



▼ REVIEW ARTICLE

EXPLORING THE IMPACT OF HOUSEHOLD AIR POLLUTION ON WOMEN'S HEALTH: A NARRATIVE REVIEW

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ABSTRACT ►

Introduction: Household air pollution (HAP) is one of the major causes of morbidity and premature mortality in the developing world. India reported roughly 780,000 premature deaths in 2016 from exposure to household air pollution (HAP) making it a leading cause of ill-health in India. Women are more vulnerable to health hazards from household air pollution exposure not only because they perform the household tasks for provision of energy, viz. gathering and processing fuel, cooking meals but also due to sheer time spent in the kitchen. Hence, this review was conducted with an objective to explore the impact of household air pollution on women's health and to recommend public health interventions and strategies to reduce the impact of HAP on health.

Methods: An exhaustive search for all materials related to the topic was made in different search engines, including Pubmed, Google scholar, World Health Organization website and Government websites for a duration of 15 days. Relevant policy documents, systematic reviews and meta-analysis, case control studies, cohort studies, cross-sectional surveys, technical publication series and research articles, published in the period from 1995-2019 were included. Overall, 49 articles were selected based upon the suitability of the current review objectives and analyzed.

Results: Various respiratory as well as non-respiratory illnesses were found to be attributed to household air pollution among women.

Conclusion: As HAP can be prevented by use of cleaner fuels, effective interventions, in the form of advocacy, behavior change communication and technological interventions along with a strong political can tackle this menace in the long run..

Key Words: Household air pollution, Indoor air pollution, Women, Biomass fuel.

≡ INTRODUCTION

Household air pollution (HAP) is one of the major causes of morbidity and premature mortality in the developing and under developed nations. World Health Organization (WHO) has reported that smoke exposure from fire generated during cooking resulted in approximately 3.8 million deaths, annually, prematurely, especially in the developing world and accounted for 7.7% of the global mortality.^[1] Overall, more than 3 billion people across the globe use polluting energy sources (such as wood, dung, crop

residues, coal, charcoal, etc.) for cooking not only exposing themselves to the health hazards of indoor air pollution but also contributing to ambient air pollution.^[2,3] WHO has reported that cooking alone is a source of 12% of global ambient fine particulate matter, leading to approximately, 5 lakh of the 3.9 million premature annual worldwide mortality from outdoor air pollution. Burning fuels such as dung, wood and coal in inefficient stoves or open hearths produces a variety of health-damaging pollutants, including particulate matter (PM), methane, carbon monoxide,

polyaromatic hydrocarbons (PAH) and volatile organic compounds (VOC).^[1]

India and China, with 43% and 30%, respectively, of their populations using solid fuels contributed to over 950 millions of people were exposed to household air pollution in 2016. According to a WHO report published in 2013, population using solid fuels in India is 81% and 26% respectively, in rural and urban areas.^[1] India reported roughly 780,000 premature deaths in 2016 from exposure to household air pollution (HAP) making it a leading cause of ill-health in India.^[4]

Women are more vulnerable to health hazards from household air pollution exposure not only because they perform the household tasks for provision of energy, viz. gathering and processing fuel, cooking meals but also due to sheer time spent in the kitchen. These women, thus, suffer from higher risk of various respiratory and cardiovascular diseases related to pollution exposure, apart from chronic strain and injuries associated with gathering of fuel.^[1]

Even though progress has been made towards reduction in reliance on burning solid fuels, it is at a faster rate in better resource countries than in low resource nations, there is still a long way ahead for a complete transition to clean energy sources in all households across the globe.

Hence, this review has been conducted with an objective to explore the impact of household air pollution on women's health and to recommend public health interventions and strategies to reduce the impact of HAP on health.

MATERIALS AND METHODS

An exhaustive search for all materials related to the topic was made in different search engines, including Pubmed, Google scholar, World Health Organization website and Government websites for a duration of 15 days. Relevant policy documents, systematic reviews and meta-analysis, case control studies, cohort studies, cross-sectional surveys, technical publication series and research articles, published in the period from 1995 – 2019 were included in the review. A total of 74 studies were identified. Fifteen studies were excluded because of the unavailability of the full version of the articles. In addition, ten more studies were excluded as they were beyond the scope of this review. Overall, 49 articles were selected based upon the suitability with the current

review objectives and analyzed. The selected articles and documents were then categorized in different sections viz. household air pollutants, its implication on women's health; interventions for reducing its impact on health; and implications for research. Keywords used in the search include household air pollution, indoor air pollution, women and biomass.

RESULTS

Household air pollutants

Household activities such as cooking, lighting and heating with unclean and inefficient technologies, emit a range of harmful pollutants. In India, almost half the population uses firewood followed by liquefied petroleum gas (LPG), cow dung cake, coal, lignite, or charcoal; kerosene; electricity; biogas, etc.^[5] Pollutants with the strongest evidence for public health concern include particulate matter (PM), carbon monoxide (CO), ozone (O₃), nitrogen dioxide (NO₂) and sulphur dioxide (SO₂). Fine PM with a diameter of 2.5 microns (PM_{2.5}), can lodge deep in the lung alveoli and even enter the bloodstream, causing major adverse impact on respiratory, cardiovascular and cerebrovascular systems. The major source of generating particulate matter at household level is burning of unclean fuels in open hearths, non-availability of smoke vents, poor ventilation, use of inefficient stoves etc. Apart from these pollutants generated as a direct result of combustion of fuel, a variety of other pollutants from non-combustion sources are also emitted at household level. These are radon, lead, asbestos, VOC, moulds and bacterial growth. These are most commonly released into the air from a variety of building materials, such as insulation and ceiling and floor tiles, heating, improper ventilation, etc.^[6]

Implications on women's health

The impact of HAP on health depends upon varied heterogeneous exposure patterns to different pollutants based on the fuel used, type of stove used, available ventilation, cooking time and activity patterns, weather conditions, etc.^[7,8] Here exposure implies the concentration of pollution in the immediate breathing environment during a specified period of time which can be measured either by monitoring at personal level directly or indirectly by combining multiple pollutant concentrations in environment based on time-activity pattern.^[7] To address better understanding of this

dynamic relationship between levels of pollution and behavior, it has been emphasized that more uniform and much sophisticated approaches are the need of the hour for exposure assessment to address and reduce the complexity and variability associated with exposure to indoor air pollution.^[8]

RESPIRATORY ILLNESSES IN WOMEN

Chronic Obstructive Pulmonary Diseases (COPD)

The particulate matter causes acute respiratory infections, chronic bronchitis, COPD, and also lead to exacerbation of COPD. Sulfur dioxide and nitrogen dioxide have been implicated in causing wheezing and exacerbation of bronchial asthma, COPD and also cardiovascular diseases. Apart from this, nitrogen dioxide also causes respiratory infections and deteriorates lung functions.^[9] Household air pollution exposure is the most important cause of COPD in non-smoking population especially in rural women.^[1,10-12] A study done on women from rural Turkey attributed 23.1% fraction of COPD among them to exposure to biomass smoke, after adjusting for possible confounding factors.^[13] A study done in Mexico showed that women exposed to household smoke develop COPD, and increased mortality similar that of tobacco smokers.^[14,15] Biomass fuel smoke was found to be associated with an interstitial lung disease referred to as 'hut lung', a form of pneumoconiosis in rural women from developing countries, originally described as 'Transkei silicosis'.^[16]

Tuberculosis

A Systematic review and meta-analysis revealed that Second Hand Smoke exposure was associated with an increase in the relative risk of Latent TB Infection and active TB after controlling for confounders.^[17] A nested case control study from India reported biomass fuel to be an independent risk factor for pulmonary tuberculosis.^[18] A few other studies done in India and Europe revealed no significant association between type of fuel used and TB.^[19,20]

Lung cancer

Smoke emitted from both coal and biomass combustion contains substantial amounts of carcinogens like polyaromatic hydrocarbons, formaldehyde, etc.^[1] A case-control study among women diagnosed with lung cancer reported that

in non-smoker women, biomass fuel exposure was associated with higher risk of developing lung cancer after adjusting for factors like smoking and passive smoking.^[21] Studies from China and Mexico, have reported data for non-smoking women stating long-term exposure to BMF smoke from cooking contributes to the development of adenocarcinoma of the lung.^[22,23]

NON-RESPIRATORY ILLNESSES IN WOMEN

Cardiovascular Diseases:

Epidemiological evidence shows that exposure to PM is strongly correlated with increased risk of cardiovascular disease (including ischaemic heart disease) and stroke.^[1,24] A study from Guatemala reported that reduction in wood smoke exposure by use of improved chimney stove resulted in lowering both systolic and diastolic blood pressure.^[25] Another study also reported reduction in ST-segment depression on electrocardiogram following a stove intervention.^[26] A Golestan Cohort Study in northeastern Iran reported increased risk for all-cause and cardiovascular disease mortality with household exposure to high-pollution fuels among women compared with men. It also revealed a significant increase in ischemic heart disease and a trend toward stroke.^[27]

Cataract

Evidence is available showing HAP exposure responsible for up almost 25% of the total burden from cataract.^[27] Studies in western India and Nepal reported use of wood to be an important cause of age-dependent cataract, cause for eye irritation, etc. respectively.^[28,29] The limited evidence for active trachoma in children and trichiasis in women suggests associations with household biomass fuel use, although the assessment tools were fairly crude.^[30]

Burns

Fire-related burns from household fuel use in low income households are not uncommon. Burns caused by stoves and open fires are a major cause of death in low resource nations, especially among children and women. These burn injuries often lead to lifelong disabilities and disfigurements. Solid fuel and kerosene stoves are often situated at floor level, in poorly lit kitchens, such that children can touch or fall into them



easily. Millions also suffer burns from using kerosene lamps each year.^[1]

According to injury surveillance data, 24% of surveyed households suffered from fires, burns, or poisonings. Kerosene and electricity were responsible for 73% of the burns reported. The most common burns were scalds and flame burns and among flame burns, majority happened because the kerosene stove exploded.^[31] Previous research indicated that the evidence regarding injuries appears to decrease with rising income. However, in South Africa, the relationship between poverty and burn and poisoning due to household energy use was thought to be non-linear.^[32]

Adverse pregnancy outcomes

Epidemiological evidence is available to prove that HAP increases the risk of adverse pregnancy outcomes including fetal mortality, low birth weight (LBW), preterm birth, small for gestational age, intrauterine growth retardation, and birth defects, etc.^[33-37] The exposure to biomass fuel among pregnant women was found to be associated with approximately 50% increased risk of low birth weight babies.^[38] As compared to babies born in households using low pollution fuels (viz. electricity, LPG, biogas, and natural gas), those born in homes using high pollution fuels (viz. wood, straw, animal dung, crop residue, coal, and charcoal) were lower in their birth weight.^[39] Another study done in India reported population attributable risk of firewood as cooking fuel for stillbirths in India as 11% and 1% for kerosene cooking. They found biomass and kerosene cooking fuels to be associated with stillbirth occurrence in their population sample.^[40]

Miscellaneous

Since women look after the household work, they are the ones who have to carry heavy loads of wood, dung and other fuels on their head or back. This can lead to physical strain, chronic pain, and even acute problems such as spinal injuries, fractures, muscle strains and also complications during pregnancy.^[1] Other health implications of HAP include kerosene poisoning, infertility nasopharyngeal and laryngeal cancers, cervical cancer, and leukemia.^[1,41]

PUBLIC HEALTH INTERVENTIONS FOR REDUCING IMPACT OF HAP ON WOMEN'S HEALTH

Enough epidemiological evidence is available across the globe which suggests that HAP is a cause of increasing morbidity and mortality among women. Thus, it is high time to address this important public health issue with an urgent intervention. It is also important to keep in mind that there are several factors viz. social, cultural, and economical factors which influence the decision of people about use of fuel & energy for cooking. In addition, factors like free availability of traditional fuels, lack of awareness about problems with smoke or alternative clean sources of energy, the aesthetic appeal of stoves, and women's perception about other alternatives are also some of the major hindrances in reducing the problem of HAP. A multi-pronged strategy encompassing behavior change communication with provision of cleaner and design based interventions at household level ably supported by political commitment and relevant policies enabling use of cleaner energy sources is the need of the hour to tackle the menace of HAP.

Behavior change communication:

Various major socio-cultural and economic factors need to be addressed to effectively bring about a change in use of improved cooking heating and lighting. To have a successful transition from traditional methods of cooking to use of cleaner energy technologies it requires a certain degree of motivation and behavior change among all household members of the family. Behavior change communication strategies can be based on the following:

Spreading awareness among people about the serious health impacts of HAP, different ways of reducing exposures with better kitchen management, use of alternative cleaner sources of energy to replace direct combustion of biomass fuel, etc. is important.

Health education strategies can also aim to increase awareness about provision of better ventilation in the cooking area, either by opening window or doors, using a chimney, or even outdoors cooking or redesigning household structure thereby reducing exposure to harmful air pollutants.

Modification of design of cooking stove from traditional smoky ones to those which are fuel efficient, smokeless and have a chimney or smoke outlet for indoor pollutants is advisable. To increase the likelihood of usage new stove designs must be culturally appropriate to meet the cooking needs of the households they aim to target.

Overall wellbeing of the family: by reducing the time spent / lost on fuel collection and ill health due to HAP, children can improve school attendance, also it will help in income generation thus alleviating poverty. Out of pocket expenditure on various respiratory and non-respiratory illnesses due to HAP will be greatly reduced, leading to tremendous decrease in economic burden on the families.

Technology based interventions:

Physical environment: Improved housing standards and design, better cross ventilation, use of smoke outlets or chimneys can reduce the exposure levels at household level although it can contribute to ambient air pollution. It was reported that lung cancer incidence in farmers in China, decreased by more than 40% when they switched from unvented fire pits to stoves with chimneys.^[42]

Use of cleaner stoves: Use of low emission biomass stoves can serve as an effective intermediate in the transition to use of cleaner stoves, though not completely effective, it will definitely reduce the emission of harmful pollutants. Alternatively use of induction cook stoves which are electricity based are one of the cleanest stoves available but they may not be a feasible option in low resource nations if electricity supply is inadequate, unreliable or not affordable. In India in the year 2009-2010, Ministry of New and Renewable Energy, under the National Biomass Cookstoves Initiative, aimed to design and develop the most efficient, cost effective, stoves, with an aim to enhance the availability of clean and efficient energy for poorer sections of India.^[43]

Use of cleaner energy: Liquid petroleum gas (LPG), Biogas and ethanol are the cleaner fuels available for use at household levels to minimize health hazards of HAP. Better availability of these along with provision of subsidies or poorer sections of the society will increase

the uptake of these cleaner fuels on a mass level. Discouraging communities to use coal or kerosene for cooking or lighting purposes will reduce the exposure levels.

Use of alternative energy sources: Solar and wind energy can be utilized for electricity generation and thus be utilized for cooking purposes especially in tropical countries where these can be tapped to a maximum.

GOVERNMENT POLICIES FOR ADOPTION OF CLEAN ENERGY:

In India, Pradhan Mantri Ujjwala Yojana (Prime Minister's Brightness Scheme- PMUY): It was launched in 2016 with an aim to safeguard the health of women & children by providing them with a clean cooking fuel (LPG). Under this scheme, 500 million LPG connections are to be provided to families living below poverty line with a support of Rs.1600 per connection in the next 3 years. Ensuring women's empowerment, especially in rural India, the connections are issued in the name of women of the households. 71915298 PMUY connections have been done as of now.^[44]

"Give it up" – Social campaign: In 2015, the Government of India launched the "Give It Up" campaign, which calls on middle and upper class affordable households to voluntarily cancel their rights to an LPG subsidy and transfer it to a low-income household.^[45] In 2007, the Indonesian government reallocated subsidies for kerosene to LPG, resulting in 40% shift of population to use LPG by 2011.^[46]

Subsidies for cleaner cookstoves: proved critical for enabling under-resourced families to purchase devices in several studies in India. In India in the year 2009-2010, National Biomass Cookstoves Initiative, aimed to enhance the availability of clean and efficient energy for poorer sections of India.^[43]

Miscellaneous: Pay As You Go (PAYG) in Africa and South East Asia for access to solar electricity, Conditional cash transfers for using of clean energy sources, lease arrangements for stove are some of the other policy decisions taken by the Governments of low and middle resource countries.^[47-49]

Implications for further research

Even though pressing evidence is available to suggest role of HAP in causing adverse health outcomes in women, there are many areas amenable to research in this field. There is immense need to develop standardized exposure assessment tools to aid further research. Role of biomarkers in exposure assessment can also not be neglected. In addition, more epidemiological studies can be conducted to examine the role of HAP on non-respiratory illnesses like cardiovascular disease, cataract, adverse pregnancy outcomes, etc. Moreover, effectiveness of advocacy, behavioral and other technological interventions can be assessed by conducting randomized controlled trials across varied geographical regions in the world.

CONCLUSION

Household air pollution mainly impacts the health of women and children and also is an important cause for significant worldwide morbidity and mortality. Considering the fact that HAP can be prevented by use of cleaner fuels, mainstreaming this burning issue at a global platform is important. At the same time, effective interventions, in the form of advocacy, behavior change communication and technological interventions along with a strong political will to tackle the problem with adequate inter-sectoral coordination towards promoting better public health is the need of the hour.

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