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Exploring community-based participatory research for household and ambient air pollution projects: insights from key informants

Eunice Phillip^{1*}, Aisling Walsh¹, Sarah Jewitt², Farah Elnakoury³, Joella Simon³, Ronán M Conroy¹ and Debbi Stanistreet¹

Abstract

Background Despite the extensive use of community-based participatory research (CBPR) in health-related projects, there is limited work on how CBPR processes result in outcomes, especially in household and ambient air pollution (HAAP) research. This study explores the reflections of key informants on factors that shape the implementation and outcomes of CBPR in HAAP projects.

Methods We conducted semi-structured interviews with 13 key stakeholders, including academic researchers, non-governmental organisation administrators, a policymaker, and community members. All interviewees have experience in CBPR projects. Interviews were analysed using framework analysis, and findings were mapped to Wallerstein et al.'s CBPR conceptual model, which consists of four constructs: context, partnership processes, intervention and research, and outcomes.

Results The findings are described under two main categories: 'barriers to participation' and 'good practices for effective CBPR design and implementation'. Relevant sub-categories were barriers at the structural, research, community, and individual levels. Suggestions for good practices included respect, cultural humility, trust, effective communication, suitable and affordable interventions such as improved cookstoves, appropriate participatory research tools, and gratuity for the community's time.

Conclusion Key informants' perspectives identified factors supported by the CBPR model to inform the design and implementation of the CBPR approach. The add-ons to some of the model's factors, such as intra-community dynamics, give value to the informants' knowledge to support community-research partnerships and improve outcomes in HAAP intervention projects. Addressing these factors at the design stage and reporting CBPR evaluation could deepen the understanding of community-research partnerships.

Keywords CBPR, Participatory approach, Air pollution, Framework analysis, CBPR principles, CBPR conceptual model

*Correspondence:

Eunice Phillip
eunicephillip@rcsi.ie

¹Department of Public Health and Epidemiology, School of Population Health, Royal College of Surgeons in Ireland, University of Medicine and Health Sciences, Dublin D02DH60, Ireland

²Faculty of Social Sciences, School of Geography, University of Nottingham, Nottingham NG7 2RD, UK

³Department of Medicine, Royal College of Surgeons in Ireland, University of Medicine and Health Sciences, Dublin D02DH60, Ireland



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Background

Poor access to, and affordability of clean and modern energy leaves most households in low-income communities/countries (LICs) exposed to pollutants from burning biomass fuels (e.g., wood, charcoal, or dung) on inefficient stoves in poorly ventilated dwellings. The pollutants, which include small particulate matter (PM_{2.5}), carbon monoxide and nitrogen oxides, are linked to ill health and death due to chronic respiratory diseases, cardiovascular diseases, and stillbirth [1–4]. They also contribute to climate change [4]. Studies of uptake and sustained use of interim solutions such as improved biomass cookstoves and kitchen ventilation have identified several barriers. These barriers include cost, effectiveness and, notably, limited user involvement in the design, implementation, and delivery of HAAP interventions [5, 6]. Addressing these barriers could improve outcomes of sustainable development goals (SDGs) 7.1 (access to affordable, reliable, and modern energy) [7], 3.9 (reduce mortality from environmental pollution) [8], and 13.3 (build knowledge and capacity to meet climate change) [9].

Evidence suggests that participatory approaches, such as CBPR, participatory action research and community-engaged research, are essential to improving health and power disparities in health research, especially in vulnerable communities [10, 11]. Reports show that CBPR contributes to the effective delivery and adoption of complex interventions aimed at improving health outcomes in projects such as HIV/AIDS [12, 13], water and sanitation [14, 15], and improved cookstoves [16]. Furthermore, the CBPR approach can lead to community-level systemic changes, enhanced learning opportunities, sustained health efforts, spin-off projects, enhanced community capacity, co-governance, and project sustainability beyond its lifespan [17–19].

Some of these benefits, such as the sustained use of interventions and systemic changes, suggest that CBPR can durably increase the uptake and adoption of HAAP interventions. For example, Jerneck and Olsson [16] tied their project's success to CBPR. Improvements in their cookstove design, production, and adoption were augmented by engaging a small farming community in sub-Saharan Africa (SSA) in cleaner cooking and reducing carbon emissions [16]. Similarly, in Matavel et al.'s study [20], the adoption of improved cookstoves in 40 communities in central Mozambique was stimulated by enhancing their capacity-building through training and involving the community in cookstove design, implementation, and maintenance. However, Ronzi et al., found that engaging and incorporating participants' perspectives at all stages did not necessarily lead to the uptake of cleaner cooking fuels [21]. Although their study associated the low uptake with socio-economic factors, no link was made between

the CBPR approach and the study outcomes, representing a gap in HAAP studies [22].

An enhanced understanding of participatory factors such as those described in Wallerstein et al.'s CBPR conceptual model could be essential to support equitable community and academic partnerships that inform and improve the sustainability of air pollution interventions. Wallerstein et al.'s CBPR conceptual model [10] identifies how dynamic interactions across four domains (contexts, partnership processes, intervention and research, and outcomes) facilitate the adaptation of CBPR principles in ways that create equitable partnerships and project outcomes (Fig. 1). Empirical testing of this model for its validity and suitability in describing the relational pathway of the CBPR constructs [23–25] made it suitable for mapping informants' perceptions of factors that shape the operationalisation of CBPR in health-related projects in LICs. This study drew on the experiences of key informants (KI) of implementing CBPR in low-income contexts to inform the design and implementation of Wallerstein et al.'s CBPR conceptual model for a HAAP study.

This study is part of 'The Smokeless Village Project' (TSVP), an intervention project aimed at using a community-led approach to reduce household and ambient pollution in a rural community in Malawi. The project is described here: <https://www.rcsi.com/impact/details/2023/03/a-community-led-approach-to-improving-health-in-malawi> and further in a previous study which explored existing community practices and their relationship with HAAP [26].

Methods

This paper employed a qualitative method to explore the individual experiences of 13 key informants who had experience in CBPR health intervention projects in LICs.

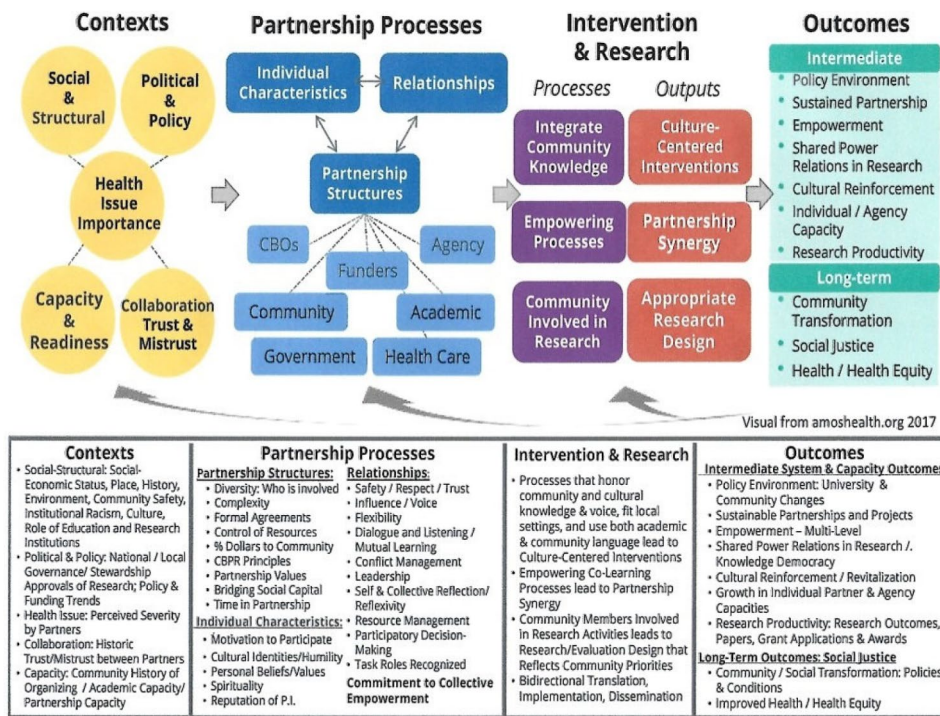
The study was approved by the *College of Medicine Research and Research Ethical Committee*, Blantyre, Malawi (P.03/21/3279) and the *Research Ethics Committee, Royal College of Surgeons in Ireland (RCSI)*, Dublin, Ireland (212558360).

Sampling of participants

Participants were identified using purposive sampling drawn mainly from the TSVP research team and steering group members. For community-member participants, community leaders at the TSVP site suggested members who have been active in community development projects. Additional information on sampling and recruitment is available in Additional File 1.

The study sample ($n=13$) consisted of six academic researchers (group A), one policymaker and one non-governmental organisation (NGO) leader (group B), and five community members (group C). The five academic

Adapted from Wallerstein et al, 2008 & Wallerstein and Duran, 2010, <https://cpr.unm.edu/research-projects/cbpr-project/cbpr-model.html>



Visual from amoshealth.org 2017

Fig. 1 Wallerstein et al.'s CBPR conceptual model. Available at <https://engageforequity.org/cbpr-model/full-model/> re-accessed 24/07/2023

Table 1 Description and characteristics of key informants' groups and mode of interview delivery

Interview group and selection criteria	ID	Key informant affiliation	Key informant location	Inter-view format
A: Academic researchers with field-based expertise or leadership in health intervention projects who are TSVP team members or collaborators.	KI1	University, Population Health	HIC	Video Interview (Microsoft Teams)
	KI2	University, Geography	HIC	
	KI3	University, Population Health	HIC	
	KI4	University, Public Health, Bioethics	LIC	
	KI5	University, Engineering	HIC	
	KI6	Government, Health service, Water and Sanitation Hygiene specialist	HIC	
B: Policymaker and NGO leaders directly involved at an organisation or government level, decision-making, planning, and implementing health initiatives in communities.	KI8	Non-government organisation (Energy)	LIC	Video Interview (Microsoft Teams)
	KI9	Policymaker (Energy)	LIC	
C: Community members who have been residents for two years or more in Nsungwi village or worked for 5 years or more in the community.	KI10	Community leader	LIC	Face-to-face
	KI11	Community health surveillance assistant	LIC	
	KI12	Community homemaker	LIC	
	KI13	Community farmer	LIC	
	KI14	Community farmer (HIV activist)	LIC	

researchers were from high-income countries (HICs), while all other participants were from LICs. All group A members had extensive social research experience, and all participants had CBPR experience in LICs (Table 1).

Data collection

Between August and November 2021, EP, a PhD researcher, carried out the semi-structured interviews.

An interview guide informed by Israel et al.'s nine principles of CBPR [27] was developed for each participant group by EP under the guidance of experienced qualitative researchers AW, DS, and SJ. The nine principles are a set of guides to facilitate commitment to equity and power sharing in research processes and actions [27]. The interview guides focused on the following:

- Participants’ engagement in, and description of past health-related research or projects.
- Reflections of the participatory approach processes, including barriers and facilitators.
- Recommendations for designing and implementing the CBPR approach for a planned HAAP project.

All interviews were carried out in the English language except for three community member interviews, which were conducted in the Chichewa language. In this instance, an interpreter who was not a community member (to ensure confidentiality) was hired to assist with translation. All the participants received an information leaflet, and written consent was obtained prior to the interviews. Each interview lasted approximately one hour and was audio (face-to-face) and video (Microsoft Teams®) recorded.

Data analysis

We followed Gale et al.’s seven steps to framework analysis method [28]. A full description of our analysis is provided in Additional file 2 and described briefly here. Analysis included verbatim transcription of all interviews and familiarisation by reading through and cross-checking with the recordings [28]. Transcripts were open coded inductively and assigned descriptive labels. The labels were reviewed and grouped to form a working analytic framework to code and index the transcripts. Recurring codes were grouped as categories and sub-categories and subsequently merged and/or relabelled as needed (see Additional file 3). Each participant’s responses were

summarised and charted in the corresponding cells of the framework matrix (See Additional files 4 and 5). Patterns compared within and across the participant’s groups aided the interpretation and reporting of findings. We subsequently mapped the findings to Wallerstein et al.’s CBPR conceptual model in our discussion session. Analysis was done in NVivo analysis software (Version 12) [29] and in Excel®.

Results

The two categories identified are ‘barriers to participation’ and ‘good practices to effective CBPR design and implementation’ (Fig. 2). Barriers to participation were captured under four sub-categories at four levels: ‘structural’; ‘research’; ‘community’; and ‘individual’ levels. Subcategories within the CBPR good practices category include ‘promoting participation’ and ‘enhancing sustainability’.

Barriers to participation

Informants were asked about operationalising the CBPR approach based on their experience with health intervention projects. Their responses featured several barriers at the structural, research, community, and personal levels (Fig. 2)

Structural level barriers

Informants in groups A and B reflected on the challenges of research funding and the technical difficulties of involving the community at every stage of the research. They emphasised that the funding system and ethical

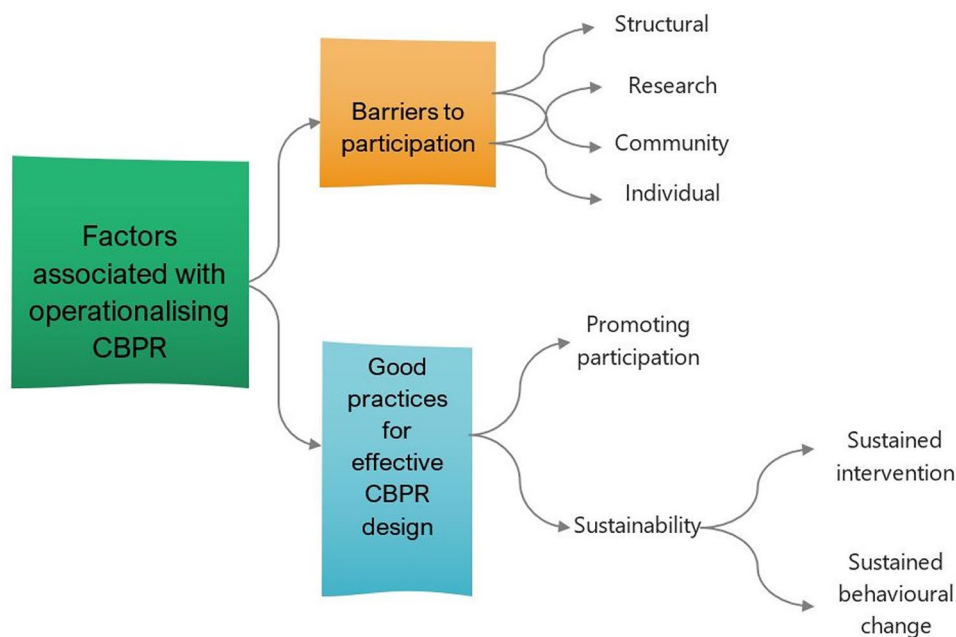


Fig. 2 Barriers to participation and good practice for sustained intervention use and behaviour change: The figure shows the interlinking and multi-level categories and sub-categories of factors associated with operationalising CBBR in health research from participants’ reflections and experiences

approval requirements sometimes limit active community involvement at certain stages, such as the research proposal stage, as quoted below.

“It’s kind of a chicken and egg situation, really. You want to involve the community from the beginning. It is simply not possible at the proposal stage. From a pragmatic view, you don’t know who the community is going to be, even if you know, not having ethical approval would make it very difficult to have active involvement in project design.” –K11.

Limitations could also arise at the analysis level, where potential confidentiality issues may occur with access to other community members’ data. While leveraging existing community skills and providing training in research methods could enhance the community’s capacity to engage with analysis (KI5), barriers such as limited funds, insufficient training time, and a lack of community interest in learning at this research level could limit involvement.

“I think this depends on the nature of the funding, time, the capacity of the community and the extent the people want to be involved.” – K13.

Other related funding issues include the attention drawn to the appropriateness of offering incentives to participate and the prescriptive nature of many research funding calls.

Research level barriers

At the research level, disregarding the community’s existing social and cultural values (i.e., positions assigned to different people based on their gender or economic status) and leadership and communication structures (i.e., positions accorded to people to communicate on behalf of the community) were viewed by informants as a barrier to effective CBPR implementation and community–research dynamics. According to a group A informant, discounting these community structures could limit communication and sharing of information.

“...Because once people know that you are an outsider, you’re coming in and denigrating or rejecting their worldview..., it could be disastrous. I don’t think you can effectively engage or collaborate with [the] people” – K14.

Similarly, the assumed power and superior knowledge accorded to the research team—mostly from being the custodians of the finances or interventions—can inhibit the community’s contribution to knowledge creation.

“And there’s this kind of big headedness, I suppose, when we design for people that maybe haven’t got as much as we have.” –K15.

Another significant barrier at the research level was the introduction of unaffordable and unsuitable interventions to the community, resulting in a lack of interest and engagement with the interventions. An informant from group B exemplified this from his experience in the Malawi rural electrification project. He stated:

“People were not buying it [electricity credit] ... We realised that most people in the rural areas could not afford to pay the initial connection fees.”–K19.

In addition, the use of non-participatory research tools and communication techniques were highlighted as barriers to the exchange of information and knowledge that inhibit participation. Conflict-related factors such as a mismatch between the research priorities and the community’s needs (KI2, KI5, KI6, KI9, KI10, KI12) and the use of community resources such as land space for research purposes (KI2) were also highlighted as inhibiting participation.

Community level barriers

Regarding community-level barriers, some group A informants mentioned the leaders’ influence on who participates or gets sampled in the community as limiting inclusive participation.

“They [leaders] are going to be the people we engage with initially...But I wonder, and we often wonder, when we’re thinking about community participation, do some people get left behind? Or perhaps not included.” –K13.

Notably, all informants described the involvement of community leaders and engagement with insider knowledge as valuable to gaining entry to, and engaging with, the whole community. However, power dynamics and gender imbalances were mostly noted as a hindrance to inclusive community participatory decision-making activities.

“When it comes to men and women, men are always a bit more dominant. They want to speak out more than the women. We had both men and women together, and we noticed women were not speaking up.” –K18.

Other barriers at this level include existing friction within the community (KI2, KI6, KI8), mistrust from past research experience or the community’s perception

of ulterior research motives (KI1, KI2), and uninterested due to the research burden (KI2).

Individual level barriers

Discussions of barriers to participation in research at the individual level by group A and B informants included limited time to engage (away to earn a living), low capacity to engage (physical illness), and intimidation or self-stigma (from low education or economic status, especially when in groups with educated or affluent community members). However, most informants in group C associated barriers to participation with a lack of motivation linked to the absence of incentives.

“Some will not join in if there is nothing [financial incentives] in it for them. otherwise, some are just lazy to join.” –KI10.

Good practices for effective CBPR design and implementation in HAAP

The uptake and sustained use of interventions such as improved cookstoves to address air pollution solutions remains a challenge. We asked the key informants to provide suggestions based on their experiences to inform the design and implementation of CBPR in our planned HAAP project [26]. Their proposed ideas were captured as ‘promoting participation’ and ‘sustainability’. We sub-categorised sustainability as ‘sustained behavioural change’ and ‘sustained use of HAAP interventions’ (See Fig. 2).

Promoting participation

This subcategory describes informants’ outlooks on ways to facilitate active and effective community participation and engagement in HAAP research.

The value of not ‘demeaning people’s worldview’ and respecting the community’s culture and values was echoed across the informants as core to reducing conflict and promoting interest and total community participation. To achieve this, several informants recommend being culturally sensitive and addressing one’s bias and preconceived beliefs about the community’s social, cultural, gender, and decision-making structure at household and community levels.

“Even if you find it almost distasteful because it doesn’t sit with your idea of gendered relationships or whatever, and it’s really important that you don’t impose any of your own values. This means recognising and respecting that is the way the community works.” –KI1.

Despite this, some group A informants cautioned against associating limited decision-making power only to gender, citing examples of (1) cultural norms, as women may also “shut down” when they are in an all-women group with their ‘apongozi akazi’ (mother-in-law)–KI5, (2) “more influential people pushing the decision-making agenda”–KI2, and (3) people not wanting to be the “dissenting voice” when leaders have spoken–KI8. With these different dimensions of socio-cultural sensitivity, KI1 and KI2 advise “to get a handle” on what the community priorities are and invest time to understand “where the strength lies”, especially in relation to gender roles in HAAP.

Also cited as essential to community participation is effective communication. Informants focused this on ‘who’ is delivering, to ‘whom’, ‘when’, ‘how’, and the content of the message. The informants unanimously believed that ‘who’ delivers the message must be trusted and respected within the community. This supports the importance of insider knowledge (insights gained from individuals who are familiar with the community [30]) in guiding participatory processes like the provision of a safe place for engagement (KI4). The trusted person could include a religious authority (KI6), influential and/or community leaders (KI11, KI12), and local researchers who are well-placed to lead communication, primarily because of language advantage.

“To some extent, we’ll be relying on the Malawian colleague. By definition, they have a better understanding, particularly through language, of what those issues (cultural, gender issues) are. We need to be guided by them.” –KI1.

One informant was critical of getting fixated on insider knowledge and highlighted the need to source some outsider perspectives (insights gained from individuals who are external or have no direct affiliation with the community being studied [30]).

“For that different perspective you think about things differently from a cultural perspective. You think of asking some of the questions that people who were very close to the community might not think of asking, and I think that set of external eyes is really important.” –KI3.

All group A informants judged who gets the messages and when as being essential to effective collaboration and project buy-ins. They drew attention to the importance of addressing the entire community at an early stage, irrespective of the community segment with the highest HAAP health burden or those being targeted for the interventions.

“One of the important things to do is make sure you’ve got everybody on your side. It’s not enough to convince the women about a cleaner stove... that message needs to get through to everybody so that everybody understands the impact of household air pollution and how engaging can benefit everyone.”–K11.

In addition to communicating the project’s direct benefits, such as improved health outcomes (KI9, KI10), informants mentioned that indirect benefits of participation should also be communicated to motivate and facilitate community engagement. Such messages could include *“how the community are an active part of creating solutions to HAAP issues”* (K11) or being employed on the project (KI9). And while knowledge exchange is needed to promote participation, one group A informant cautioned against doing all the talking, but to *“use your eyes and ears. You’ll learn a lot that way”* (KI6).

Also common among the informant groups was acknowledging and respecting the community’s invested time with monetary or other valuable incentives. This expectation was expressed by a group A informant as a source of caution to avoid conflict and by a group C informant as a source of motivation to engage with the interventions (KI11).

“As a researcher, you kind of feel I’m not an NGO with a big pot of money. But what’s in it for them [community] to give up their time? ...having that feeling that research is getting in the way of their lives and they might resent it.”–K12.

Once the community is on board, providing a clear definition of their roles within the project can reduce ambiguous boundaries within the community-research partnership. Several informants remarked that definitions should centre on equitable power-sharing partnerships (KI1, KI3, KI11) with the existing community’s skills and knowledge (KI2, KI3, KI5, KI6, KI12) and the community’s capacity to make decisions to engage (KI1, KI3, KI5).

“If you don’t give people any power or ability to make decisions, then they don’t engage the same and they don’t invest in the project. If they have that role within the project, they’re not going to be so invested in either the findings or in the benefits to them.”–K11.

Regarding establishing trust, some group A informants suggested creating time to engage with the community beyond the scope of the project to build rapport and trust, which in turn, fosters participation.

“You have to be a more familiar face. Not just go in and do what and then get out. But actually, spending a little bit more time with the community because that is how you get those women that didn’t come out.”–K12.

Similarly, creating time *“just to hang around and experience people’s lived realities”* with HAAP and *“share stories... of what life is like”* (KI5) was alluded to as a means to foster familiarity and rapport. Engaging with existing skills and resources within the community, e.g., local tradesmen and craftspeople, was also implied by most group A informants as essential to support community-research rapport and partnerships. In connection to fostering a trusting partnership to enhance participation and engagement, group C informants commonly stressed that the research team should place priority on delivering the project’s goal as communicated to the community.

“First, you have to let everybody know and understand how important this is to us all. And then, show us that you will indeed fulfil what you are promising us to happen in this village. And then, we will devote with all our hearts to help in anything that you will ask for.”–K112.

Also highlighted as significant in promoting participation are the researchers’ participatory leadership skills within the HAAP project and their ability to operationalise the CBPR components within the community’s available structures and resources.

“In a way, it starts with good leadership. And that’s down to me [K11] and you [EP]. That means the overall project but also your leadership of the participation aspects. You need to have participative leadership to set the scene and have the right context.”–K11.

Another group A informant discussed cultivating the habit of affirming the community’s contributions during the CBPR process to *“assist them to see the value in what they are doing, saying, okay, we’re doing a good job”* (KI3). She argued that these affirmations could enhance the community’s capability to plan for future projects.

Finally, informants suggested several research tools to facilitate the implementation of an effective CBPR HAAP project of benefit to the research and community. These are summarised in Table 2 below.

Sustainability

Complementary to participation facilitators, this sub-category captures informants’ views on sustaining the use of HAAP interventions and sustaining behaviour change.

Table 2 Facilitating research tools for participatory research

Research tool	How tool benefits the community and the research	Source
Photovoice	Community and research: Gives power and control to openly express their views, thus producing richer data	KI1
Open interviews	Research: Allows exploration of other topic areas, adding depth to data and gathers perspectives of people who may be reluctant to speak in groups but may have a lot to say	KI1, KI6
Participatory Transect walks	Community and research: Ensure inclusivity of households not engaging at the community level or on the physical and health peripheries. Enhance participants' sense of belonging to be sought after. Also, facilitates the voices of people not comfortable in large community meetings and focus group discussions	KI6
Resource mapping	Community and research: Allows systematic exploration of what matters and why and the resources available in the community to address issues	KI2, KI4
Needs assessment	Community and research: Tailors the intervention to community needs and fosters sustainability	KI5, KI6
Train-the-trainer/participatory learning	Community and research: Fosters community skill enhancement, sense of community, and behaviour change. It allows exploration of community and personal level dynamics during interactions	KI2, KI6, KI11

Key: **Photovoice:** using photography by participants to describe perceptions of issues in their language to promote dialogue. **Open Interview:** Having Informal conversations with individuals in the community. **Participatory transect walk:** Walking through the community and engaging community members in conversations related and non-related to the project. **Resource mapping:** Exploring the existing resources (human, knowledge, skills) and mapping them to needs in collaboration with the community. **Needs assessment:** Exploring the community needs continuously throughout the project using an open feedback approach to communication. **Train-the-trainer or participatory learning:** Enhancing skills training of a few community members with the aim of them transferring the skills and knowledge to others. Also, engaging communities to support each other and learning from observed success to achieve a common goal. This also works with researcher learnings from the community to the wider research team

Sustaining use of intervention A group A informant linked the sustained use of HAAP intervention to the community's understanding of the suitability of that intervention to meet their needs and suggested including a participatory intervention demonstration activity in the HAAP design. As an example, he cited:

"We [researchers] do a water boiling test, we don't actually cook food on the [improved stove], so we don't really appreciate what they're going to be like in use" –KI5.

Most group C informants mentioned skill enhancement as a tool to achieve sustainability. One participant extended this beyond the sustained use of the intervention to include possible economic gain, suggesting *"training them" [the community as entrepreneurs] "so [that]*

they can save some money" –KI10. On the other hand, some in group A (KI2, KI6) advised making the HAAP interventions "really simple technologies" that the community can build with local and readily available materials. Narrating from a HAAP-related experience, skill enhancement was alluded to as supportive of sustained project outcomes.

"The uptake was pretty high, over 80%, but they [community] felt that once the artisans had gone, they were left a little bit helpless. If the thing broke ... they didn't necessarily know how to do it That long-term support or provision of the longer-term support would have probably helped it [project] to be even more successful than it has been."–KI2.

Sustaining behaviour change In addition to enhancing community capacity through skills enhancement, the health surveillance assistant urged researchers to allow the community to be their own change-maker by giving ownership of the intervention monitoring to the community. It was described as an empowerment tool to support a sustained community-level behaviour change. Using an example of a community nutrition screening program where sustained change was achieved, she stated:

"When we are screening nutrition, we use people in the community to go around and see what is happening, to encourage others. They can do that, help each other, and they can see the changes... They can say, oh, this child is speaking up. Now, this child's wasting is going down. The community can do it, and so, train them, okay, and empower them."–KI11.

A similar view was shared by a group A informant (KI2) who described the role of a "village motivator" as one involved in motivating or educating the villagers to adapt to the new intervention.

Finally, a group A informant (KI1) urged sustaining the community-research relationship past the project endline. This was described as a capacity-building measure, "a continuum", with the outlook of involving current community members in possible scale-up projects with other localities. However, the lack of recurring project funding limits engaging the community in such capacity-building undertakings.

Discussion

In this section, we discussed the result categories, barriers to participation, and good practices for effective CBPR design and implementation in HAAP projects using Wallerstein et al.'s CBPR model and the published evidence [10, 24, 25, 31] by the model's authors. Our

aim was not to test the model but to understand where the participatory factors identified from the informants' experiences fit within the existing CBPR conceptual model. At the time of the study, the model was being proposed for use in designing a CBPR approach for a HAAP intervention project.

The four domains of the CBPR model—'contexts', 'partnership processes', 'intervention and research', and 'outcomes'—provide the flexibility to adapt and connect CBPR principles to project activities [10]. Our study findings align with several of the CBPR model domain factors and highlight where barriers could exist in real-life settings and what good practices could enhance the implementation of the CBPR approach. Table 3 shows where our study's categories fit within the model.

Contexts domain

The contexts domain highlights the social-structural, political and policy, health issues, collaboration, and capacity factors needed to move the other domains forward [24]. It advocates positioning the CBPR activities in the context of (i) socio-economic status (SES), (ii) historical research collaboration, (iii) politics and policy, (iv) knowledge and perceived severity of health issues, (v) historical collaboration, and (vi) community capacity and readiness to engage, and academic partners' capacity to support institutional policies and practices. However, issues related to these factors could occur that could impede participation. For example, the level of involvement in research processes, perception of the severity of the health issue, and acceptance of the research aim are all linked to community-level barriers such as level of skills and education, time-constraints and existing trust/mistrust of research from historical collaboration. Equally, inadequate assessment of community health needs and assets (linked in this study to funding, ethical regulations and time constraints) creates research-level barriers, which can widen gaps in the research team's capacity to recognise and plan for the community-level barriers.

Several good practices mentioned in this study support planning an effective CBPR approach to address some of these issues. These include (i) assessing and implementing affordable HAAP interventions to reduce health disparities (SES), (ii) delivering on the research goals and minimising historical distrust that communities may have experienced with previous top-down or tokenistic research [31], or a lack of congruence over core values; (iii) respect for community time and a having safe environment to engage (cultural, safety, and environmental); (iv) effective communication strategies (education); (v) skill enhancing activities, and assessing the community's capacity to engage at all research levels (education, capacity and readiness to engage). The research team's capacity

and readiness to implement an effective CBPR approach (discussed briefly in the study) addresses several of the community-level barriers within the domain and supports setting the foundation for the socioeconomic, structural, and cultural factors [24]. This is explicit in the capability of the research team to engage the community in effective communication, in addition to assessing the suitability of the research objective to the community's needs. Although we reported funding, time, and ethical barriers to assessing the community's capacity to engage, we argue that it falls within the CBPR researchers' role to report these limitations to the funding and ethical bodies. This can help to facilitate more need-specific funding calls and enhance community-research collaborations.

Partnership processes domain

The partnership processes' domain relates to how and the extent to which the partners' voice and knowledge are integrated into the research design, intervention, and activities to create an equitable partnership [24, 25, 31]. Its three factors, partnership structures, individual characteristics, and relational dynamics, are essential to achieving an equitable partnership from design to outcome in a CBPR project [24].

Our findings within the 'partnership structures' factor identified community-level barriers related to who in the community is involved in the community-research partnership and controls the community's resources. For example, in communities with an autocratic leadership style and in community groups ranked by economic status and academic achievements, higher-status members are likely to dominate discussions, resulting in an unequal distribution of knowledge, power, and voice in decision-making activities. The unequal distribution leads to 'elite bias'—a higher affinity of the community elite with outsiders— or, in this case, the research team [32]. Our findings also show that such power imbalances can occur at the research-level. Researchers, either by virtue of being custodians of research funds or being perceived as having higher knowledge, could dominate discussions and make autocratic decisions for the project. Several suggestions to ameliorate these community and research-level barriers strongly echo the model's outlook of forming CBPR partnerships. Specifically, expanding research communications to the whole community, irrespective of the target intervention group, and instigating gender-inclusive participatory decision-making, mirrors and adds to the model's diversity of partnership structures beyond place and race/ethnicity [24]. Additionally, our study emphasised the important role of research-team members who share nationality and language with the community as best suited to act as insiders in facilitating partnership processes. This is similar to the role of a 'bridge person', described in the model's individual factors as an

Table 3 A matrix of study findings with the CBPR conceptual model domains and factors. The matrix gives an outlook on where CBPR activities fit in the model and informs the planning of the outcome evaluation factors of implementing the activities within each CBPR domain

	Research Findings				Key recommendations for CBPR in HAAP			
	Barriers to participation (level)				Good practices for effective CBPR HAAP			
	Structural	Research	Community	Individual	Promoting participation	Sustainability	Facilitating research tools	
Contexts	Social-structural: *SES, Place	◆	◆	◆	√			-Build a strong foundation through open, effective communication to assess community priorities, needs, beliefs, political structure, economic status, and experience with research. Have non-research conversations to build rapport and trust.
Partnership Processes	Political & policy	◆			√		√	
	Health issue importance		◆		√		√	
	Collaboration-trust & mistrust		◆		√		√	
	Capacity & readiness	◆	◆	◆	√		√	
Partnership Processes	Partnership structure	◆	◆	◆	√†		√	
	Individual Characteristics	◆	◆	◆	√		√	
	Relationships/Relational	◆	◆	◆	√†		√	-Enhance trust, address pre-conceived ideas, humility, and cultural sensitivity; incorporate non-research-related community activities to build rapport; create a feedback-reassessment loop; gratitude for time; appreciate community contributions; engage local skills; define roles & communicate inclusivity for all; Bilateral communication and active listening; †: Be aware of possible unequal power and knowledge within community members that could affect who interacts with the research team—inclusivity
Intervention & Research	Integrate community knowledge	◆	◆		√			-Provide opportunities for equitable power sharing through participatory decision-making on suitable HAAP interventions and leadership; employ empowering research tools, e.g., skills training.
	Empowering processes	◆	◆		√		√	-Plan for a community-level member-checking activity, i.e., taking the result back to the community and co-designing a dissemination activity with the community.
	Community involved in research	◆	◆	◆			√	
	Culture-centred intervention	◆					√	
	Partnership synergy						√	
Appropriate design	◆				√		√	

Table 3 (continued)

CBPR Conceptual Model Domains	Research Findings				Key recommendations for CBPR in HAAP	
	Barriers to participation (level)				Good practices for effective CBPR HAAP	
	Structural	Research	Community	Individual	Promoting participation	Facilitating research tools
Outcomes	Inter-mediate system and capacity outcomes	◆	◆			
	Policy environment					
	Sustained partnership			√†		
	Empowerment					
	Shared power relation in research					
	Cultural reinforcement			√		
	Individual/ agency capacity			√		√
	Research productivity					
Long term outcomes	Community transformation					
	Social justice					
	Health/ health equity					

◆ Denotes where factors identified as barriers fit within the domain factors; √ Signifies where factors identified as good practices fit within the domain factors; † Denotes additional findings from the study; Blanks: Model factors that are not reflected in the study

*SES: Socio-economic status

-Ensure outcome evaluation. Monitor and ensure the feedback loop is maintained throughout the project and continuously re-integrate learnings into project CBPR processes.
 -Foster a sustained partnership with the community. What would the process and the outcome be for all partners?

academic team member with shared race/ethnicity to facilitate the integration of local knowledge [24]. However, we argue that the model's description of the bridge person's role does not address intra-community power and status imbalances. Since such imbalances could limit participation, we recommend future studies to explore these intra-community dynamics and the impact, if any, of a bridge person in mitigating them. Further, our findings within the model's role recognition and formal agreements emphasised the need for clarity around the CBPR project's role, responsibility, and accountability structure to help reduce conflict with any existing community leadership style and community-group dynamics. However, the need for formal agreements such as memoranda in the partnership structures [31] was unreported in this study.

Also, our findings advocate for involving local community artisans in research projects and providing gratitude for participation and time invested in the research. This exemplifies the model's partnership factor, '% dollar to community', described as providing adequate incentives and sharing grant funds to promote marginalised communities' participation in health research [10, 31]. Investing time in community activities to foster equitable partnerships also accords with the model and supports its importance in building trust.

With respect to individual characteristics, we identified individual-level barriers mostly from individuals' lack of motivation to engage. This can be related to the research team's individual characteristics, including ethnocentric beliefs and disregard or disrespect for the community's values. Also, the researcher's reputation was highlighted as essential to the partnership process, with findings emphasising the importance of researchers' respect for community values and beliefs, cultural sensitivity, humility, and the need to shelve pre-conceived beliefs. These findings illustrate several of the model's partnership processes factors, which assert the need for flexibility within the research team to listen and work within the existing community decision-making and power structures to support open communication and mutual learning. In addition, we found consistency in our findings on the delivery of project commitments, with the model's description of trust as earned by "following through" and "keeping promises" [24]. This concept of trust is required to mitigate the often complex sources of conflict in the research-community dynamics [31]. This, in addition to the value of researcher's reflections on their assumed research power, is posited by the model to circumvent conflicts and maintain positive partnership dynamics [25, 31]. Researcher reflexivity was, however, not defined in our findings.

Intervention and research domain

There are similarities between the factors expressed by informants in this study and those described by the CBPR model's intervention and research domain to design a culturally appropriate project [24].

The findings placed importance on the extent of, and how, partners' voices and knowledge are integrated into the project design and interventions. It stresses participatory decision-making and bilateral exchange of information to co-create knowledge. However, we found limitations in the domain's factor on community member involvement in research activities to reflect the community's priorities. These limitations, including community skills levels, time to engage, time to train, and community capability to be involved at all research activity levels, could hinder communities' involvement in some research activities. However, participatory activities that build or enhance capacity could address some of these limitations. For example, knowledge and skill transfer using a train-the-trainer approach (time-to-train), photovoice and participatory transect walks (skill enhancement, time-to-engage), and co-design and participatory decision-making (capability and capacity to engage). Reporting participatory limitations due to funding and ethical barriers to the appropriate authority could instigate the discussion required at the policy and funding level to address the issues.

The most significant finding from our study in this domain was the importance of implementing affordable and suitable interventions to meet the community's needs. Similar to the domain's culture-centred factor, planning HAAP interventions informed by user needs and socio-economic and cultural factors accords with our findings on good practices to enhance uptake and sustained use of HAAP interventions.

Outcomes domain

System and capacity changes such as multi-level empowerment and improved health are central to the outcome domain in the CBPR model. Our findings on building trust and enhancing community and project capacity to achieve sustainability beyond the project lifetime through skills training, learnings, bilateral knowledge exchange, equitable partnerships, and empowerment are consistent with the model [24]. While several feedback loops have been posited within the model for CBPR evaluation, our study found barriers at the research and structural level to conducting participatory evaluation (PE) after the project has ended. Primarily, this was associated with the nature of short-term research funding, which plays into limited or no time to evaluate the implemented CBPR activities within the context, partnership, and research domains to influence immediate and long-term outcomes.

This finding broadly supports Springett and Wallerstein's discussion of funding and time as a limitation of the PE, amongst others, including the researcher's skills in conducting the evaluation [33]. Despite this evaluation constraint, one resonating concept in our study from the informants' reflective evaluation is CBPR's outcome as a capacity-building tool for the researcher and the community. However, desirable outcomes—such as enhanced awareness and cultural sensitivity of the researcher and increased community autonomy in decision-making, ownership, and social change—would depend on how effectively the CBPR approach was implemented.

Conclusion

To shape the design and implementation of the CBPR approach in a HAAP project, this study explored key informants' perspectives and recommendations of their real-life experience of participatory approaches in LICs. The findings provided valuable context to a versatile CBPR conceptual model and supported its domains for use in a complex HAAP intervention study. It informed the design and implementation of the CBPR approach, the evaluation markers of adoption, uptake, and sustained use of HAAP interventions (SDGs 3.9, 7.1), and community capacity outcomes of the household and ambient air pollution (SDG 13.3) project in Malawi.

We conclude that implementing a CBPR approach to improve health outcomes and health equity is multi-faceted and has several interlinking structural, research, community, and individual factors. CBPR's emphasis on enhancing the community's voice, knowledge, and skills in the community-research partnership should be the epicentre in implementing the approach. To support this and deepen our understanding of the different domain factors, we recommend using, evaluating, and reporting the approach's strengths and limitations. The enhanced understanding would inform funding and policy to address structural issues and create a repertoire of findings in different contexts to reinforce our understanding of pathways from design to outcome of CBPR projects.

Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
CBPR	Community-Based Participatory Research
HAAP	Household and Ambient Air Pollution
HIC	High Income Countries
HIV	Human Immunodeficiency Virus
KI	Key Informant
LICs	Low-Income Communities/Countries
PE	Participatory Evaluation
PM _{2.5}	Particulate Matter of 2.5 micron or less
SDGs	Sustainable Development Goals
SES	Socio-Economic Status
SSA	Sub-Saharan Africa
TSPV	The Smokeless Village Project

Supplementary Information

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Supplementary Material 1
Supplementary Material 2
Supplementary Material 3
Supplementary Material 4
Supplementary Material 5

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Author contributions

EP conceptualised and designed the study, collected and analysed data, and wrote the manuscript. AW, DS, and SJ contributed to the conceptualisation, design, and supervised analysis and writing process. FE and JS contributed to data analysis. RC contributed to the interpretation and writing. All authors read and approved the final manuscript.

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Data availability

The qualitative dataset generated in this study is not publicly available because the authors do not ethically have participants' permission to share the data, and there is a risk of deductive disclosure with the dataset. Questions about the study and data can be directed to the corresponding author at enicephillip@rcsi.ie.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the College of Medicine Research Ethics Committee (COMREC) in Malawi (P.03/21/3279) and the Research Ethics Committee, Royal College of Surgeons in Ireland (212558360). Informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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