

Impact of Indoor Air Pollution on Health in Lowto-Middle Income Countries

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Background and Study Objective



- Outdoor and indoor/household air pollution (IHAP) is highly prevalent across the globe, especially in low-to-middle income countries (LMICs)^{1,2}.
- Negative associations between IHAP and health and quality of life (QoL) of residents in LMICs have been found in several studies in the literature^{3,4}.
- Despite the need, there has been little work to categorize the risk factors (demographics, social, cultural, economic, and political) among residents from LMICs exposed to IHAP.
- The objective of this study was to conduct an updated review of the literature on the impact of IHAP on health and QoL among residents in LMICs.

Methods

- A systematic review of peer-reviewed articles published between January 2015 and March 2024 was conducted through manual searches from PubMed and Google.
- Abstracts and non-English articles were excluded from our search.
- Keywords included: indoor air pollution, health, quality of life, and low-to-middle income countries.
- Preferred Reporting Items for Systematic Review and Meta-Analyzes (PRISMA) guidelines were followed.

Results

Figure 1. PRISMA diagram of studies included in the review

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- The final number of studies included in this review was 118 [Figure 1].
- Factors contributing to increased IHAP in LMICs included low income, lower education status, residence type (rural vs urban), traditional use of cooking devices (biomass, solid fuels), poor ventilation, and indoor cigarette smoking (n=23).
- Of the 118 included articles, 55 reported a negative impact of IHAP on residents' health.
 - Most of these studies (n=29) showed associations with respiratory-related conditions, such as lung disease, pneumonia, COPD, asthma, and respiratory infections [Table 1].
 - Other conditions included general health (n=9), cardiovascular (n=8), depression, anxiety, and cognitive impairment (n=4), diabetes (n=2), cervical neoplasia (n=1), cancer (n=1), and arthritis (n=1) [Table 1].
- Several studies (n=21) showed impact of IHAP on maternal health and child-birth defects, stunting, and mortality (Table 1). Low birth weight, childbirth measurements, and linear growth among children were some of the commonly studied outcomes.
- QoL was found to be negatively associated with IHAP in one article [Table 1]. The St. Georges Respiratory Questionnaire, EuroQoL 5 Dimension 3 Level System (EQ-5D-3L), and the Patient Health Questionnaire 9 (PHQ-9) were used for evaluation of association between biomass smoke exposure and self-reported QoL measurements in tuberculosis patients in Uganda.
- Potential IHAP interventions studied included use of liquefied petroleum gas (LPG), improved cookstove use, outdoor cooking, improved housing, and wearable technologies (n=18) [Table 1].

Table 1: Distribution of the study articles by region and outcomes measures

Theme	Total number of studies	Specific country/regions studied#	Diseases studied/Outcome measures
Adult medical conditions	55		
Respiratory	29	Nepal, Maputo, India, Congo, Tanzania, Rwanda, China	Pneumonia; respiratory infections, illness/disease, symptoms, respiratory health; pulmonary tuberculosis; lung disease; COPD*; asthma; nasopharyngeal inflammation; lung function change
General health	9	Ethiopia, South Africa, China, India, Tanzania	Vulnerability to household emission from choice of cooking fuel to health risk; association between baseline co-morbidities and kerosene vs clean (gas or electricity) or solid fuel (biomass and coal) and health outcomes; associations between IHAP and outdoor air pollution and burden of disease
Cardiovascular	8	Albania, Peru, Honduras	High blood pressure; CVD**; cardiometabolic health; metabolic syndrome; blood lipid concentrations and waist circumference; angina pectoris
Mental health	4	India, Mexico	Depression; cognitive impairment/decline; anxiety symptoms
Diabetes	2	Honduras	Association between exposure to IHAP with HbA1C levels and diabetic status
Cervical neoplasia	1	Honduras	Association between burning wood in the kitchen and risk of cervical neoplasia
Cancer	1	Multiple LMICs	Use of kerosene on cancer risk
Arthritis	1	Multiple LMICs (China, Ghana, India, Mexico, Russian Federation, South Africa)	Association between household air pollution and arthritis
Children and women/maternal health	21	Nepal, Rwanda, Ghana, Guatemala, India, Peru, Uganda, Bangladesh, Ethiopia, Malawi, Nigeria, Sri Lanka, Honduras, Myanmar	Pneumonia morbidity and mortality; respiratory infections; adverse pregnancy outcomes; low birth weight; child survival/stillbirth; childhood stunting; leukocyte telomere length among toddlers; persistent childhood cough; birth outcomes; child cognitive abilities; atopy; child mortality; pneumococcal density related to nasopharyngeal inflammation; asthma; HbA1C and diabetes; linear growth among children
Quality of Life	1	Uganda	Biomass smoke exposure on QoL among patients treated for tuberculosis
Interventions	18	Ethiopia, India, Uganda, Vietnam, Kyrgyzstan, Honduras, Guatemala, Peru, Rwanda	Air pollution exposure monitoring; behavior change communication to promote modern cookstove purchase and use; indoor air pollution prevention practices; improved housing; exposure to nitrogen dioxide from biomass to LPG****; wearable devices; cadmium exposure; cooking outdoors or with cleaner fuels
Factors/variables associated with IHAP***	23	Ethiopia, Rwanda, Peru, South Africa, Bangladesh, Brazil, Chile, China, Colombia, India, Pakistan, Tanzania, Zimbabwe, Malawi, Nepal, Kenya	Facilitators/barriers to improved cookstove adoption; cooking activity patterns and perceptions of air quality interventions; perceptions of improved biomass and LPG stove use; determinants of solid fuel use; characterizing exposure to HAP^; geographic and socioeconomic variation in markers of IHAP; in- kitchen aerosol exposure; second-hand smoke exposure

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- Cooking style and type of material used for cooking, lack of appropriate ventilation, and indoor smoking remain the biggest sources of indoor air pollutants that are deemed to be harmful to health and downstream negative clinical and economic outcomes.
- Further research is needed from a cultural, geographic, economic, and practical perspective of implementing interventions that lead to an efficient monitoring, detection, and lowering of IHAP and subsequent clinical and economic outcomes^{5,6}.

Conclusions

Discussion

- With growing research and evidence generated on IHAP and its negative associations with residents' health and quality of life in LMICs, it becomes imperative to update and consolidate prior findings from systematic reviews.
- Our study provides a consolidated and specific approach to delineate the impact of IHAP on disease, QoL, factors associated with IHAP, and research on interventions and policy challenges.
- As has been found and reported previously, IHAP in LMICs is multi-factorial and leads to negative outcomes across many diseases. Moreover, symptoms associated with respiratory medical conditions were more prevalent.

#If mentioned (otherwise the study may be a systematic review of LMICs); *Chronic obstructive pulmonary disease; **Cardiovascular disease; ***Indoor/household air pollution; ****Liquefied petroleum gas; ^Household air pollution

- Residents in LMICs lack the necessary education, medical infrastructure, and financial resources to implement interventions to monitor, detect, and appropriately mitigate the negative impact of IHAP.
- Further research is warranted to identify perceptions and risk factors of IHAP as well as implementation of interventions to improve indoor air quality, health, and QoL in LMICs.



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