

Original Research Article

Dealing with Indoor Air Pollution: An Ethnographic Tale from Urban Slums in Bangalore

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ABSTRACT

Background: Indoor air pollution (IAP) was recently recognized as the single largest environmental risk to health. In India, residents of non-notified urban slums face a disproportionate threat associated with this health risk due to their high dependence on biomass fuels for cooking.

Purpose of the study: To provide a detailed analysis of the contextual factors shaping people's choices, views and needs with respect to cooking equipment in non-notified urban slums of Bangalore. Furthermore, an implication for designing and implementing a solution to reduce IAP exposure in these settings is explored.

Methodology: An ethnographic study was conducted across three heterogeneous non-notified slums in Bangalore, India. Data was collected over 3 months in the form of observations, interviews (22) and community forums (3), focusing on understanding how participants experience living in slums and how these experiences shape their cooking practices.

Findings: The study identified interrelated and co-dependent factors spanning across social, financial and ecological dimensions and are engaged in a complex interplay. These include insecure living conditions, constrained physical and social space, varying views on comfort, hygiene and cleanliness, perception of smoke as irritant, and limited temporal and financial resources.

Conclusions: The highly heterogeneous and dynamic character of the slums points towards the need to adopt a flexible, adaptive and context-conscious approach to the design and implementation of a solution to IAP. Furthermore, there is an emerging need to focus on alternative incentives, different from the ones traditionally addressed by initiatives and studies on IAP. The knowledge of slum dwellers vis-à-vis their surrounding environment, cooking practices and equipment points towards the indispensability of employing a participatory approach whereby the end-users are engaged with other

stakeholders in co-creating a solution to IAP and other issues impinging upon its adoption and sustainability.

Key words: Pollution, cooking, stoves, slum, India, ethnography.

INTRODUCTION

Recognised by the World Health Organisation (WHO) as the world's single largest environmental risk to health, indoor air pollution (IAP) accounted for 4.3 million deaths in 2012, constituting 7.7% of the total global mortality. [1] Exposure to IAP has been linked to a wide range of diseases in adults and children, such as Acute Lower Respiratory Infections (ALRI), chronic obstructive pulmonary disease (COPD), lung cancer, cardiovascular diseases (CVD), ischemic heart disease, stroke, cataract, and burns and poisonings. [1-3] Moreover, emerging evidence increasingly links IAP with other conditions such as adverse pregnancy outcomes, low birth weight and perinatal mortality, asthma, otitis media and other acute upper respiratory infections, tuberculosis and nasopharyngeal, laryngeal and cervical cancer. [4,5] The main source of IAP is smoke released from cooking on open fires and traditional stoves that use coal, wood and biomass fuels. [6] In India alone, these practices are employed by a staggering 700-800 million people, [6,7] making IAP the second largest risk factor attributable to the total national burden of disease. [8]

Over the last two decades, India has witnessed an increasing number of interventions aimed at designing and distributing improved cook stoves (ICS). However, many of these programmes have either failed or achieved limited success. [9-12] An illustrative example is the Indian National Programme on Improved *Chulhas* (NPIC), a heavily subsidized, nationwide attempt initiated in 1983 by the Indian government to disseminate ICS with built-in chimneys among rural households. While it was reported that the intervention distributed an impressive 34 million products before its scaling down

and eventual cancellation in 2000-2001, subsequent studies reported that any initial achievements made have not been sustained to the present day. [13] A wide range of factors, including, but not limited to, neglect to address context-specific cooking needs, lack of user-friendliness, high maintenance, administration's lack of communication within itself and with end users, and unforeseen effects of underlying government policies and subsidies were attributed to the failure of the initiatives. [9,13,14] Large scale interventions such as the NPIC frame problems and solutions in universally applicable manners, yet their implementation often reflects the difficulties in transferring technological innovations across varied settings. [15] Accordingly, it is paramount to tailor methods of addressing the issue of IAP to specific contexts, whereby local knowledge, ecologies and practices developed by people within their environment are viewed as central to tackling the issue.

Furthermore, most studies and interventions on IAP have historically focused upon rural areas, with very few programmes targeted at the urban poor. Surveys reveal that in 2012 nearly 24% of the total Indian urban population lived in unplanned and unregistered slums, nearly half of which are non-notified, or not recognised by the government. [16-18] Concurrent with the strong urbanization process, the numbers of these settlements as well as the number of people residing there are projected to further escalate in the following years. [19] The city of Bangalore is a perfect illustration of this trend, undergoing a rapid flow of people from rural to urban areas that engenders an increase in the proportion of poor population and slum settlements within the city. [18,20] In a conversation with a team of

experts from Maastricht University and Narayana Hrudalaya Hospital, it was revealed that living mostly at the periphery of the city and deprived of government subsidies on commercial fuels, this fringe population is highly prone to cooking on *chulhas* with firewood and other biomass fuels. With these projections, the need to address the issue of IAP in these areas is urgent.

The aim of this paper is to provide a detailed analysis of the contextual factors that shape people's choices, views and needs with respect to cooking equipment in non-notified urban slums of Bangalore. Furthermore, implications for designing and implementing solutions that reduce IAP exposure in these settings will be explored.

MATERIALS AND METHODS

Study design: Leach and Scoones' 'slow race' approach ^[15] proposes that the particular interactions between constitutive social and ecological dimensions vary across regions, localities and sometimes even within communities, producing multiple patterns and multiple needs. An ethnographic approach was employed by two researchers to explore these interactions and construct knowledge on how cooking equipment and its context are interlinked.

Setting and sample: Preliminary visits to 7 slums in Bangalore were made with the help of a key informant who had close contact with and enjoyed credibility within these slums as a seasoned social worker. The inclusion criteria for the data collection sites required that the slums be non-notified and non-rehabilitated, implying that they are not recognised by the government and associated municipalities as formal settlements, and thereby lacking legal or regulated access to gas and electricity. ^[21] To maximize the richness of data collected, the slums of Peenya, Sumanahalli and Ashrayanagar were chosen for their varied characteristics

in terms of size and layout of the slum, type of housing structures, and population demographics such as religious affiliation, socioeconomic status, and status and nature of employment of residents. While the sampling was purposive in order to ensure a maximum variation and gain as much information as possible, a combination of convenience sampling and snowballing was also employed when faced with restrictions of language or availability of participants.

Data collection: Data was collected over a period of 3 months through observations, interviews, mapping through diagrams and community forums. These were documented through audio recordings, field notes and photographs.

Observations and interviews: In-depth interviews in Kannada and Hindi were conducted in Ashrayanagar, Sumanahalli and Peenya, across 12, 6 and 4 households respectively, with the help of bilingual translators and key informants since the researchers were unfamiliar with the local languages. Since the responsibility of cooking traditionally lies with the women, putting them at a disproportionate risk of adverse health outcomes from IAP, ^[22] the interviews were directed mainly at women, while a number of men above the age of 20 years were also included in the sample. However, as most households consisted of only one room, some interviews evolved into joint interactions.

The interviews, lasting between 40 and 90 minutes, aimed to understand how interviewees experienced living in slums and how these experiences shaped their cooking practices. The main topics of discussion included characteristics of and perceptions towards cooking equipment and fuels, cooking habits, and financial considerations. The interviews were semi-structured in nature, in order to give participants more control over the pace and content of the interview, while ensuring that key areas of interests were not missed out on. ^[23] With the exception

of interviews that occurred alongside household chores such as cooking and feeding or looking after babies or infants, participants undertook a mapping activity to identify desirable characteristics of cooking equipment, which helped to stimulate further reflections on the 'ideal' stove. Furthermore, continuous, informal observations of living conditions and cooking practices were made during the visits to the slums, and in one instance, the researchers took on the role of participant observers through involvement in cooking chores.

Community forums: Upon attaining data saturation during interviews, a community forum with six to twelve participants was conducted in each slum to verify and add to the knowledge gained from the interviews. These interactions with the slum dwellers were moderated by two key informants, one of whom is a researcher by profession. The composition of participants at the community forums was dynamic since some participants left to attend to their chores while others joined the discussions. These discussions which ranged in length from 60 to 90 minutes were held with the objective of gaining an overview of the communities' views towards various types of stoves - traditional, improved and modern, including benefits and drawbacks associated with each one, and to examine how these were seen to fit into their daily lives.

Data analysis: The interviews, designated serial numbers I1, I2, and so on, were transcribed verbatim, and the transcripts, observations and field notes were read and discussed exhaustively by the researchers with each other as well as key informants. Subsequently, prime themes and concepts were identified through an iterative mechanism of referral to the data collected. Finally, a non-hierarchical list of codes and associated citations was formulated and investigated thoroughly to

identify sub-concepts that were used to respond to the research questions.

RESULTS

A description of the three communities will be provided below, followed by a discussion of the contextual aspects and participants' considerations that impinged upon cooking equipment within the slums.

The context



Figure 1: Shots of Peenya and Sumanahalli

Setting: Located within 8-12 km from the center of Bangalore, and at a walking distance from local markets and public transportation lines, the three slums displayed widely varying characteristics in terms of size, spatial organisation, housing structures and demographics (Figure 1.). Since no official records exist on aspects such as area covered by the slums, date of origin of the slums and number of inhabitants, some of the figures presented in this section are based upon estimates provided by the key informant. The smallest of the three slums, Sumanahalli, consisted of approximately 40-50 families living in houses made of corrugated asbestos or concrete, plastic sheets, bamboo, and mud. The layout of the slum was highly unstructured and arbitrary, with unlevelled dirt pathways running through the settlement. Peenya, on the other hand, was characterized by a much more rigid structure, with standardised concrete housing structures laid out on two sides of narrow, parallel corridors in an attempt to

accommodate as many as 150 households in a very limited space. The largest slum, Ashrayanagar, housed over 1500 families within a densely packed agglomeration of brick and concrete houses of varying sizes, placed irregularly in a highly asymmetric matrix of pathways and narrow labyrinths that in turn led to wider main dirt streets containing small food, liquor and tea outlets. Furthermore, while Ashrayanagar consisted of a melange of religious affiliations, families in Peenya and Sumanahalli were almost exclusively Hindu.

Underlying uncertainties: As illegal and overcrowded spaces of informal housing, these non-notified slums were characterised by an abysmal lack of socio-economic, infrastructural and legal securities as well as little planning and safety provisions, a phenomenon exemplified by Peenya where families had to rebuild their lives from scratch after the settlement was completely burned down in a fire nine years ago. Housed under high tension electric cables, a similar sentiment was echoed by the residents of Ashrayanagar in their perception of the current circumstances as “...a life of death...” (I3, male). In addition, due to non-recognition of the slums by the Government of India (GoI), access to basic public amenities like electricity and water was irregular and shoddy at best and, in the case of Sumanahalli, non-existent. Electricity was often procured illegally or, in some cases, by the use of private solar panels. Also, obtaining documents such as voter ID cards, BPL ration cards (for families living below the poverty line), that act as gateways to government programmes and services like subsidised gas, as well as official proof of residence, was a virtual impossibility. As a result, this meant on one hand that most respondents lived rent-free in the current location on an average for three to ten years, with exceptions ranging from as little as a few months to as much as twenty

years. On the other hand, it eliminated any assurance of continued tenure, putting slum-dwellers under a constant threat of eviction and/or slum demolitions as part of the city’s slum “redevelopment” drive by the Karnataka Slum Development Board.

“There is no guarantee. If they kick us out, they kick us out. We are like footballs; a poor man’s life is a football.” (I3)

This transience in tenure was also associated with the highly cursory nature of their employment, since their location was dictated by where work could be found and often changed without much notice. Having originally migrated from rural Karnataka and neighbouring states in search of employment, the slum-dwellers performed odd jobs in construction and demolition, or garment industries, marked by lack of regularity and security and associated with a low socio-economic status. Most households, ranging from one-person units to families of 15, lived in one-room constructions, with little or no furniture. Little more than plastic bags containing food provisions, clothes on meager wooden shelves or sleeping mats on the floor could be observed in the houses. In a few isolated cases in Ashrayanagar, material possessions extended to beds, tables and TVs.

Cooking and cooking equipment: Within the context of the slums under consideration, a multitude of social, financial and ecological factors were seen to interact with cooking equipment in a two-way relationship of interdependence and mutual constitution. The following sections will provide an overview of this process by maintaining a central focus on the cooking equipment.

Stoves and fuels: In order of their prevalence, stoves found were traditional woodstoves, including mud and three- or five-stone *chulhas*, kerosene stoves, and gas stoves (pictures). Some of the households employed ‘multiple models of stoves’, ^[24] where a combination of the three types of stoves was found. While the

kerosene and gas stoves were acquired from local shops, it was found that traditional woodstoves were hand made in each household in the slum, usually by an adult member of the family, with materials such as mud, cement, bricks or stones, collected from the surroundings of people's homes or from their workplace. These materials were so easily accessible and the actual activity of building a traditional woodstove so ingrained in the community that in some cases respondents did not comprehend the question of its acquisition and/or construction:

'We put three stones together and we put fire in it, and it's done. What is there to make?' (I3)

In fact, respondents maintained that in case of relocating, the ease of building a new *chulha* rendered the mobility of stoves futile.

'It's available anywhere. Just put two stones together and you have a chulha.' (I3)

Furthermore, a number of easily accessible substances were used as fuels for traditional woodstoves. While additive materials including paper, waste and plastic bags were mostly obtained from consumable items, daily chores and work, primary fuels such as wood and coconut shells were usually bought from local shops. A number of respondents reported that they also collected wood and coconut shells from the vicinity of slums. However, collecting was found to be a source of acquiring fuel in a smaller measure than it was reported by previous studies in rural areas. ^[25]

Cooking area: The cooking area could be found inside the house, outside the house in a space built adjacent to the house, or outside in the open. The placement of *chulhas* inside the house was dictated according to convenience, to increase comfort and facilitate cooking-related movements, and in some cases by 'vastu', a set of Hindu beliefs on the 'appropriate' place for things in any space. Woodstoves

were often placed next to the door or underneath windows or improvised wall openings for better lighting and an increased ventilation of smoke, which was seen as a source of discomfort, responsible for soot-covered walls, and made those exposed to it less fair, an attribute negatively related to perceptions of physical beauty, as expounded by a respondent:

"If someone like you stays here for a day, they'll turn black. If we stay outside for a month as well we will also become nice. But because there is smoke in here, we become (dark) like this." (I2, female)

Another important aspect that had to be factored in by slum dwellers when deciding upon the placement of the cooking area was space availability, which depended upon the layout of the slums and housing structures. Families lived, slept and carried out chores within single room structures, making space a valuable and sparse commodity.

"Before, the chulha was inside but that took up too much space. There was no space to move, to sit, or sleep..." (I2).

On the other hand, space available outside the houses varied greatly between and even within slums, similarly impinging upon the possibility of cooking outside. For instance, in Peenya, with the exception of a few houses facing the street at the periphery of the slum, the rest exited onto narrow corridors with insufficient space for *chulhas*. Moreover, while cooking outside provided better lighting and ventilation of smoke, it also raised other issues such as dirt and dust, battling the elements, complaints from neighbors, lack of privacy and concern for one's image.

"It looks bad. Whoever is outside, they can see it, anyone coming and going can see. People ask 'What are you making? Give me some.' Everyone says to give them some. That's why I cook inside." (I2)

In some cases, slum dwellers built a one-person shack of bamboo, asbestos

and plastic sheets adjacent to the house, which served as cooking area and provided a minimum level of privacy and protection from the elements and dust. However, when cooking in the open or in a construction next to the house, the cooking process was encumbered by constant movement between the cooking space outside and the storage space inside for the requisite ingredients and other tools for cooking.

The ‘construction’ of cooking equipment:



Figure 2: Woman supervising her child's homework while cooking

The construction and use of stoves took place in a meaningful manner tailored to the environment of urban slums, and was designed to maximize comfort and facilitate the cooking process. As such, the height of the stove was only slightly above the ground level to account for the limited availability of space and the habits of living and undertaking most household chores at ground level (Figure 2). For instance, vegetables were cut by using a wooden chopping tool placed on the floor and supported by the user's feet. In order to minimize the effort and time spent on cooking, women developed certain habits where actions had a specific order and purpose, as part of their cooking process: *“I make the rice to boil first, and in the meantime I put the ingredients together, and then while that is cooking slowly, I do my other work...”* (I2)

In addition to rice dishes, the main courses cooked on a daily basis consisted of traditional cuisine such as roti, chapatti, dal, sambar, tomato curry and tomato chutney. Discussing requirements for these dishes and cooking practices unveiled a number of stove ergonomics that were shaped by the cooking process. Different dishes demanded varying flame characteristics. For instance, while boiling rice required a steady, low flame that afforded the cook the opportunity to multi-task, cooking *roti* (flat Indian bread) called for strong flames over a large surface area, so as to ensure uniform roasting of the *roti*. Also, it was generally agreed that to best facilitate the cooking process for most dishes, at least two hobs are desirable.

Previous exposure to certain cooking equipment was also seen to play a pivotal role in ‘constructing’ ideas associated with it. It was observed that most respondents possessed cooking equipment similar to that used in their native place. Divergences from this pattern were brought about due to changing circumstances. For instance, some families that used to have chimneys in their previous living environment could not install them in their current houses due to spatial and infrastructural constraints. Furthermore, the sense of familiarity and comfort associated with cooking equipment was also affected by the individual's previous experiences.

Another important consideration was found to be time spent cooking. For instance, non-vegetarian dishes and dishes with more extravagant ingredients, in addition to a larger financial investment, demanded more time and effort to prepare, and were reserved for special occasions like weddings, religious ceremonies and festivals and weekends. Time spent cooking emerged as an important determinant of choices made in the cooking process, affecting not only the type of dishes cooked but also the type of stove used.

“...the taste is good in that (wood) stove. But for time, kerosene stove. But even compared to kerosene stove, gas cylinders are a lot better.” (I18, female)

One factor which raised an interest for time saving was, not surprisingly, a busy working schedule. It was found that employed individuals had limited time to devote for cooking. This, when coupled with higher income, meant that they preferred equipment that cooked faster despite its higher prices. It was found that unemployed respondents and those who worked less regularly did not perceive time saving to be as important as cost savings associated with cooking with woodstove fuels. Interestingly, in households that possessed the multiple model of stoves and energy use, two types of ‘emergencies’ were found to change the routine usage of stoves: emergency of money and emergency of time. Slum dwellers that generally used gas stoves would switch to the cheaper woodstove in times of financial emergencies. On the other hand, slum dwellers that normally used woodstoves reported that they would utilize their kerosene or gas stoves to decrease cooking time, when time was an emergency. Such practices were also observed, for instance, when seasonal factors reduced the availability of “good, dry wood” for the traditional *chulhas*.

Financial considerations: The unregulated character of employment resulted in an uncertainty of employment, irregular working periods and an inconsistent flow of income. Living under conditions of poverty meant that in the best of circumstances, income and expenses followed each other in quick succession. In fact, a hand-to-mouth existence was so banal that keeping a track of regular expenses seemed like a redundancy to the slum-dwellers. The income was received at the end of each week as cash-in-hand and was channeled into the weekly continuum of income-expenditure and debts of the household,

with little savings. A large majority of the household expenses were decided upon by the primary earner of the family, most often the male head of the family, and were tailored to fit the income. Provisions such as food, ingredients and fuel for cooking formed the largest component of recurring expenses, except in case of health emergencies, and repair of the house.

The lack of housing and financial security, in addition to erratic income patterns contributed to a reluctance to make financial expenditures towards modifying the current living spaces. Rather, their efforts were directed towards procuring new and secure housing, following which items of comfort and decoration for the new tenements were considered important.

“Interviewee: The most important thing is that: a roof over our heads. The first thing you need to survive is a house. If you don’t have food, you can drink water and stay hungry for a day. If you don’t have a house, where would you go? [...] Once we get the house, we’ll think of everything else.

Furthermore, in the use of financial resources for ‘non-essentials’, substances that provided immediate comfort or pleasure, such as junk food, clothes, jewellery, tobacco and alcohol, and family-based events like festivals and weddings took precedence. Among other priorities were ridding themselves of indebtedness through repayment of old loans, and investment in small savings schemes, mostly for their children’s education and weddings. In cases of extreme poverty, with earnings as low as Rs 50 (US \$0.79) per day, all financial resources were dedicated to food and the occasional visit to family in nearby villages.

The slum dwellers generally maintained that financial considerations were instrumental in determining the type of stove used. For instance, the type of

stove used was often also viewed as a cursory indicator of the financial standing of an individual or a household within the slum.

“One who has a little bit of money uses kerosene. One who has a little more money uses gas.” (I17, male)

This was true insofar as that a certain income threshold was required to purchase cooking equipment, as it could hardly be expected of someone whose earnings are barely enough for subsistence, to buy a kerosene stove. In some cases of interviewees owning different types of stoves, the irregular income reflected upon the usage of different fuels and stoves:

“...It all depends upon the monetary considerations that we have. If we have the money, we will go for the gas cylinder. If we don't have, if little bit money, (it) means we go for kerosene. Then, if that (money) is not there, for emergency purpose, we have been using that (pointing at the wood stove outside)” (I12, female)

Therefore, at any given time, different households within a community were seen to have different needs and priorities with respect to cooking equipment, which were "dictated" largely by their income at the time. However, it was found that higher income was not a singular, inflexible determinant for change towards less polluted fuels, but one amongst many factors that influenced perception and choice of cooking equipment.

Social identity: Owning and using a traditional wood stove was seen to be associated with a sense of belongingness to the slums, thereby making cooking equipment a socio-spatial constituent ^[26] of interviewees' identity as a slum-dweller. This “social” characteristic associated with traditional firewood stoves was accompanied by a simultaneous experience of pride from belonging to the slums and a sense of shame for the deficiencies of that life.

“Nowadays, there is a social side to it, the general population cooks on gas – you don't see chulhas anymore. Have you seen one anywhere? Besides our slums, you won't see chulhas anywhere.” (I3)

Interviewees further made a distinction between slum dwellers as ‘insiders’ and others as ‘outsiders’, a social division that impinged upon the choice of stove used, as exemplified by one woman in her monologue on cooking for ‘outsiders’:

“When your people come, we make tea on (the kerosene stove). Your people don't like the tea with the smell of smoke. We are used to it.” (I2)

Furthermore, it was observed that previous experiences of the respondents greatly influenced both their choice and perception of different cooking equipment. *“From the beginning, (we) are used to use this kind of stove, so that's why (we) are stick to this kind of stove only.” (I1, female)*

The tendency of individuals to use cooking equipments to which they had been previously exposed in the form of tradition, native or ancestral practice, or habits carried on from childhood was widely observed. Even in one of the few households where Liquefied Petroleum Gas (LPG) was the main tool for cooking, the interviewee reported the use of a similar stove by her mother. It was similarly observed in diagrammatic mapping of ideal stoves that participants generally portrayed structures closely resembling their existing equipment with little or no change.

Smoke and health: The amount of smoke released was seen as dependent on the type and quality of fuels: wet or raw wood and other biomass fuels as well as plastic and paper were considered to produce more smoke.

“If firewood is good, dried, so much of smoke is not coming. [...] If the wood is bad or wet, then there will be a lot of smoke. Also if the wood is raw. If the wood

would be good, there will not even be a bit of smoke. The wood should be dry, it shouldn't be tender.” (I3)

None of the respondents linked smoke exposure to negative health effects. While issues such as coughing, eye irritation, sore eyes, watering of the eyes, burning throats were associated with exposure to smoke, these were considered to be a source of discomfort and annoyance, rather than a health risk. Moreover, the smoke was perceived to be a natural and inevitable part of the cooking process, and to most interviewees, the effect of the smoke on an individual was associated with his/her experience with it.

“Smoke comes in, we are used to it. People like you cannot sit here. You will say ‘smoke!’, but we are used to it.” (I3)

As a result, dealing with smoke was not considered to require any extraordinary measures.

“If we are cooking inside, we will open the door, and this much is enough. So we are not thinking of any solution for that, because we are not finding any problem with the smoke.” (I1)

The interviews also unveiled an interesting view regarding a ‘cooling down’ and ‘heating up’ effect of different fuels on the body.

“From the kerosene stove, the body gets hot. [...] After eating, the body becomes too hot. It (the stove) gives out a smell, and from the smell, the body becomes hot. If you cook on the wood stove, it's cooling. To get the cooling effect of the fire, it's better to use the woodstove. From the wood, there is no smell, the body stays cool. The wood is good for your health.” (I3)

DISCUSSION

This paper aimed to analyse the contextual factors that shape people's choices, views and needs with respect to cooking equipment in non-notified urban slums of Bangalore. The study revealed a number of implications for designing and

implementing a solution to IAP in these settings.

No one solution: The findings of the study highlight a network of constituent elements such as physical and social space, comfort, hygiene and cleanliness, views towards smoke, financial considerations and time, that are engaged in a continuous interplay with each other in shaping cooking and cooking equipment in the slums. The study also reveals that this interplay of factors varies widely between and within the three slums under consideration, making them unique ecosystems with their own set of needs and resources. Under these circumstances, setting up a one-size-fits-all solution might very well mean setting it up for failure, reinforcing Smith's ^[27] statement that there is unlikely to be any magic stove to solve the IAP issue everywhere. A flexible approach and adaptability to different contexts would be indispensable in the formulation and implementation of a solution.

People-centric approach: Cooking practices in the slums are seen to be shaped very closely by the circumstances under which people lead their daily lives. As individuals that would be directly affected by any initiative that engenders changes in cooking practices, slum-dwellers must be placed at the core of the project, and its processes and priorities must be shaped by local perspectives, experiences and knowledge, as is already indicated by Leach & Scoones ^[15] in their call for a slow race to development. In order to optimise accessibility of the people to the solution, the range and scope of the solution should be tailored to local resources and capacities. The solution, its constituent materials, and repair and maintenance mechanisms would need to be available locally, easy to access and use. Furthermore, due to the low and transient income within these communities, financial accessibility can only be ensured through low-cost solutions

combined with flexible payment systems that are customised to individual financial capabilities.

Need for new incentives: Studies and initiatives for reducing IAP in rural areas have traditionally focused upon the reduction of time spent collecting fuel resulting from increased fuel efficiency as a potentially marketable feature. However, the effectiveness of such incentives are diminished in urban slums where people are more prone to buying firewood, rather than collecting it, given the over-strained infrastructure of the city with reduced natural sources of wood. In these financially and spatially constrained settings, lower cost of the solution, reduced expenditure on fuel and space conservation would function as more compelling reasons to change cooking practices. Similarly, since the smoke inside homes is associated more with blackened walls than ramifications of smoke exposure on health, focusing on the prospect of clean walls and soot-free belongings might incentivise the installation of a chimney or investment in low-smoke *chulhas*. In each of the settings targeted, it will be imperative to identify and focus upon incentives that are important to the people.

Integrated and collaborative action: It was observed within all three slums that considerations towards IAP, exposure to smoke and its health effects, and alternatives to traditional cooking equipment were largely overshadowed by the more pressing insecurities and insufficiencies of life in slums, and the wide range of consequent challenges and issues that call for resolution in order to ensure acceptable living conditions. For instance, living under the threat of unpredictable, forceful relocation acts as a strong deterrent to investing in improvements in their current homes, or incurring expenses towards smoke-reducing mechanisms like installing chimneys in the slum-houses. This

necessitates the adoption of an approach that simultaneously targets interlinked and interacting issues in the slums, such as poverty, health care, water and sanitation, employment, land rights and education. These complexities call for concerted efforts and collaboration between multiple actors from a wide range of disciplines: medicine and allied health sciences, social work, development studies, anthropology, social marketing, engineering, private and commercial enterprises, governmental agencies ^[25] to name a few. Moreover, action needs to be initiated towards the incorporation of voices of the low income groups and lessons from local studies into broader frameworks such as government policies and programmes, at a national as well as on a global scale. ^[28]

Limitations of the study and recommendations for future: Challenges in engaging respondents in the study were brought about by differences in language and cultural notions. Over a period of 3 months, these gaps could be bridged to a limited extent. Since challenges in transmitting and receiving nuanced information arose in the use of amateur translators, it is recommended for studies in these settings to recruit translators trained or experienced in basic qualitative research methodologies. Due to severe spatial limitations, interviews were conducted in crowded spaces within slums, often in the presence of spouses, family members or neighbors, thereby running the risk of observer effect and social acceptance bias. The transient nature of communities also posed difficulties in reaching respondents for follow-up. The study was further constrained in its depth of exploration. While the communities were chosen for diversity, they do not fully represent the heterogeneity of non-notified urban slums. A longitudinal study that represents a greater diversity of slums and maintains a central focus on slum-dwellers while concomitantly involving a wider range of

relevant actors, such as governmental representatives, non-governmental organisations (NGOs) and private companies is needed in order to gain a more complete picture.

CONCLUSION

Recently recognized as the largest environmental risk to health, IAP disproportionately affects the poor and the marginalized who cook on open fire or leaky stoves. Within urban contexts, the most neglected of this population are those found in non-notified slums. In Bangalore, the number of these settlements and their inhabitants are on the rise, increasing the urgency to address it. In order to facilitate solutions aimed at reducing exposure of residents of non-notified Bangalorean slums to IAP, the present study aimed to identify and investigate contextual factors that shape people's views and their needs with respect to cooking equipment and the considerations that these entail for planning and designing relevant solutions. The findings reveal a large array of interacting factors within each settlement: insecure living conditions, constrained physical and social space, varying views on comfort, hygiene and cleanliness, perception of smoke as an irritant, and limited temporal and financial resources. As such, a flexible approach to the development and implementation of solutions are indispensable. Furthermore, the knowledge of slum dwellers with regards to their surrounding environment, cooking practices and equipment point towards the indispensability of employing a participatory approach whereby the end-users are engaged with other involved stakeholders in a process of co-creating a solution to IAP and other issues that impinge upon its adoption and sustainability. Moreover, the settlements engender certain barriers to prioritizing the acquisition of cooking equipment. Addressing issues of household and income insecurity and uncertainties would

facilitate the uptake of improved cooking equipment. In order to facilitate the flexibility of the solutions and allow them to respond to a dynamic and ever-changing environment, the intervention needs to be incorporated into an integrated and collaborative initiative towards overall slum development.

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Abbreviations

ALRI Acute Lower Respiratory Infections
 BPL Below Poverty Line
 COPD Chronic Obstructive Pulmonary Disease
 CVD Cardiovascular Disease
 GoI Government of India
 IAP Indoor Air Pollution
 ICS Improved Cook Stove
 LPG Liquefied Petroleum Gas
 NGOs Non-governmental Organisations
 NPIC National Programme on Improved Chulhas
 WHO World Health Organisation

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