Household air pollution and childhood pneumonia in South Sudan: will clean cooking stoves reduce the incidence and mortality?

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Pneumonia causes more childhood deaths compared to other infectious diseases. Studies have showed that young children exposed to household air pollution (smoke) caused by burning of unprocessed solid fuels such as wood, charcoal, crop waste, animal dung and coal had double the risk of pneumonia infections compared to children who are not exposed or those from families using cleaner fuels such as electricity or gas. In 2012, more than half a million children below the age of 5 years died as a result of exposure to household air pollution worldwide. Based on studies which have indicated that reduction of household air pollution also reduces its health risks such as pneumonia, the World Health Organization recommended the use of cleaner fuels and/or technologies that offer significant health benefits, including the use of clean cooking stoves. Around 99% or all households in South Sudan use solid fuels for cooking in both rural and urban areas. This puts children in South Sudan at risk of pneumonia related deaths attributed to household air pollution. Therefore, promoting the use of clean/improved cook stoves such as the Uga Cooking Stove (locally made in Uganda, using charcoal) is critical to reduce the risk of childhood pneumonia and pneumonia related death in South Sudan.

Key words *Household air pollution, childhood pneumonia, South Sudan, clean cooking stoves*

Introduction and background

In 2012, exposure to household air pollution (HAP) caused by cooking and heating with unprocessed biomass (solid) fuels such as wood, charcoal, crop waste, animal dung, and coal claimed 4.3 million lives worldwide. This mostly occurred in low and middle income countries with almost 600,000 deaths in Africa, and out of all the global deaths attributable to HAP, 534000 occurred among children under the age of five years [1]. Among all-childhood mortality, pneumonia is the leading global infectious cause accounting for 15% of all deaths among children less than 5 years of age. In 2013, it had killed approximately 935000 children under the age of 5 years [2].

South Sudan is among countries with the highest infant and under five mortality rates in the world recorded at 67 and 104 deaths per 1000 live births respectively [3]. In 2012, the International Vaccine Access Centre Pneumonia Report rated South Sudan among the top 15 countries with the highest pneumonia related mortality globally [4]. Although this is based on aggregated data for both South Sudan and Sudan, the South Sudan Household Survey (SSHHS) also showed that pneumonia is the leading cause of death among children under the age of five years [5]. This is further supported by the "Count down to 2015" report which showed the overall DPT3 vaccine coverage in South Sudan to be as low as 59% and less than 50% of children with pneumonia getting the right treatment [6]. See Figure 1.

The use of solid fuels is rampant in South Sudan and the reasons are beyond the scope of this article. The SSHHS 2010 showed that nearly all (99%) of households in South Sudan use solid fuels for cooking, with no difference in types of solid fuel use between rural and urban homes or between "rich" and "states" [5]. However, the same study showed that the percentage use of firewood for cooking is highest in Warrap and Lakes states (93%) and lowest in Central Equatoria and Western Bahr el Ghazal states (62%).

Aims

To discuss the health risks associated with household air pollution resulting from the use of solid fuels with particular emphasis on the related incidence and mortality of childhood pneumonia and, explore an affordable approach through the use of cleaner or improved cooking stoves.

Methods

Information for this paper was obtained by searches of ScienceDirect, the Global Alliance for Clean Cookstoves Website, the World Health Organization websites, the Liverpool School of Tropical Medicine electronic

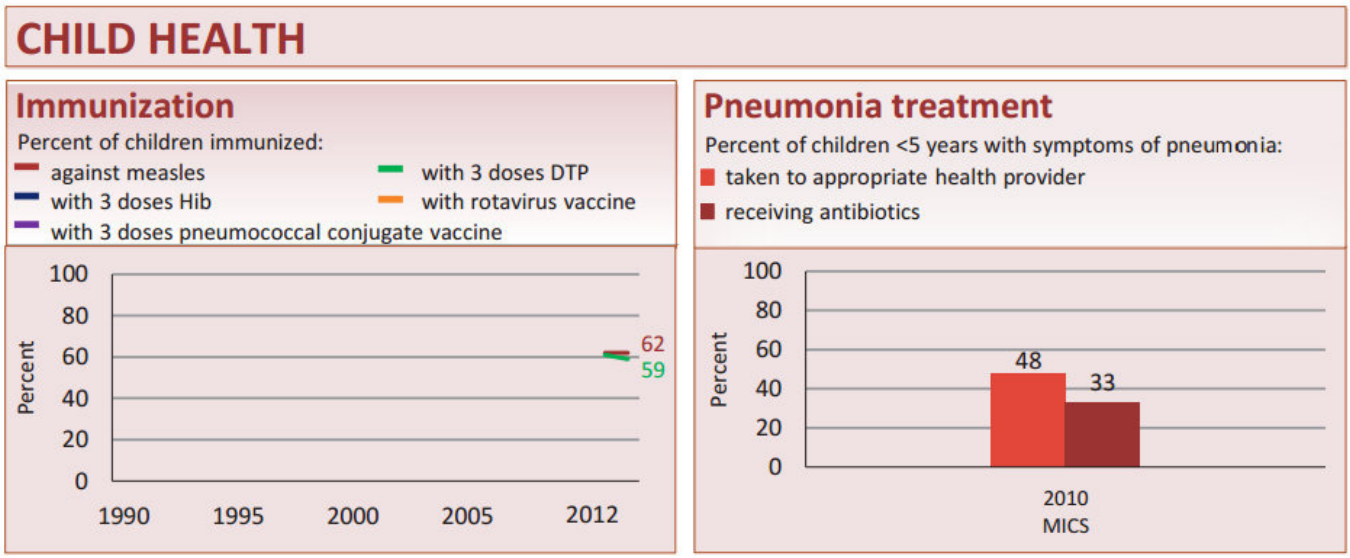

Figure 1. Child health. Reprinted with permission from World Health Organization Fulfilling the health agenda for women and children, the 2014 report – Countdown to 2015. Page 172. Child Health.

library using the search terms "household air pollution", "indoor air pollution", "cookstoves", "pneumonia", "under five", and "acute respiratory infections", The University of Edinburgh online library using the search terms "Childhood pneumonia AND Poverty" and, The University of Liverpool online library searching the DISCOVER data base using the search terms "Childhood pneumonia AND/OR developing countries". Ten articles were used for this review.

Health effects of solid fuel use

The burning of solid fuels using open fires or inefficient cooking stoves produce hundreds of gases and aerosols (suspended solids and liquids) which include particulate matter (PM), carbon monoxide (CO), nitrogen oxides, sulphur oxides, poly-aromatic and different hydrocarbons, plus a variety of organic matter [7]. The PM and CO are the main pollutants responsible for many types of health risks attributed to the use of solid fuels. The major effect on respiratory health is more likely to be caused by PM2.5 (fine particles with diameter up to 2.5 mm) because it is filtered to a limited amount by the naso-oropharynx and thus, can penetrate into the bronchi and alveoli [7]. In addition to bronchial irritation, these particles hinder aspects of the humoral and cellular immune systems thus giving infectious micro-organisms (viruses and bacteria) easy access into the respiratory system [7].

Meta-analysis of studies showed that young children exposed to smoke from burning of household solid fuels had twice incidence of acute lower respiratory infection (ALRI), especially pneumonia compared to children who are not exposed or those from families using cleaner fuels [8]. Other health effects attributed to the use of solid fuels [8] although not specifically discussed in this article include:

Chronic obstructive pulmonary disease in adults.

- Low birth weight.
- Stillbirth.
- Perinatal mortality.
- Risk of childhood injuries from burns (falling into open fires).
- Risk of snake-bites encountered in the process of gathering firewood.
- Financial burden incurred by falling sick or taking care of a sick child as a result of household air pollution.

Clean cooking stoves and their health benefits

Fuel use is often interpreted as an 'energy ladder' based on increasing cleanliness, efficiency, cost, convenience, and improving socio-economic status and decreasing health impacts [9]. See Figure 2. One can therefore deduct that socio-economic status and choice-making stand at the centre of the ladder. It could be argued that developing countries such as South Sudan, being newest in the world could not afford to provide the cleanest types of fuel to all (or most) of its citizens. However, could choosing improved and less environmentally degrading method(s) of energy production be feasible? The authors of this review article think the answer is a "BIG YES!" There are a variety of improved Uga-cooking stoves with a range of designs and performances. However, a good example for our setting is the improved charcoal cooking

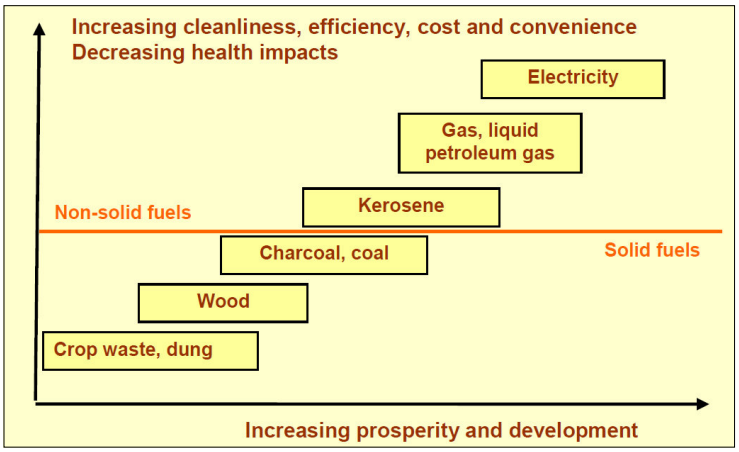

Figure 2: The energy ladder. Reprinted with permission from World Health Organization Indoor air pollution health and the burden of disease. Page 1. Energy ladder. Copyright©WHO2005.

http://www.who.int/indoorair/info/briefing2.pdf

Figure 3. The Uga Cookstove: uses charcoal, locally made in Uganda (credit Gasim Omer Elkhalifa Abd-Elfarag)

stove (Figure 3), designed in such a way that it reduces CO emissions compared to the traditional stoves. A Guatemala randomized intervention trial had confirmed that reduction of indoor air pollution by the use of the plancha stoves (almost similar to the improved stoves described above) is associated with lower incidence of ALRI among infants up to 18 months of age [8].

Introducing the clean cooking stoves in South Sudan

In order to introduce and ensure sustained use of the clean cookstoves in South Sudan, there is need to conduct a quality improvement project on a small scale as a pilot study in a suburban residence in South Sudan prior to a roll-out at a large scale. Funding to conduct such a pilot study can be ensured from non-profit non-governmental organizations such as the Global Alliance for Clean Cookstoves. The Global Alliance for Clean Cookstoves is a new public private-initiative committed to provide clean and efficient cooking solutions with a goal targeting 100 million homes to adopt clean and efficient cookstoves by 2020. The alliance includes over twenty partners which include organizations, companies, and UN and government agencies; some are currently working in South Sudan (such as the World Health Organization, Deutsche Gessellschaft für Technische Zusammenarbeit 'GTZ', World Food Program, and U.S. Agency for International Development). International governmental missions (embassies) in South Sudan, and other non-governmental organizations currently supporting health activities in South Sudan can also be a source of funding for such a study.

Sustained used of the clean cookstoves can be ensured through community engagement from the planning stages of the pilot study until the end. They should be informed of the study, it processes, benefits and expected outcomes. Awareness activities to promote acceptance and sustained use of the stoves is critically needed. This can be done through the use of IEC (information, education, communication) materials, radio talks, television, automated mobile text messages by mobile phone operators, and local artists (singing about household air pollution, its risks, and solutions). Like many other quality improvement projects, there will be need to evaluate the continued use of the stove from time to time.

Conclusion and recommendations

Other types of interventions such as improved household ventilation or behavior change may reduce levels of HAP or exposure or both. Nevertheless, reducing emission rates from HAP is considered as the most effective intervention, because contaminants produced in the home enter the ambient environment, contributing to outside air pollution exposure, and re-enter homes, thus aggravating HAP [10]. The World Health Organization Guidelines for Indoor Air Quality [10] recommended that "Governments and their implementing partners should develop strategies to accelerate efforts to meet these air quality guidelines. Where intermediate steps are necessary, transition fuels and technologies that offer substantial health benefits should be prioritized". With this in minds, we can conclude that promoting the use of improved/clean cooking stoves is a viable means for South Sudan to reduce the incidence of childhood ARTI, especially pneumonia and its related morbidity and mortality. This is achievable without changing of the energy source (charcoal) already in use by many in South Sudan. Further research is needed on the practical challenges of making fuel-efficient stoves more widely used in South Sudan.

Conflicting interests

The authors of this review are not linked to any companies/organizations producing the cooking stoves mentioned in the article. No financial assistance was received for writing this article.

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