PM_{2.5}) in homes some 20 to 40 times the WHO 'safe' air quality guideline level in 2010; this resulted in 4.3% of the GBD in 2010, with 4 million premature deaths from childhood pneumonia and a range of adult diseases [2].

Core to this work have been systematic reviews and the RESPIRE trial co-led by Universities of Liverpool and Berkeley [3]. RESPIRE is the first ever Randomised Controlled Trial (RCT) of low-cost technology to reduce air pollution in human populations. It tested the impact of reducing HAP exposure on child pneumonia, and showed that while a good quality chimney stove could reduce exposure (by about 50%) and achieve some reduction in pneumonia risk, exposure reduction to levels much closer to WHO guideline levels are needed to prevent most pneumonia cases caused by HAP. Building on the experience with RESPIRE, Liverpool WHO CC are co-investigators on a new RCT evaluating the impact of an improved combustion stove on childhood pneumonia in Malawi (CAPS – MRC JGHT grant).

The systematic reviews conducted by Liverpool WHO CC have provided intervention effect estimates for several important preventive strategies and tools, including the Global Action Plan for the Prevention and Control of Pneumonia & Diarrhoea (GAPPD) and the Lives-Saved Tool [4] which is used to prioritise interventions for child and maternal survival, work undertaken by UoL jointly with the WHO, UNICEF and the Child Health Epidemiology Reference Group (CHERG) since 2009.

Liverpool WHO CC has led research on policy for securing effective and lasting uptake of improved household energy interventions at scale through a comprehensive mixed-methods systematic review [5]. Carried out under competitive tender for UK-DFID and incorporated in the WHO Guidelines (section 4), the review identified key factors across domains spanning household/community characteristics and preferences, to national and international policy on energy supply, finance and regulation. The UoL is currently working with DFID, WHO, UN Global Alliance of Clean Cookstoves (GACC) and other partners to develop a tool to support implementation of these findings in LMICs.

Research by the Liverpool WHO CC modelling the benefits of a 10-year programme to shift Indian solid fuel-using homes to low-emission alternatives [6] found that substantial health (deaths, Disability Adjusted Life Years (DALYs) and climate change (CO₂-equivalent) co-benefits can be

obtained through household energy improvements.

3. References to the research

Key publications

The following publications report research outputs of work that has been on going throughout the period of research. The work itself was used prior to publication to underpin the outputs outlined in section 4.

1. Bonjour S, Adair-Rohani H, Wolf J, **Bruce N**, Mehta S, Prüss-Ustün A, et al. Solid Fuel Use for Household Cooking: Country and Regional Estimates for 1980-2010. *Environ Health Perspect*. 2013;121(7):784-90. Citations: 2 Impact Factor: 7.260
2. Lim S, Vos T, Flaxman A, et al, (**Bruce N, Pope D, Dherani M**). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2224-60. Citations: 203 Impact Factor: 39.060
3. Smith K, McCracken J, Weber M, Hubbard A, Jenny A, Thompson L, et al (**Bruce N**). Effect of reduction in household air pollution on childhood pneumonia in Guatemala (RESPIRE): A randomised controlled trial. *Lancet*. 2011;378:1717-26. Citations: 55 Impact Factor: 39.060
4. **Bruce N, Dherani M**, Das J, Balakrishnan K, Adair-Rohani H, Bhutta Z, **Pope D**. Control of household air pollution for child survival: estimates for intervention impacts. . *BMC Public Health* 2013; 13 (Suppl 3):S8 Citations: 0 Impact Factor: 2.076
5. Rehfuess E, Puzzolo E, **Stanistreet D, Pope D, Bruce N**. Enablers and Barriers to Large-Scale Uptake of Improved Solid Fuel Stoves: A Systematic Review. *Environ Health Perspect* 2013 (in press). Impact Factor: 7.260
6. Wilkinson P, Smith K, Davies M, Adair H, Armstrong B, Barrett M, et al (**Bruce N**). Public health benefits of strategies to reduce greenhouse-gas emissions: household energy. . *Lancet*. 2009;374(9705):1917-29. Citations: 76 Impact Factor: 39.060

Key research grants

2001-2005. **NIEHS (US)**. Indoor air pollution and child ARI: a randomised trial, US\$1,734,457, PIs K Smith (UC Berkeley) and **N Bruce**.

2003-2006. **World Health Organisation** (Geneva), additional support for Guatemala study to include investigation of RSV infection in children, and respiratory health of women, US\$71,000, PI **N Bruce**.

2003-2008. **Department for International Development, Knowledge and Research**. Smoke health and household energy – scaling up, £250k. Jointly with ITDG (International NGO), 2003-2008, PIs **N Bruce and D Pope**.

2007-2010. **World Health Organization**. Global comparative review of experiences with household energy interventions. A systematic review of the impacts on household air pollution (and exposure and health outcomes if available), in context of interventions that being delivered in the context of development programs, US \$45,000, PI **N Bruce**.

2009-2010. **The Wellcome Trust**. Near-term health effects of sectoral policies to reduce greenhouse gas emissions in high and low-income settings, £ 21,000, Co-I **N Bruce**.

Impact case study (REF3b)

2011-2012. **Department for International Development.** Systematic review of enabling or limiting factors influencing the large scale uptake by households of cleaner and more efficient household energy technologies, covering cleaner fuel and improved solid fuel cookstoves, £40,150.

2012-2017. **UK Medical Research Council.** An advanced cookstove intervention to prevent pneumonia in children under 5 years old in Malawi: a cluster randomised controlled trial, £2,678,588, PI Dr Kevin Mortimer (Liverpool School of Tropical Medicine), Co-Is **N Bruce** and **D Pope**.

4. Details of the impact

In 1993, the health, development and climate consequences of household energy in Lower and Middle Income Countries (LMICs) were barely recognised outside a small number of specialist agencies. The UoL's research has shown that HAP is the 4th most important risk factor globally leading to 4m premature deaths and 11m DALYs. The research has been significant in generating international awareness and mobilising action. The Liverpool WHO CC has had a central advisory role in many initiatives including the (i) United Nations Foundation Global Alliance for Clean Cookstoves (GACC) – a public-private partnership aiming to secure the health, economic, climate and related benefits of clean cooking, and (ii) the United Nations initiative on Sustainable Energy for All (SE4All). Bruce co-chaired the GACC health working group which informed the strategic plan (Igniting Change, 2011 [8]), Bruce and Pope led an NIH-sponsored workshop (May 2011) informing GACC research agenda, and have consulted on research funding allocation for GACC.

The work is influencing global household air pollution initiatives. For example, through secondment with the WHO Public Health and Environment Department (PHE) from 2009 to present, Bruce has contributed to the UN SE4All strategy, including the recently published tracking framework and work to strengthen data collection on household energy use through national surveys including the Demographic and Health Survey. He has also contributed to health impact assessment from climate change mitigation strategies through recently-established collaboration between WHO and the United Nations Environment Programme-led Climate and Clean Air Coalition (CCAC) which is focused on securing climate and health co-benefits of action on short-lived climate pollutants and which builds on UoL's modelling approach. The Executive Director of UN GACC, stated in 2013 that *"the University of Liverpool research led by Professor Bruce has spurred global efforts over the past 15 years to quantify and communicate the health burden from household air pollution, particularly in Sub-Saharan Africa and Latin America... it has certainly helped gain commitment for action at the highest levels and will support the development of the clean cookstoves and fuels markets"* [10]. These actions are also leading to health improvements, lower costs for poor families and reducing carbon emissions.

Liverpool WHO CC systematic reviews provided estimates of risk for the GBD-2010 study, and intervention effect estimates for several important preventive strategies and tools. These include (i) the Global Action Plan for the Prevention and Control of Pneumonia & Diarrhoea (GAPPD) – a WHO/UNICEF initiative integrating evidence-based prevention and treatment measures for the two largest causes of death of children under 5 years, and (ii) the Lives-Saved Tool which is used to prioritise interventions for child and maternal survival and which the UoL has been working on with the Child Health Epidemiology Reference Group (CHERG) since 2009. Bruce served as a key adviser on HAP for both GAPPD and CHERG, and recently served on the expert committee advising the Bill and Melinda Gates Foundation on financing strategy for supporting work on HAP and child pneumonia. The Director of Maternal and Child Health and Development at WHO Geneva, stated in 2013 that *"UoL-led research has been instrumental in developing the environmental component of our integrated strategy for the prevention and control of pneumonia, which remains the single largest global cause of under-5 mortality"* [11].

Bruce was a WHO steering group member of WHO's indoor air quality guidelines in 2010 [13]. The Liverpool WHO CC is coordinating new WHO Guidelines on indoor air quality, designed specifically to address the scientific and implementation issues for household fuel combustion with a focus on LMICs. They are in an advanced state of development (publication expected early 2014). Bruce,

Pope, Stanistreet and Dherani are on the expert Guidelines Development Group (GDG). The GDG is responsible for defining the guidelines scope, evidence review including methodological quality, and drafting recommendations. The guidelines incorporate much of the UoL's systematic review and primary research (including RESPIRE). The Director of the Department of Public Health and Environment, WHO stated in 2013 *"The University of Liverpool research led by Professor Bruce has, over a number of years, made an important and influential contribution to WHO strategy on energy, air pollution health and climate. This evidence, together with direct technical inputs from the Liverpool University team, have provided much of the core evidence base for new indoor air quality guidelines for household fuel combustion, reports and other collaborative work which is supporting WHO's contribution to implementing effective policy for this issue."* [12] These new WHO guidelines will be used by governments and other implementing agencies to develop policy, standards and regulation affecting the lives and health of almost 3 billion people, and make an important contribution to preventing up to 4 million premature deaths annually.

5. Sources to corroborate the impact

Each source listed below provides evidence for the corresponding numbered claim made in section 4 (details of the impact).

7. End Preventable Deaths: Global Action Plan for Prevention and Control of Pneumonia and Diarrhoea. WHO and UNICEF (2013) Geneva.

Research evidence used as basis for inclusion of reducing household air pollution as an intervention for preventing pneumonia, and includes reports on global solid fuel use and the RESPIRE study.

8. Igniting change: a strategy for universal adoption of clean cookstoves and fuels. UN Foundation Global Alliance for Clean Cookstoves 2011, Washington DC.

The main strategy document for the UN Foundation Alliance, which incorporates the outputs of the working groups, including that for health informed by the UoL research.

9. International Workshop Agreement (IWA) on international standards for cookstoves and fuels. International Organisation for Standardisation, March 2012.

The initial stage of development of international standards has been an IWA. For health risks, this uses emissions rate tiers based on exposure-response evidence, derived mainly from the RESPIRE study. An ISO technical committee has recently been formed to develop full ISO standards.

10. Letter: UN Foundation Global Alliance for Clean Cookstoves. Supporting statement dated 8 October 2013.

11. Letter: Department of Maternal and Child Health and Development, WHO, Geneva. Supporting statement dated 30 October 2013.

12. Letter: Department of Public Health and Environment, WHO, Geneva. Supporting statement dated 8 October 2013.

13. Selected Pollutants: WHO Guidelines for Indoor Air Quality. WHO (2010). ISBN 978 92 890 0213 4. http://www.euro.who.int/_data/assets/pdf_file/0009/128169/e94535.pdf