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A health intervention or a kitchen appliance? Household costs and benefits of a cleaner burning biomass-fuelled cookstove in Malawi

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ABSTRACT

Pneumonia is the leading cause of mortality for children under five years in sub-Saharan Africa. Household air pollution has been found to increase risk of pneumonia, especially due to exposure from dirty burning biomass fuels. It has been suggested that advanced stoves, which burn fuel more efficiently and reduce smoke emissions, may help to reduce household air pollution in poor, rural settings.

This qualitative study aims to provide an insight into the household costs and perceived benefits from use of the stove in Malawi. It was conducted alongside The Cooking and Pneumonia Study (CAPS), the largest village cluster-level randomised controlled trial of an advanced combustion cookstove intervention to prevent pneumonia in children under five to date. In 2015, using 100 semi-structured interviews this study assessed household time use and perceptions of the stove from both control and intervention participants taking part in the CAPS trial in Chilumba. Household direct and indirect costs associated with the intervention were calculated.

Users overwhelming liked using the stove. The main reported benefits were reduced cooking times and reduced fuel consumption. In most interviews, the health benefits were not initially identified as advantages of the stove, although when prompted, respondents stated that reduced smoke emissions contributed to a reduction in respiratory symptoms. The cost of the stove was much higher than most respondents said they would be willing to pay.

The stoves were not primarily seen as health products. Perceptions of limited impact on health was subsequently supported by the CAPS trial data which showed no significant effect on pneumonia. While the findings are encouraging from the perspective of acceptability, without innovative financing mechanisms, general uptake and sustained use of the stove may not be possible in this setting. The findings also raise the question of whether the stoves should be marketed and championed as 'health interventions'.

1. Introduction

Around half of the world's population, mostly in low-income countries, relies on solid biomass fuels (such as dung, crop residues, firewood and charcoal) as their main means of cooking and heating fuel (WHO, 2013). These fuels are typically burned in open, usually three stone, fires which burn inefficiently, releasing numerous toxic partial products of combustion (Bruce et al., 2000; Ezzati and Kammen, 2002; Pant et al., 2014; Smith and Mehta, 2004). Household air pollution (HAP) released from the inefficient burning of solid biomass fuels has direct adverse impacts on human health, especially amongst young children and their mothers (Duflo et al., 2008; Gordon and Graham, 2006; WHO,

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2013). Exposure to HAP has been found to nearly double the risk of pneumonia in children under five years of age (Dherani et al., 2008).

In an effort to reduce the negative health impacts of HAP among poorer households, and the negative externalities of biomass fuel consumption (including greenhouse gas emissions and deforestation), non-governmental organisations and governments have long been trying to disseminate cleaner burning cookstoves throughout much of Africa, Asia, and South America. The Global Alliance for Clean Cookstoves (GACC), an initiative undertaken by the United Nations Foundation, seeks to distribute 100 million clean cookstoves by 2020 (GACC, 2015).

The reported direct health benefits associated with clean cookstove use are varied. Studies have found that the reduced smoke emissions associated with cleaner burning cookstoves have led to health improvements (Clark et al., 2009) including reductions in respiratory symptoms (Alexander et al., 2014; Bautista et al., 2009; Burwen and Levine, 2012; Romieu et al., 2008) and a decrease in the incidence of acute lower respiratory infections (ALRI) (Ezzati and Kammen, 2002). However, other studies have found little or no evidence of health benefits (Hanna et al., 2012; Smith et al., 2011). Economic evaluations suggest that cleaner burning biomass-fuelled cookstoves are highly beneficial societal investments (García-Frapolli et al., 2010; Habermehl, 2007, 2008; Hutton et al., 2007; Mehta and Shahpar, 2004), although a modelling analysis suggests private net benefits may be negative, as the acceptability and use of cleaner stoves poses a challenge. More specifically learning how to use new stoves and adjusting to new fuels may be time consuming, inconvenient or culturally inappropriate (Jeuland and Pattanayak, 2012).

In spite of the efforts to promote their usage, advanced cookstove interventions have not seen widespread adoption and sustained use amongst households in low- and middle-income countries. Several reasons have been suggested (Lewis and Pattanayak, 2012; Rehfuess et al., 2014; Malla & Timilsina, 2014), such as the mixed evidence on the fuel consumption savings and health benefits discussed above, as well as the potential cost barriers and liquidity constraints which may drive the decision on whether or not to adopt cleaner stoves (Miller and Mobarak, 2015; Mobarak et al., 2012). More context-specific evaluations are therefore necessary to fully appraise the stoves in local circumstances and to understand the different aspects of adoption behaviour amongst households.

The health economics literature on adoption behaviour is an emerging area of research (see for example Bensch and Peters, 2015; Bensch et al., 2015; Dupas, 2011; Cohen and Dupas, 2010; Kremer and Miguel, 2007). In recent work, Dupas (2011) highlights the importance of including both the extensive margin of behaviour (mere adoption of a technology) as well as the intensive margin (how a technology is used and perceived) in evaluating the full effect of an intervention. Our study contributes to this literature by investigating the socioeconomic costs and benefits of adopting the new technology from the household's perspective using detailed primary data.

To our knowledge there are few qualitative studies that have examined the intensive margin of advanced combustion cookstoves, and certainly none in Malawi. The extent that the stoves are perceived as effective health products is discussed.

2. Methods

2.1. Study context

In Malawi, up to 95% of households rely on solid biomass fuels cooking (Fullerton et al., 2009): Pneumonia is the leading cause of under-five mortality in Malawi, with an estimated 1000 deaths in 2010 attributed to the disease (WHO, 2013). World Health Organization (WHO) guidelines on indoor air quality recommend maximum 24-h average air concentrations of no more than 35 mg/m^3 $PM_{2.5}$ (Bruce et al., 2015). In Malawi, however, a study into household air pollution found that within 80% of homes tested, $PM_{2.5}$ levels were four times greater than the WHO level for outdoor air quality (Fullerton et al., 2009).

This qualitative study relates to The Cooking and Pneumonia Study (CAPS) (Mortimer et al., 2016). CAPS was a cluster-randomised controlled trial (RCT) undertaken in two sites in Malawi: Chikhwawa and Chilumba (Trial registration: ISRCTN59448623). The RCT aimed to understand if the provision of an advanced cookstove would prevent pneumonia in children under five years old. In 2012, a total of 100 village level clusters were randomised into control or intervention arms in Chilumba. Intervention participants were given two Philips HD4012 fan-assisted stoves, a solar panel to power the stoves, one cooking pot, user training, and maintenance support, in order to replace traditional cooking methods that use a three-stone fire. Training consisted of initial demonstrations at the community level and subsequent advice offered during scheduled three-monthly household visits. Damaged cookstoves were repaired and replaced as promptly as possible, acknowledging that there were inevitably brief periods when a household would be reliant on just one cookstove. As the Philips stove has a surface area for only one cooking pot at a time, participants were given two stoves to allow for users to cook multiple items at once to help minimise use of supplementary cooking methods (i.e. three stove fires). Engineered and manufactured as an “advanced” cookstove in Lesotho, the Philips stove reduces smoke emissions by up to 90% and has a thermal efficiency of up to 42% (SNV, 2013). Field tests in Chikhwawa suggested emissions associated with a given cooking task were reduced by approximately 75% compared to the open fire (Wathore et al., 2017). Control arm participants continued their usual cooking methods. Those in the control arm were sensitised to the trial at the same time as intervention participants and were told that they would receive two fan-assisted cookstoves at the end of the trial, on the grounds of equity, ethics and retention. Trial results, published in 2016, found no evidence that an intervention comprising cleaner burning biomass-fuelled cookstoves reduced the risk of pneumonia in young children in rural Malawi (Mortimer et al., 2016).

This qualitative study was conducted in the Chilumba CAPS trial site in 2015 when the trial results were unknown to both researchers and respondents. Chilumba is located in Karonga, a northern district of Malawi. The district is largely rural, with the approximate 270,000 person population relying mainly on subsistence farming and fishing (LSHTM, 2015a). The site is nested within the Karonga Prevention Study (KPS) research site which undertakes trials through villages registered in a demographic surveillance system – allowing researchers access to data collected in a subpopulation of 35,000 since 1979 (LSHTM, 2015b).[42] This was the first cookstove trial in the area. Prior to the study, there was no reported use of cleaner burning cookstoves in this setting.

2.2. Design and data collection

To align with the study design of CAPS, and to reduce the possibility of the Hawthorne Effect on intervention subjects (McCarney et al., 2007), participants were selected from both the control and intervention arms of the study. A sample size of 100 households was chosen to allow for a large sample for qualitative work. Using the CAPS participant database, ten village clusters were randomly selected, five from the control arm and five from the intervention arm. Ten households in each cluster were then randomly selected