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A review: How does air quality feedback benefit the implementation of the smoke-free homes initiative?

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ABSTRACT

Introduction: Smoke-free regulations forbidding smoking in all indoor settings are perceived as effective. In Indonesia, 59,3% of adults were exposed to SHS from in-house smoking. Smoke-Free Homes (SFH) programs can potentially improve health outcomes and encourage smoke-free environments, but some challenges remain to be addressed. Air quality feedback can be used as an additional tool that provides objective information on how smoking affects the amounts of air pollutants in their home, as a promising technique to promote behavior change. This study aims to explore the usage of air quality feedback on the implementation of SFH.

Methods: A comprehensive literature review on PubMed entered from 2008-2024 was undertaken with the keywords "air quality AND feedback AND smoke-free".

Results: In total, the search identified 10 articles that met the inclusion criteria. Most of the constructs in the articles had similarities, so findings were abstracted into a table according to intervention, device, place-to-device installments, feedback delivery, measurement, duration, and outcome. Most of the study was conducted in high-income countries. SHS-related PM2.5 concentration was detected at home with 'Dylos' in the majority of the studies. The household was provided personalized information on the PM2.5 concentration using various media, including modern technology. The findings of this study showed varied results on the PM2.5 concentration. However, different strategies were needed in some disadvantaged and vulnerable populations to promote behavior change.

Conclusion: This study depicts the role of air quality feedback in supporting the implementation of SFH initiatives. The implementation of indoor air quality feedback has shown varying degrees of results in improving indoor air quality. Nonetheless, it is thought that air quality feedback is an affordable, practical, and accessible intervention that can be used in Low-Middle Income Countries (LMICs) to supplement the SFH initiatives.

Keywords: Air quality; feedback; personalized information; second-hand smoke; smoke-free home.
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INTRODUCTION

The tobacco epidemic is a global concern and a public health threat. Among 1.3 billion smokers worldwide, around 80% live in developing countries.[1] According to the World Health Organisation (WHO), exposure to second-hand smoke (SHS) was one of the main risk factors for fatalities globally in 2019, accounting for around 1.3 million deaths.[2] In comparison to other Southeast Asian countries, SHS exposure is highly prevalent in Indonesia. Around 44.13% of Indonesia's non-smokers were exposed to SHS.[3]

SHS appears by combusting tobacco products that are emitted by smokers around someone who does not smoke.[4] It was estimated that this exposure causes about 11 million disability-adjusted life years annually in the world.[5] According to WHO, over a million people die from heart disease, cancer, and other illnesses each year because of second-hand smoke.[6] The study by Andriani et al suggested that pregnant women who were exposed to SHS may give birth to children who have Low Birth Weights (LBW) and sizes.[7] In infants and children, SHS can result in many infections, Sudden Infant Death Syndrome (SIDS), meningitis, and asthma attacks.[8,9] For the elderly, especially those with pre-existing lung problems, lung cancer risk increases as a result of passive smoking.[10] It is worth noting that there is no acceptable amount of subjection to SHS.[11] Hence, preventing SHS exposure is urgently needed.

Most people are either exposed to SHS at home or a place of work.[12,13] As many as nearly 79% of mothers were exposed to SHS in their residences.[7] In Indonesia, 59,3% of adults were exposed to SHS from in-house smoking.[14] Additionally, a study by Rakesh et al found that 23,2% of senior high school students in Ernakulam, Southern India, were exposed to SHS from a family member.[15] The study in Northern Thailand showed that 46,8% of middle school students reported having SHS exposure at home, with the primary source of exposure from their father, followed by relation, number percentages of 45,4% and 24,1%, respectively.[4] Ironically, even though 80% of adults believe that SHS can cause serious illness, more than half of the adults are still being exposed to SHS inside their homes.[14] Meanwhile, people spend a minimum of two-thirds of their time at home. To protect individuals against SHS exposure, extensive smoke-free regulations that forbid indoor smoking are perceived as the only effective approach.[12] It is believed that the absence of a smoke-free regulation in a home was linked to and contributed to SHS exposure at home.[4]

To address the issue, in 2010-2018, Quit Tobacco International (QTI) was developing community-based smoke-free homes (SFH) and began with a community declaration in Yogyakarta, Indonesia. Following the developed country's lead in SFH implementation, QTI was a progressive move in Indonesia. U.S. households have already increased their prevalence of smoke-free home rules over the past 2 decades from 1992 to 2011.[13] This initiative sought to establish SFH through community participatory approaches and health promotion to protect non-smokers rather than ask smokers to quit smoking. Based on Padmawati et al, there is a crucial result in the implementation of SFH, there was an increase of 43% in smokers not smoking inside the home.[16] Positive feedback has emerged from this intervention that SFH has been officially declared in 135 urban communities in Yogyakarta as of 2018.[16] The same program was held in the Bantul District and presented positive results as well. According to a study conducted by Trisnowati et al, after one year of implementation, 55% of male smokers reported avoiding smoking around pregnant mothers (95%), children (78%), and non-smokers (56%).[17] In Indonesia, initiatives to promote smoke-free homes have been put in place to lessen SHS exposure, especially for vulnerable populations.

SFH programs can potentially improve health outcomes and encourage smoke-free environments, but some challenges remain to be addressed. Some communities in Indonesia view smoking as socially acceptable, which makes it laborious to enforce a smoke-free home in household settings, especially in rural areas.[17] Some tobacco users had severe addictions to smoking, as one of the common challenges.[18] The resistance to change, especially in health promotion, is related to skepticism towards science, medicine, and health professionals.[19] To address this challenge, raising awareness about the hazards to one's health posed by SHS exposure through educational material and public campaigns is not sufficient. Feedback on air quality can be utilized as an additional tool that provides objective information on how smoking affects the amounts of air pollutants in their home, as a promising technique.[20,21] This approach is considered low-cost; it may serve as motivation and actionable information for individuals to alter their behavior and promote SFH.[22] Through these combined initiatives, it will be able to accommodate the concern about individual autonomy to mitigate the resistance issue in behavior change.[19] Relevant health communication is crucial to promote optimal results and continuum care, as well as promoting awareness and appropriate responses to numerous challenges.[23]

None of the existing SFH programs in Indonesia has delivered air quality feedback, with most of the studies related to it having been conducted in high-income countries and overlooked in LMICs.[22,24] This study aims to explore the usage of air quality feedback on the implementation of SFH and the impact on behavior change. Therefore, it can contribute to complementing and developing the existing SFH program (short-term) and support the possibility of increasing the smoking cessation rate (long-term).

METHOD

We performed a literature review on PubMed entries from 2008-2024. Search terms used for the database including "air quality AND feedback AND smoke-free" to search all fields. In total, the search yielded 23 articles (Figure 1). If the title were insufficient to identify whether the content was relevant enough to meet the selection criteria, the abstract would be

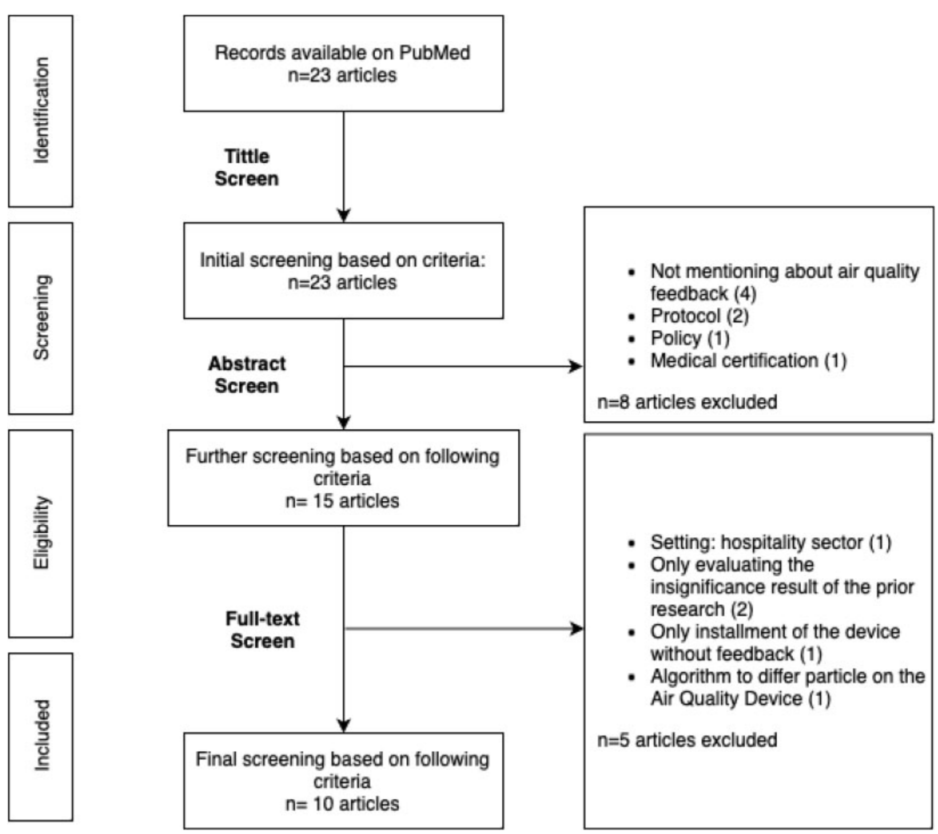

Figure 1. Selection process for the literature as it is recommended by PRISMA.

reviewed. The full paper was reviewed in cases where the abstracts did not provide clear guidance on the exclusion criteria. Title, abstract, and full texts were then filtered to ascertain alignment with the requirements listed: (1) English language, (2) Randomized controlled trial, experimental study, or feasibility study, (3) Home setting, (4) Reported on baseline data, implementation, and evaluation of SFH. Literature that didn't fit the inclusion criteria was excluded. Some of the articles were excluded considering the second criterion because they performed as protocol or policy. Even though the articles used a suitable design considering the third criterion, one article used the hospitality sector as its setting. Other reasons for exclusion were the absence of feedback results and only explaining the algorithm of the device. In total, 10 articles published during 2013-2022 were selected for inclusion criteria.

Data from 10 included articles were extracted, organized, and managed using Excel spreadsheets. Study characteristics were abstracted into a table according to publication year, location, study design, study method, population, age, gender, sample size, and history of smoking. Most of the constructs in all the articles had similarities, so findings were abstracted into a table according to intervention, used device, place-to-device installment, feedback delivery, measurement, duration, and outcome. Settings of where the described participant homes were summarized in narrative form because they varied from each article.

RESULTS

This study employs three study designs, of which four of the identified studies used the RCT design.[5,11,24,25] Further study with a quasi-experimental study without a comparison group[21], and five included articles employing feasibility studies.[9,18,22,26,27] The analysis's investigations encompass a wide range of geographical areas, including multiple nations, with most of the study being conducted in high-income countries, particularly before 2021. Two reported papers were conducted in the United States[11,26], with other papers carried out in European countries, including three from Scotland[5,9,21], and one from England[27], one from the UK[25], one from Greece[21], one from Italy[21], one from Catalonia[21], and another study conducted in Israel, West Asia[18]. Two papers from Low-Middle Income Countries (LMICs) were published in 2021-2022, including one from Bangladesh[24] and one from Malaysia[22]. The sample sizes across these studies vary widely, ranging from 4 to 1350 participants, with average adult age ranging from 21 to 54 years old (Table 1).

The most used method to gather the data was quantitative.[5,11,18,22,24,25] and the others were mixed method studies.[9,21,26,27] The qualitative interview process was conducted using a telephone in two papers.[9,21] The population of the interventions varied, encompassing households with smokers and non-smoking residents of any age,[24] children may be present,[26] living with children under 14 years of age,[11] under 16 years of age,[9,22] under 8 years of age,[18] under 6 years of age,[9] or under 5 years of age.[27] One paper focused on disadvantaged mothers[5] and another paper emphasized the population of smokers who were admitted to acute medical wards and have undergone discharge planning to receive intervention at home.[25]

The home setting of participants where people usually were able to smoke was described to vary. There are a few designated indoor spaces where smoking is permitted by family members, whether by the smokers themselves or non-smokers, such as attached garages, balconies, living rooms/lounges, bedrooms, toilets, kitchens, and dining/utility rooms.[22,26] As many as 53,6% of participants have outside space in their homes.[24] In one study, smoking regulations at home were discussed, and all respondents stated that smoking was allowed inside the home.[21]

Air quality monitor devices

SHS-related PM2.5 concentration was detected at home with Dylos in most of the studies,[5,11,21,23,24,26] Three studies used SidePak,[25,27] and one of which also combined SidePak and Dylos,[18] and only one study installed Purple Air.[22] The Dylos is a low-cost device (US $400-425) that functions almost silently, is easy to use, and can measure in-home air quality every 10 seconds[5,11,18]. Cheaper than Dylos, Purple Air only costs US$ 279.[22] Purple Air is a portable device that is also able to measure and log real-time PM2.5 concentration in both indoor and outdoor settings every 120 seconds.[22] The Side Pak is a device that measures the mass concentration of particles by light scattering.[27] It costs $4000, the highest device compared to Dylos and Purple Air.[18] A comparison between the household's average 24-hour PM2.5 concentration and the WHO daily PM2.5 Guideline as a health-based standard for air quality was one of the feedback items in all studies (Table 2).

Based on Table 2, the majority of the studies placed the device in the main living room area inside the house.[5,21,22,25–27] is believed that the living room is the place where household members congregate and spend the majority of their time inside the home.[5] Placing the device in the living room offers a representative of an individual's exposure at home.[21] To bring objective information, especially to protect the vulnerable population, the device can be installed in the bedroom where a child or pregnant woman sleeps.[11,26] The device needs to be installed between 50 to 100 cm above the ground, distance from open windows and the main house entrance, and avoid obvious sources of PM such as cookers.[21,22]

Feedback delivery techniques

Most studies provided a graph of air quality monitoring to be explained to the participant.[18,21,24–27] Studies reported the use of media education in the feedback process, such as leaflets,[24] pamphlets,[5] short booklets, and videos.[22] The usage of modern technology can be integrated into the feedback process using SMS or email.[21] Remote feedback was able to be delivered using the telephone in two studies,[21,22] one of the reasons due to the social restrictions of COVID-19.[22] (Table 3)

A challenge in promoting air quality feedback was participants' conclusions that tobacco smoke was not hazardous since the level of PM2.5 concentration by smoking sources is lower than non-smoking sources, such as domestic activities, so the graph could be unhelpful.[18] To address this issue, participants were asked to complete a diary that contains a record

Table 1. Summary of the characteristics of 10 included articles

No	Lead Author	Year	Location	Design	Method	Population	Age in year	Gender (n(%))	Sample (n)	Current smokers and non-smokers
1	Mdege *et al*[24]	2021	Mirpur, Dhaka, Bangladesh	Three-arm, Cluster RCT	Quantitative	Families who live with at least one adult smoker and one non-smoking resident of any age	Mean (SD): 40.6 (12.5) Median (range):38.1 (20.1–85.5)	Male: 1277 (94.6%) Female: 73 (5·4%)	1350	Number of adult resident smokers Mean (SD): 1.1 (0.3) Median (range): 1.0 (0.0–3.0)
2	Berardi *et al*[11]	2022	San Diego County, California	RCT	Quantitative	Families with children who also have at least one adult smoker	Mean: 32.94 (adults) 4.06 (children)	NA	298	NA
3	Semple *et al*[5]	2018	Scotland	RCT	Quantitative	Disadvantaged mothers	Mean (range): 21.6 (17–43)	Female: 117 (100%)	117	Smokers n(%): 81 (69%)
4	Dobson *et al*[21]	2020	Centres in Scotland, Greece, Catalonia, and Italia	Pre-post study (quasi-experimental study without comparison group)	Quantitative Qualitative (telephone interview)	Households with at least one in-home smokers or non-smoker who live with in-home smokers and take care of children	NA	NA	86	NA
5	Zulkifli *et al*[22]	2022	Malaysia	Feasibility study	Quantitative	Households with at least one smoker or nonsmoker who live with smokers and children	Total (%) 18–24: 2 (7.4) 25–54: 21 (77.7) ≥55–64: 4 (14.8)	Male: 24 (88.9%) Female: 3 (11.1%)	27	Other people smoke in their homes: n(%) 0= 11 (40.7%) ≥1 = 16 (59.2%)
6	Dobson *et al*[9]	2017	Scotland	Feasibility study	Quantitative Qualitative (individual telephone interview)	Parents of children under 6 years old who reside in a house where there is a smoker	NA	NA	4	NA
7	Klepeis *et al*[26]	2013	San Diego County, California	Feasibility study	Quantitative Qualitative (Focus Group Discussion)	Families who with a minimum of m one adult smoker and may be living with children	Mean (range): 36 (18-52)	Male: 6 (46%) Female: 7 (54%)	13	Smokers: 77%
8	Marsh *et al*[27]	2016	England	Feasibility study	Quantitative Qualitative (in-depth interview)	In-home smokers and living with children	Mean (range): Phase 1: 27 (23–31) Phase 2: 26 (21–34)	NA	12 (phase 1=6, phase 2=6)	NA
9	Rosen *et al*[18]	2015	Israel	Feasibility study	Quantitative	Parents with at least one of them are smokers and living with children	Mean (SD): 3.4 ((±)2.2) Range: 9 months–8.5 years(children)	Male: 12 Female: 16	29	Smokers: 20 participants Partner of smokers: 9
10	Thorley *et al*[25]	2019	UK	RCT	Quantitative	Smokers aged > 18 admitted to acute medical wards	Mean (SD): 54.77 (14.50)	Female: 158 (39.11%) Male: 246 (60.89%)	404	Year of smoking: n (%) < 1= 1 (0.26%) 1–10= 25 (6.53%) 11–20=53(13.84%) 21–40=146(38.1%) 41+= 158 (41.25%) Live with other smokers: 144 (37.11%)

*)NA= Not Availablee

Table 2. Summary of device to measure indoor air quality in 10 included articles

No	Lead Author	Device	Place to Install	Comparison	Duration of Installment
1	Mdege *et al*, 2021[24]	Dylos DC 1700	Place in the home (not specific)	WHO daily PM 2.5 Guideline	NA
2	Berardi *et al*, 2022[11]	Dylos DC1700	Room nearest to where most smoking occurred and in the child's bedroom	WHO daily PM 2.5 Guideline	90 days
3	Semple *et al*, 2018[5]	Dylos DC1700	Main living room area of the house	WHO daily PM 2.5 Guideline	3–7 days on three occasions (baseline, +1 month post-intervention, +6 months post-intervention)
4	Dobson *et al*, 2020[21]	Dylos DC1700	Main living room area of the house	WHO daily PM 2.5 Guideline	30 days
5	Zulkifli *et al*, 2022[22]	Purple Air-II-SD	Main living room or the main house entrance	WHO daily PM 2.5 Guideline	minimum of 7 full days (24-h)
6	Dobson *et al*, 2017[9]	Dylos DC1700	Place in the home (not specific)	WHO daily PM 2.5 Guideline	5 days
7	Klepeis *et al*, 2013[26]	Dylos DC1100	First monitor: Open living, dining, or kitchen area Second monitor: Bedroom where a child or pregnant woman slept	WHO daily PM 2.5 Guideline	7 days
8	Marsh *et al*, 2016[27]	SidePak AM510	Main living room area of the house	WHO daily PM 2.5 Guideline	up to 2 days at baseline, week 7, and week 12
9	Rosen *et al*, 2015[18]	SidePak AM510 and Dylos	Central area in the home (not specific)	WHO daily PM 2.5 Guideline	1 day
10	Thorley *et al*, 2019[25]	Sidepak AM510	Main living room area of the house	WHO daily PM 2.5 Guideline	24-48 h, 4 weeks, 3 months post-discharge from hospital

*)NA= Not Available

of the number of cigarettes smoked, the time spent smoking, the particular area within the home where smoking occurs, and household ventilation behavior.[22,26] It is worth noting that there were different numbers of air changes due to different temperature climates between European countries and tropical countries, which led to varying levels of dilution ventilation.[22] Participants need to track some other resources of PM2.5 concentration, for instance, emissions from solid fuels, vehicles, heating, industrial, and environmental exposure.[18,24] Additionally, other potential sources of PM2.5 concentration from household activities were also noted in the diary, such as cooking, burning food, wood burning, cleaning, candles, outdoor grilling, incense, car emissions, woodworking, renovation, vaporizers, and aerosol goods consuming.[18,24,26] Before making the daily diary, residents were explained the list of examples of non-tobacco sources that need to be noted.[26] Daily diary helps to match the graph and activities, and it can identify the type of aerosol that the monitor was able to identify.[26]

The impact of air quality feedback on PM2.5 concentration

After a half year of follow-up, the average 24-h PM2.5 concentration was more than 60 μg/m^3 (classified as unhealthy) in the SFH intervention with indoor air quality feedback, a bit higher than the usual service group.[24] One study compared between interventions and found that the mean (range) PM2.5 concentration of 61.4 (5.1–295) μg/m3 in the intervention group plus standard care was less than the standard group, but insignificant (p=0,418).[5] One study compared data from baseline and follow-up phases and found that all four households' average PM2.5 concentration levels decreased after the intervention, however, statistical significance was not possible due to the limited sample size.[9] The average measured of PM2.5 concentration was 0.5 μg/m3 (range from 11-239 μg/m3) at baseline and 66 μg/m3 (range from 6-201 μg/m3) at follow-up.[9] Between baseline and follow-up evaluations, there was no statistically significant difference for the indoor PM2.5 concentrations (Z= -1.27, p=0.20) and the median of baseline PM2.5 concentrations being 38.9 μg/m3 and 32.9 μg/m3, respectively.[22]

The air quality feedback increased the likelihood that, on a given day, the kid bedroom's PM2.5 concentration levels were below the WHO indoor air quality limit, according to the statistically significant group-by-phase interaction term (p<0,001).[11] Mean PM2.5 concentration significantly reduced by about 19% and a median of 3.3% in percentage time spent over the WHO guideline limit for PM2.5 over 24 h in the home from baseline to follow-up (p=0.012).[21] The significant reduction of PM2.5 concentration between data from baseline and follow-up periods showed a median reduction of −19% (-4.1 μg/m3).[21] The reduction of SHS-PM2.5

Table 3. Summary of interventions from 10 included articles

No	Lead Author	Intervention	Feedback Delivery	Instruments	Outcomes			
					Increased maintenance and established SFH	Reduction of average PM2.5 concentration	The proportion of time that measured PM2.5 values over 24-h exceeded the WHO's guideline	Reduction number of cigarettes smoked
1	Mdege *et al*, 2021[24]	Smoke-free home intervention plus indoor-air quality feedback	Leaflet, pictorial information, 10 mins discussion with household members in person with trial investigators (1-to-1).	St George's Respiratory Questionnaire (SGRQ), EQ-5D-5L, EQ-5D-Y, Pediatric Quality of Life Inventory (PedsQL)		NS		
2	Berardi *et al*, 2022[11]	Indoor air quality feedback	Immediate feedback	NA	SIG	SIG		
3	Semple et al, 2018[5]	Standard UK National Health Service (NHS) Advice plus personalized air quality feedback	Pamphlet, 1-to-1 discussion between First Step (FS) worker and mother.	A short baseline questionnaire		NS		
4	Dobson *et al*, 2020[21]	Indoor air quality feedback	Personalized feedback was provided via SMS and email containing a graph of air quality to the smoker, and was discussed with the smoker along with goal setting and exploration of suitable methods of behavior change by telephone	A stage of the change assessment questionnaire		SIG	SIG	
5	Zulkifli *et al*, 2022[22]	Indoor air quality feedback	A smoking diary, short booklet, video about the guidance of PA-II-SD, A personalized feedback report, short personalized-feedback intervention call (remote)	Air quality questionnaire		NS		SIG (smoke indoors)
6	Dobson *et al*, 2017[9]	Indoor air quality feedback	An air quality report was given to the parent by a support worker. The second report included a comparison sheet	NA		NS		
7	Klepeis *et al*, 2013[26]	Indoor air quality feedback	Parents were shown graphs of air quality monitoring, daily dairy	Short self-administered screening questionnaire, Baseline and post-intervention questionnaire				
8	Marsh *et al*,2016[27]	Behavioral support plus a supply of NRT plus indoor air quality and cotinine saliva sample feedback	Personalized graphical feedback on home air quality was provided to caregivers using Microsoft Excel and verbal feedback	NA				
9	Rosen *et al*, 2015[18]	Motivational interviews, indoor air quality feedback, cotinine hair sample feedback, website.	Parents were shown selected graphs obtained from the 8-h PM air quality session	NA				
10	Thorley *et al*, 2019[25]	Smoking cessation pharmacotherapy and behavioral support (NICE PH48 guidelines standard) plus indoor quality feedback	Participants were shown a graph	Baseline questionnaire				NS

*)NA= Not Available, NS= Not Significance, SIG=Significance

concentration (5,29% to 77%) was shown in nearly 63% of participants.[22]

The impact of air quality feedback on behavior-changing

Two studies depicted the outcome of a reduction in the number of cigarettes smoked; one showed a significant decrease,[22] and another showed an insignificant result.[25] (Table 3) The insignificance result from the study might occur due to a short period of intervention,[24] and characteristics of the population, such as vulnerable families.[5] Based on qualitative results, participants showed changes in their smoking behavior, such as making changes to how, where, and when they smoked.[9,21] The residents started smoking outside of the home, or still smoking inside, but with the window open.[9,21]

The Project Fresh Air (PFA) with air quality feedback as its intervention also changed parents' indoor smoking behavior.[11] Another behavior change reported such as smoking consumption reduction.[21] Quantitatively, there was a difference in the mean±SD number of cigarettes smoked inside between the baseline and follow-up measurements among 23 subjects who kept complete smoking diaries, from 46±36 sticks to 35±39 sticks. During the follow-up assessment, 54% of individuals reduced their indoor smoking habit.[22] A statistically significant change in total number of cigarettes smoked indoors at baseline (median 40) and follow-up (median 26) measurements was demonstrated ($Z= -2.436$, $p=0.015$).[22] The self-reported number of cigarettes smoked reported that there was a decrease in intervention from a median of 15 (range = 9–20) to 3 (range = 0–10), respectively, but this difference was not significant.[25] It is believed that the most critical and impactful element of encouraging SHS-reducing behavior is personalized feedback.[25] However, different strategies were needed in some disadvantaged and vulnerable populations to promote behavior change. Encouragement and nonjudgmental support, together with personalized air quality feedback, are essential in encouraging participants to start and continue changing their indoor smoking habits.[25]

Feasibility and acceptability of air quality feedback to support SFH

Two studies from LMICs showed different results. In Bangladesh, these interventions are therefore not recommended.[24] The possible reasons why air quality feedback was not acceptable or did not have a significant impact were that health messages delivered were not in mandatory situations, and people were not showing interest,[24] delayed feedback of air quality monitoring,[24] variability in feedback-delivery sessions,[22] small sample size,[22] and the disadvantages experiences by the group, like the lack of support and opportunity to make a change.[5] Meanwhile, in Malaysia, air quality feedback has a potential impact to contribute to the effort of implementing SFH.[22] The intervention was also acceptable for the caregivers.[9] The successful reason for the intervention was immediate feedback, real-time, and actionable information to protect their loved ones.[11] According to qualitative results, two of eight (25%) participants reported that they had created a complete SFH.[21] The intervention can increase the likelihood of establishing and maintaining SFH ($p<0,03$).[11] According to one study, participants responded positively to the idea of monitoring the air quality in their homes and were eager to find out more information.[26] They liked the audio and visual feedback (green =clean; orange/ yellow = warning; red = danger) from the device to alert the levels of air quality in their home.[26] Air quality feedback reports were understandable and impactful.[9,18] Air quality feedback motivated participants to create SFH and reduce the level of PM2.5 concentration.[25]

To support the SFH program, there was a discussion between workers and participants about the methods for conveying to other smokers about the SHS issue, such as a smoke-free website and mobile apps containing several materials to help develop SFH.[18,25] The objective data from the air particle monitors can be incorporated into supportive health education and counseling by medical experts working in the current healthcare system.[5,11] A study involved the facilitator sharing their experience with air quality monitoring; it was said that the intervention was feasible and potentially changed indoor smoking behavior.[9] Some barriers mentioned in creating smoke-free homes and smoking outside the home, such as mental health status, poor weather conditions, and sole caring responsibilities.[21,25] Thus, it is crucial to evaluate in the early stages or when participants have trouble maintaining the change.[25]

DISCUSSION

To the best of our knowledge, this is the first literature review of the evidence that looked at the usage of air quality feedback in home settings and its impact on supporting SFH initiatives. We considered strategies for delivering input and the device as important elements for implementing indoor air quality feedback. We did not limit our searches to any country or period, which is one of the literature review's strengths. Further, we extracted data and made selections using a systematic methodology. We highlight studies with robust methods, such as RCTs, quasi-experiments, and feasibility studies. We also acknowledge the sample size as it tends to provide evidence of reliable and generalizable results.

Limitations of this review include the fact that we excluded settings outside the home, such as the public sector. In this study, we only include one database, PubMed, which is one of the largest and most widely used databases for accessing articles in the fields of medicine, healthcare, and related disciplines. It is possible that some evidence related to air quality feedback could be included in other databases. We recognize heterogeneity among the included studies, including variations in populations, interventions, or outcome measures, which may complicate comparisons and synthesis of the literature.

Findings from the article provide valuable insights that can inform community practice and policy efforts aimed at promoting smoke-free environments by providing a method to evaluate an intervention. This article suggests that personalized air quality feedback, delivered through various methods such as the combination of 1-to-1 discussions, visual aids (such as graphs, reports, leaflets, and pamphlets), and immediate feedback, can be effective in motivating behavior change. Community practitioners can use this insight to develop targeted intervention strategies tailored to the specific needs and preferences of different populations, thereby increasing the likelihood of success. Community practitioners play a crucial role in raising awareness about the harmful effects of SHS exposure and the importance of maintaining SFH, especially in the discussion process. This study can be used as evidence to design educational materials and awareness campaigns that highlight the role of smoking outside the home in promoting healthier living environments, not stopping smoking, but promoting smoking outside the home to protect non-smokers.

Policymakers can use the evidence from this study to inform the development and implementation of policies aimed at reducing SHS exposure in homes. This may include initiatives such as providing funding or incentives for the adoption of indoor air quality monitoring devices, as well as incorporating air quality feedback components into existing smoke-free legislation. Policymakers can use this information to prioritize resources and support services for vulnerable groups such as children and pregnant women, who may be particularly susceptible to the harmful effects of SHS. By incorporating air quality feedback into existing smoke-free initiatives, practitioners, and policymakers can take meaningful action to improve public health outcomes and create healthier communities.

CONCLUSION

This study depicts the role of air quality feedback in supporting the implementation of SFH initiatives. The implementation of indoor air quality feedback has shown varying degrees of results in improving indoor quality. Nonetheless, it is thought that air quality feedback is an affordable, practical, and accessible intervention that can be used in Low-Middle Income Countries (LMICs) to supplement the SFH initiatives. By providing tangible and objective data, these interventions empower individuals to make informed decisions regarding how, when, and where they smoke and the enforcement of smoke-free policies within their homes. The feedback delivery serves as a pivot aspect in the successful implementation, including the method and content. Moreover, such feedback mechanisms can serve as valuable tools for conveying to people the negative impacts of SHS and promoting healthier indoor environments, so a daily diary is crucially needed to support the monitoring result. Ultimately, the integration of air quality feedback complements SFH initiatives by fostering accountability, promoting behavioral change, and improving the well-being of households and the environment.

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CONFLICT OF INTEREST

We have no conflicts of interest to declare. We have seen and agree with the content of the manuscript, and there is no financial interest to report.

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AUTHOR CONTRIBUTION

The authors confirm contribution to the paper as follows: study conception and design: B.S.B; data collection: D.M.A.S; analysis and interpretation of results: D.M.A.S; draft manuscript preparation: D.M.A.S; supervising the findings of this work; B.S.B. All authors discussed and reviewed the results and approved the final version of the manuscript.

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