Research Article

Community-Based Cardiovascular Risk Reduction through Novel Air Health Behavioural Change Intervention (CARDINAL): Study Protocol

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Abstract

Despite the well-described cardiovascular effects of exposure to air pollution, there is still limited evidence of the effectiveness of behavioural change intervention to reduce exposure to air pollution in countries like Nigeria. The aim of the CARDINAL study is to develop and implement a community-based behavioural change intervention focused on reducing exposure to air pollution and the associated CVDs risk factor reduction. The CARDINAL study is a pre-post intervention design involving a baseline assessment, a community-wide intervention assessment, and an end-of-study assessment in selected communities of Ibadan North Local Government Area, Nigeria. The study population will comprise vulnerable populations of 300 commercial transport workers, 300 women of reproductive age exposed to indoor burning of solid fuels, and 100 healthcare providers. The primary outcome will be changes in Knowledge, Attitude, and Behaviour (KAB) score on the link between air pollution and CVD, as well as air pollution exposure reduction strategies. The CARDINAL study will provide novel data that will inform public health policies to support the implementation of scalable community-based behavioural interventions to reduce exposure to indoor and outdoor air pollution, thereby reducing the burden of cardiovascular diseases in Nigeria.

Keywords: Cardiovascular diseases; Air pollution; Behavioral change intervention; Air health documentary; Community support group; Ibadan

Introduction

Cardiovascular Disease (CVD) is the leading cause of death worldwide, with over 17 Million premature deaths in 2016. Hypertension is one of the leading risk factors for Cardiovascular Diseases (CVD) [1]. Globally, an estimated 1.28 billion adults aged 30-79 years are hypertensive with two-thirds of this population living in Low-and-Middle-Income Countries (LMICs) [2]. In sub-Saharan Africa, the estimated number of people with hypertension has increased steadily from 54.6 million in 1990 to 92.3 million in 2000 (70% rise) and 130.2 million in 2010 (41% increase from the year 2000) [3]. It is projected to rise to 216.8 million by the year 2030 (66% rise from the year 2010). In Nigeria, one in every four adults is hypertensive, with a rising prevalence from 11% two decades ago to about 30% in recent times [4]. The genesis of hypertension is complex, and its progression is influenced by a number of factors and their interactions [5]. Besides genetic and lifestyle predictors, environmental factors such as air pollution have been associated with an increased prevalence of CVDs [6,7].

The greatest environmental threat to human health is air pollution. It is responsible for more than seven million annual premature deaths worldwide, with one in eight of total global deaths resulting from air pollution exposure [8]. According to the World Heart Federation (WHF), vulnerable populations (e.g. those with an inherently higher exposure to air pollution) have a higher risk of CVD from air pollution. Several studies conducted in the developed countries have reported an association between short-term changes in ambient (outdoor) levels of fine particulate matter (particles with an aerodynamic diameter of less than 2.5 m; PM2.5) and high Blood Pressure (BP) [9-11]. Fewer studies have assessed the association between long-term (*i.e.*, months to years) exposure to PM2.5 and BP, with most studies reporting a positive association. Globally, Outdoor Air Pollution (OAP) ranks sixth among all health risk factors for mortality [12,13]. Household Air Pollution (HAP) ranks eighth globally among all health risk factors for mortality, and second in low-income countries [1,14]. Reduction in air pollution exposures is essential to attaining global targets, such as the American Heart Association and WHF goal of reducing premature CVD mortality by 25% by 2025 [1,15].

The use of solid fuels for cooking is a predominant practice in many LMICs, especially in sub-Saharan Africa. In Nigeria, cooking accounts for 91% of total domestic energy consumption and wood is the most widely utilised cooking fuel, especially

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among rural dwellers and households with low socio-economic status [16,17]. Approximately, 60% of rural community-dwellers in Nigeria still rely on unprocessed biomass fuels in the form of wood, charcoal and dung, while 30% relies on kerosene. These sources of fuel for domestic cooking are typically burnt indoors in open fires or poorly functioning stoves [18,19]. As a result, there are high levels of air pollution, to which women, especially those involved in cooking, and their young children are the most vulnerable. Indoor air pollution from household solid fuel combustion has been linked to an elevated risk of hypertension [20,21].

In LMICs such as Nigeria there is a limited understanding among specialist physicians and cardiologists of the contribution of air pollution to cardiovascular morbidity and mortality. Environmental Health Literacy (EHL), with roots in health literacy and risk communication, is fundamentally about understanding the link between environmental exposures and health [22-25]. The concept of Information, Education and Communication (IEC) has evolved from a focus on individual-level educational processes to conceptualization of an evolving process and public health philosophy that considers strategies for empowering individuals to use communication to control environmental exposures. Despite the potential for communication to mitigate the cardiovascular risks of air pollution through improved EHL, little is known about the extent and effectiveness of air pollution educational intervention [26,27].

In contributing to achieving the WHF recommendation for reducing exposure to air pollution, the Community-Based Cardiovascular Risk Reduction through Novel Air Health Intervention (CARDINAL) project will adopt a culturally sensitive approach and strategies to raise awareness and encourage appropriate preventive behaviours among vulnerable populations, and health care providers, on mitigation of air pollution. This study, therefore, proffers promising intervention strategies towards modifying behaviour to reduce exposure to indoor and outdoor air pollution and improvement of cardiovascular health in Nigeria [28].

Study objectives and hypothesis

The overarching aim of the CARDINAL study is to develop and implement a community-based behavioural change intervention focused on reducing exposure to air pollution and assessing its impact on possible change in systolic and diastolic blood pressure. The CARDINAL project has three specific objectives and underlying hypothesis:

Objective 1: Objective 1 will assess the Knowledge, Attitude and Behaviour (KAB) of vulnerable populations of men, women and health care providers on the cardiovascular benefits of reducing exposure to air pollution, before and after the educational intervention. We hypothesize that there will be a significant improvement in the KAB of respondents before and after the educational intervention.

Objective 2: We shall form a Community Advisory Network (CAN) and Community Support Groups (CSGs) comprising key influential members of the selected community. We hypothesize that the CAN and CSGs will be effective in raising awareness and knowledge dissemination on the link between air pollution exposure and CVDs to other members of the community.

Objective 3: We shall develop an evidence-based Behavioural Change Communication (BCC) package which will include a novel AirHealth documentary as an intervention instrument. We hypothesize that developing a culturally and ethically sensitive BCC-based techniques to facilitate knowledge retention and behavioural modifications towards reducing exposure to indoor and outdoor air pollution.

Materials and Methods

The study will be carried out in Ibadan North Local Government Area (LGA) of Ibadan in Oyo State, Nigeria. Ibadan North LGA is located approximately on longitude 8°5' East of the Greenwich Meridian and Latitude 7°23' North of Equators. It covers a large expanse of land with an area of about 420 km^2. The study headquarters will be located at Agodi Government Reservation Area (GRA) which houses three major markets including the popular Bodija Market and two higher institutions of learning, the University of Ibadan, founded in 1948 and the Polytechnic of Ibadan, founded in 1970. The LGA has 12 wards. In the North and East, Ibadan North LGA is bounded by Akinyele and Lagelu LGAs, respectively, while in the West it is bounded by Ido, Ibadan South-West and Ibadan South-East LGAs (Figure 1). Ibadan North LGA is the most populated of the 5 urban local government areas in Ibadan with 146 km^2 and it is heavily populated with a projected population of 506,039 people. The male population is given as 270,499 and female population as 289,540 [29]. The LGA consists of multi-ethnic nationalities and the inhabitants are mostly traders, artisans, civil servants and students. All the three tiers of health facilities which cut across private-owned and government-owned health facilities are well represented in the LGA. The University College Hospital (U.C.H), the first teaching hospital in West Africa and Adeoyo Maternity Teaching Hospital; a foremost Oyo-State Government-owned health facility, are some of the notable government-owned hospitals that are located within the LGA.

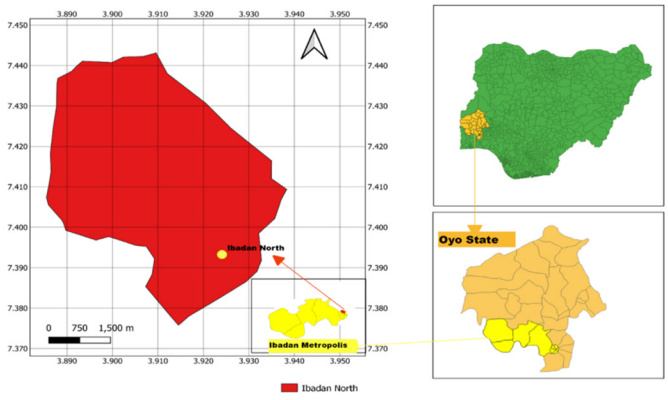

Figure 1. Map of Ibadan showing Ibadan north local Government area.

Study design

The CARDINAL study will employ a pre and post intervention design involving a baseline assessment, a community-wide intervention assessment and an end of study assessment to evaluate the impact of an intervention (Table 1). All assessments will be carried out within Ibadan North LGA after proper community entry.

Table 1: Schedule of activities from baseline to end line.

	Baseline assessment	Intervention	End of study assessment
Duration	4	4	4
Informed consent	X		X
Demographic data collection	X		X
Clinical history	X		X
Blood sugar	X		X
Blood pressure	X		X
Height, Weight, BMI	X		X
Creating CAN	X		
Training CSG	X		
Key lectures on the cardiovascular benefits of reduced exposure to air pollution		X	
Exposure to BCC intervention materials and Air Health documentary		X	
Knowledge, attitude, and behaviour survey	X		X

Note: BMI-Body Mass Index; CAN-Community Advisory Network; CSG-Community Support Groups

Measured outcomes

The primary outcome will be change in KAB score. The level of knowledge about 1) the link between exposure to air pollution and CVD, and 2) the strategies for reducing air pollution, will be assessed using a 20 and 26-point knowledge scale respectively on the AirHealth questionnaire. A correct answer for each item will be scored "1" and an incorrect answer will be scored "0". A score of ≥ 50% will be considered as good knowledge. Attitude towards air pollution reduction strategies will be assessed using a 9 point attitude scale with a score of ≥ 70% categorised as favourable. Moreover, behaviour towards air pollution reduction will be assessed using 10 item question on the AirHealth questionnaire based on adherence to standard practices and use of protective equipment [30]. Secondary outcomes are 1) change in the systolic and diastolic blood pressure and 2) subscales of the COM-B ("capability", "opportunity", "motivation", and "behaviour") score. The COM-B measures the socio-psychological behaviour towards reduction in exposure to indoor and outdoor air pollution at a community level.

Study population and eligibility criteria

The study will include vulnerable populations of men (commercial transport workers), women (exposed to indoor burning of solid fuel), as well as health care providers responsible for the treatment of cardiovascular diseases. Individuals will be included in the study if they meet the eligibility criteria of being ≥ 18 years and have been residing in the selected communities for more than 12 months. Those with a reported family history of CVD or previous diagnosis for CVD will be excluded from the study.

Sample size determination and sampling strategy

A conservative intra-cluster correlation of 0.05 gives our sampling approach a design effect of 2.11. Therefore, a minimum size of 300 participants from each target group of vulnerable men in the selected wards with a power of 0.8 will produce a 0.66 change in the KAB score. This assumes the score has a standard deviation of 2.5 and an absolute proportional change in a specific component of the KAB of 0.13, with the most conservative option of 50% prevalence at baseline.

Therefore, a total of 300 commercial transport workers, and 300 reproductive aged women exposed to indoor burning of solid fuel will be recruited using multi-stage sampling technique. Stage one: Purposive selection of five wards from a total of 12 wards in Ibadan North LGA where the target population of vulnerable men and resides. Stage two: The list of communities in the selected wards will be obtained from the Ward Development Committees (WDCs) and a clustering approach will be employed to categorise the communities based on shared characteristics such as the presence of associations of women, caterers, charcoal sellers, firewood sellers, and commercial transport (tricycle, Okada and bus) drivers. A total of two clusters will be selected from each selected ward using simple random sampling technique. Subsequently, site visit will be carried out for at least one community per cluster, prioritizing those with the highest population size and density (Figure 2). These visits will aim to inform the final community selection process. Stage three: Identification of groups of women, caterers, charcoal sellers, firewood sellers, and commercial transport (tricycle, Okada and bus) workers in each selected cluster. Stage four: Convenience sampling of women from women's associations (50% from general women group, 20% from caterers' association, 20% from charcoal sellers' group and 10% from firewood sellers group) and men from the commercial transport workers' associations (50% from bus, 30% Okada and 20% tricycle drivers) until the required sample size is obtained. After selection of eligible participants, the participant will be asked to sign a participant information and consent form if willing to participate. In the final survey, the same population of men and women will be assessed using the same approach as the baseline survey.

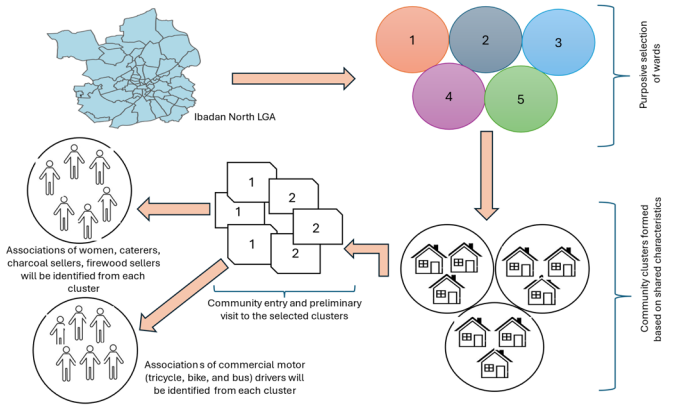

Figure 2. Schematic representation of the sampling procedure.

Recruitment of health care providers: All public and private health facilities within the selected wards, including the University College Hospital (UCH), will be requested to nominate up to 2 health care providers responsible for the treatment of cardiovascular diseases. A total of 100 (30 cardiologists; 20 neurologist, 20 radiologist and 30 nurses) health care providers will be invited to participate in the study. In the final survey, the same population of healthcare providers will be assessed using the same approach as the baseline survey.

Data collection

Data will be collected with the help of trained Research Assistants (RA). The RAs (2 RAs per ward) will be individuals with at least a master's degree in any science/health discipline and a good understanding of Ibadan North LGA terrain. The RAs will be exposed to a 2-day training covering the aims and objectives of the CARDINAL project with specific emphasis on the methodology, definition of essential variables and the instruments for data collection (AirHealth questionnaire, consent forms and information sheet). They will be trained by a health promotion expert on interviewing skills and obtaining informed consent from participants.

Data collection instrument: All materials including AirHealth questionnaire and instructions for anthropometric and CVD risk factor monitoring will be forward-back translated by two linguistic experts from English into Yoruba, which is the local language of the people of Ibadan. The AirHealth questionnaire will capture pertinent demographic data including questions relating to age, sex, educational level, employment, monthly income, CVD risk factors, house type and history of the disease. Anthropometric data including recording of weight, height, BP and measurement of fasting lipid profile will be collected. Weight will be measured in kilograms to the nearest 100 g using digital scales on a flat surface and height will be measured in centimeters to the nearest millimeter using a stadiometer. An automated BP monitor will be used to measure blood pressure, according to established standardized methods, in millimeters of mercury (mmHg). Three measurements will be performed on the participant's left arm with an interval of 1 min between each measurement. Final BP will be calculated as an average of the second and third measurements [31]. To ensure reliability of the AirHealth questionnaire, a pre-test will be conducted among 10% of the sample size (30 vulnerable men and women, and 10 healthcare workers) among a similar population in Osogbo LGA using Cronbach alpha technique.

Data collection process: For each population of men and women in the selected communities, the socio-psychological determinants of reduced exposure to air pollution-related behaviors will be assessed using the constructs of the COM-B model of the behavior change wheel. The behaviour change wheel is a framework for designing and evaluating interventions. At the centre of the behaviour change wheel model, is the COM-B model, which stands for Capability (C), Opportunity (O), Motivation (M) and Behaviour (B) and posits that all three components influence behaviour. The application of the COM-B model to the reduction of air pollution exposure is as shown in Figure 3 [32].

Results

Intervention materials

The intervention comprises a comprehensive education on the cardiovascular benefit of reduced exposure to air pollution. The intervention package and themes to be used to communicate the CARDINAL message is shown in Table 2. The intervention materials and measurement tools will be designed using the specific objectives of the study with the goal to reduce exposure to air pollution among vulnerable populations. The COM-B model will be used as an underpinning theoretical framework based on its ability to successfully predict health behaviors, such as reduction in exposure to indoor and outdoor air pollution from cooking and vehicular emissions [32]. This framework captures a range of behavioural mechanisms that may be involved in change, including those that are internal (psychological and physical) and those that are external, involving changes to the environment.

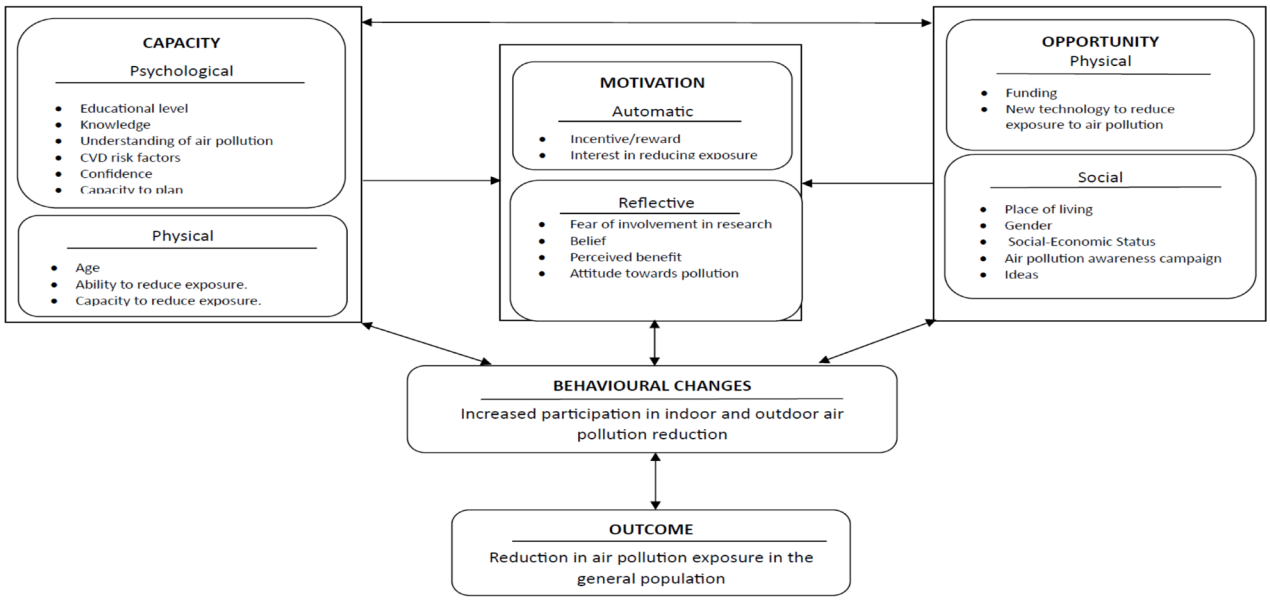

Figure 3. Application of the COM-B model to reduce exposure to indoor air pollution in the general population.

Table 2: Intervention package and thematic areas for the cardinal study.

Studies population	Intervention material	Themes
Commercial motor drivers	Air health documentary	Epidemiology different types of CVD
	Banners	Mechanism of interaction between air pollution and CVD
	Posters	What is Outdoor Air Pollution (OAP)?;
		Sources of OAP;
		Types of Outdoor Air Pollutants;
		Air pollution from vehicular emissions; Nexus between OAP and CVDs;
		Strategies for mitigating exposure to OAP including use of N95 respirators and regular servicing of engines
Women engaged in indoor cooking using solid fuel	Air health documentary	Epidemiology of CVD and the different types
	Banners	Mechanism of interaction between air pollution exposure and CVD
	Posters	What is Household Air Pollution (HAP)?;
		Sources of HAP;
		Types of Household Air Pollutants;
		Air pollution from cooking fuels and stoves;
		Interaction between HAP and CVDs;
		HAP exposure mitigation strategies through the use of face masks, improved cooking methods and ventilation
Health care providers	Air health documentary	Pathophysiology and management of
	Workshop	pollution-attributable cardiovascular disease;
	Handouts	Tracking pollution exposure;
		Identification of patients likely to benefit from air pollution reduction;
		Air pollution mitigation strategies including improve building ventilation;
		Dietary modifications and air pollution

Intervention materials will be developed through a design sprint process that involved validating ideas through information from baseline assessment, literature review, design, and prototyping. The intervention package will consist of education materials including AirHealth documentary, banners, fliers, posters which have been designed to increase capability, motivation, and opportunity among the study population. The intervention package will be developed by the CARDINAL team of experts in the field of environmental health, environmental epidemiology, cardiovascular epidemiology and public health. This intervention materials aims to improve the psychological capability of the participants and improve motivation, both reflective and automatic, to reduce exposure to indoor and outdoor air pollution.

AirHealth documentary: The AirHealth documentary is a short video of interviews with experts in the field of environmental health, environmental epidemiology, cardiovascular epidemiology and public health on the cardiovascular benefits of reduced exposure to indoor and outdoor air pollution. The interviews will provide information on the definitions, sources and types of air pollution, as well as their association with CVD and strategies for reducing exposure to indoor and outdoor air pollution.

Banners, fliers and posters: The key messages that will be depicted in the banners, fliers and posters will be the: concept of air pollution, its sources and types; concept of CVD and the different types; the association between air pollution and CVD; and tips for reducing exposure to indoor and outdoor air pollution. The banners, fliers and posters aim to improve physical and psychological capability of participants and

improve reflective motivation to adopt the strategies for reduced exposure to indoor and outdoor air pollution.

Formation of Community Advisory Network (CAN) and Community Support Groups (CSGs)

A total of five distinguished persons will be selected across the five different wards in Ibadan North LGA to form the Community Advisory Network (CAN). The CAN members will include community leader, faith-based leader, health worker and media person with consideration for gender equity and representativeness. Individuals who will be selected into the CAN will be a well-known person who have been residing within the wards/communities for more than 12 years and have good understanding of the communities and different men's and women's associations within their wards. The recruitment of the CAN members will be facilitated using purposive and snowballing procedures. Community gatekeepers including the WDCs will be consulted and engaged for the purpose of recruiting distinguished and well-informed individuals for the CAN. The CAN will meet monthly through the project timeline to brainstorm and discuss the objectives and progress of the CARDINAL project with the support of the Nigerian Cardiac Society (NCS), (Figure 4).

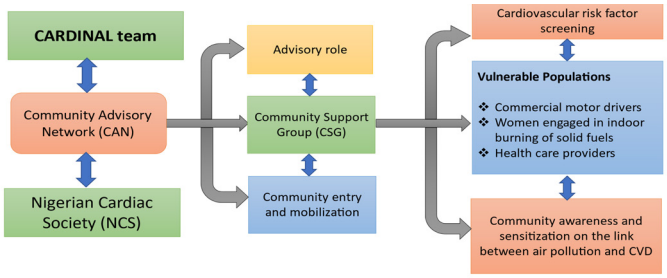

Figure 4. CARDINAL project workflow.

In addition, the CAN will support the CARDINAL team to constitute the Community Support Groups (CSGs). The CSGs will be individuals suggested by the CAN, who resides permanently in the selected communities, have a minimum of secondary school education and able to communicate effectively in both Yoruba and English Languages. A total of four CSGs per community cluster will be involved in the study. The CSGs will be responsible for the dissemination of the intervention package. At the inception, the CSGs will be exposed to a 2-day training session which will be facilitated by the investigators. The training will focus on detailing the content of the intervention package and its dissemination strategies.

Intervention dissemination

The intervention package will be disseminated in separate groups to influence key behavioural change among the men's and women's populations.

General women, caterers, charcoal sellers, and firewood sellers' associations: All recruited women from the different associations will be brought together at a single forum to explain the intervention package. During the intervention dissemination by the CSGs, emphasis will be placed on indoor exposures especially among women engaged in indoor cooking using solid fuel such as firewood, charcoal, biomass, kerosene etc., (Table 2). The intervention material will include an AirHealth documentary, posters, and banners.

Commercial motor (tricycle, Okada and bus) drivers' associations: All recruited men from the different associations will be exposed to the same intervention package with emphasis on outdoor exposures among commercial transport workers (Table 2) by the trained CSGs. The intervention material will include an AirHealth documentary, posters, and banners. The CSGs will increase capability and motivation and provide the opportunity for decision-makers among commercial motor drivers to discuss the adoption of measures to reduce pollutant emissions of motor vehicle, e.g. through maintenance and regular servicing of engines.

Health care providers: A total of 100 health care providers responsible for the treatment of cardiovascular diseases from private and tertiary health centres in Ibadan North LGA will be invited to a day training workshop. The training workshop will be facilitated by experts within the CARDINAL team and focus on the pathophysiology and management of air pollution-attributable cardiovacular diseases. The AirHealth questionnaire for health care providers will be used to assess their knowledge before and after the intervention.

Statistical analysis

The analyses of the quantitative data will include a comparison between pre and post-intervention. Mean levels for continuous variables, and proportion for categorical variables, will be estimated for baseline and follow-up assessment using paired t-test and chi-square test. Similarly, differences in the outcome variables between the pre and post-intervention will be estimated with similar survey regression procedures. Statistical analyses will be carried out using SPSS version 25 and R programme version 4.0. Data will be analysed at 95% level of significance.

Ethical consideration

The study has been approved by the Oyo State Ministry of Health Ethics Review Committee (Reference number: NHREC/OYOSHRIEC/10/11/22). Letter of permission and supports were received from the Oyo State Ministry of Hhealth and Local Government Health Authority (LGHA). Additionally, supports were sought from community gatekeepers including chairs of WDCs and leadership of commercial transport worker's associations in the LGA. Written informed consent will be obtained from all participants prior to the study. Interested participants will sign or thumbprint on the informed consent form. Participants will be informed of the right to withdraw from the study at any time without question if they do not feel comfortable to continue.

Discussion

The CARDINAL study is the first behaviour change intervention in sub-Saharan Africa aimed at understanding the cardiovascular effect of reduced exposure to indoor and outdoor air pollution at the community level among vulnerable populations of men and women. There are numerous novel aspects of the CARDINAL study. First, as far as we know, the CARDINAL project is the first in sub-Saharan Africa to attempt to educate vulnerable men

and women in the community, and health care providers, on the links between air pollution and risk of CVDs. It is one of the few community-based studies that will investigate the knowledge, attitude and behaviour of community members on indoor and outdoor air pollution exposure reduction strategies in relation to CVDs. Despite the well-described cardiovascular effects of exposure to air pollution, most health care professionals report they do not discuss the impact of air pollution exposure with their patients. The findings from this study will clearly reveal opportunities to improve awareness about strategies to limit air pollution exposure among vulnerable groups [33].

Second, the application of culturally sensitive and community tailored approaches using CAN and CSGs is a unique approach to disseminate vital information to a broader population. This approach is expected to facilitate a wider coverage of the CARDINAL message to promote behavioural and lifestyle changes among members of the community. Third, this is the first study to develop a novel AirHealth intervention package for people of African ancestry. The use of a combination of community-driven strategies and AirHealth educational documentaries to improve awareness and knowledge of the cardiovascular benefits of reduced exposure to air pollution has not been adopted before in this setting. The results of this study will provide valuable evidence on which to base new policies, and strengthen existing ones, to reduce population exposure to air pollution knowing fully well that NCDs contribute to 50% of all disease burden and more than 30% of all deaths in Nigeria. In Nigeria, firewood is the most widely utilized cooking fuel especially among rural dwellers and households with low socio-economic status [16,17,34]. Approximately, 60% of community-dwellers in Nigeria still rely on unprocessed biomass fuels in the form of wood, charcoal and dung. Further research is required to develop evidence-based, sustainable and scalable interventions to promote air pollution exposure reduction and to strengthen the implementation of such interventions through existing Government frameworks policies and reduce the burden of air pollution-related NCDs in Nigeria.

Air pollution is currently the 13th leading cause of global mortality. The public health burden of exposure to air pollutants is disproportionately large among developing nations such as Nigeria where the growth of CVD prevalence exceeds the rest of the world [35]. Extreme exposures (e.g., PM levels>100-150 µg/m3) occur in these regions due to a confluence of factors (e.g., traffic congestion, rapid industrialization, fewer regulations). Indoor air quality is also typically worse due to continued biomass burning (still impacting roughly 3 billion people), fewer available household ventilation systems and the prevalence of second-hand smoke. Several interventions to reduce exposure to indoor and outdoor air pollution have demonstrated effectiveness in countries such as the USA [36,37] and Germany. According to Rawat and Kumar, there is no single intervention method for controlling exposure to indoor and outdoor air pollution, but a combined application of several methods can be more effective [38].

The key strengths of the current project are the new data that will emanate from this pre-post intervention in a large area and the sustainability of air pollution exposure reduction interventions delivered by CSGs. These will be important new data for Nigeria and will underpin the case for action, specifically highlighting the potential for air pollution reduction integration within existing healthcare delivery systems. These findings may also help inform air pollution exposure reduction programmes in other LMICs especially in sub-Saharan Africa. Additionally, the intervention uses various behavioural change mechanisms and has considered the social norms and community dynamics for the local region.

The study, however, has a few limitations. The study is restricted to one state in Nigeria and does not have a control arm due to logistical and budgetary constraints. Therefore, we cannot claim that the study will provide definitive data about the effect of this intervention across the entirety of Nigeria, however, the results are likely to be broadly generalizable to the cities like Ibadan due to the similarities in family structure, culture, and activities, and will provide evidence of feasibility for scale-up.

Conclusion

This study will generate important new evidence and clearly define the potential for behavioural change interventions for indoor and outdoor air pollution exposure reduction in Nigeria. The findings will be targeted primarily at policymakers to support the implementation of scalable community-based interventions to reduce exposure to indoor and outdoor air pollution. Findings will also be disseminated more widely through health and environmental societies, health foundations, scientific conferences and peer-reviewed publications, as well as to the participating communities.

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Conflict of Interest Disclosure

The authors declare they have no conflict of interest.

Authors' contribution

AGF and AMA conceptualized and designed the study. AGF wrote the first draft of the manuscript. AGF, TB, AOO, OMM, OA, SK, ESM, IOA, MA and AMA contributed to the design of the study while AGF, TB, AOO, AO and MM designed the data collection instrument. All authors edited and approved the final draft. AMA and AGF led the funding acquisition as overall PI and MPI respectively.

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