Awareness, Knowledge, and Sources of Carbon Emissions Among Healthcare Personnel in Primary Health Care Centres in Kano Metropolis, Nigeria

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ABSTRACT

Healthcare facilities are significant, often overlooked contributors to greenhouse gas emissions, particularly indirect (Scope 3) sources such as procurement, staff commuting, patient transportation, and waste management. This descriptive cross-sectional study assessed carbon-emission knowledge and awareness among healthcare personnel and identified the major emission sources in eight selected Primary Health Care (PHC) centres in Kano Metropolis, Kano State, Nigeria. A structured questionnaire was administered to 396 respondents selected through multistage sampling using Yamane's formula; 394 copies (99.5% response rate) were retrieved and analysed using descriptive statistics. Personnel showed good basic knowledge of everyday emission sources, with over 90% correctly identifying staff commuting, patient transportation, waste disposal, and facility operations, but only 45.4% had received formal training and only 34.3% were aware of relevant guidelines. Transportation of medical supplies (99.5%), staff commuting (99.2%), procurement of consumables (98.7%), and healthcare waste transportation (98.5%) were the leading emission sources. The study concludes that awareness is not matched by adequate training or policy knowledge, and recommends regular training, targeted awareness campaigns, and clearer institutional guidelines to close the identified gaps.

KEYWORDS

Carbon emissions, Primary Health Care, Scope 3, knowledge and awareness, Kano Metropolis

I. INTRODUCTION

Healthcare facilities are increasingly recognized as important, though often overlooked, contributors to greenhouse gas emissions (Health Care Without Harm, 2019). Beyond the direct emissions associated with on-site energy use, health facilities generate substantial indirect (Scope 3) emissions through procurement of pharmaceuticals and medical supplies, staff commuting, patient transportation, and management of healthcare waste (Lenzen et al., 2020). In low- and middle-income countries, Primary Health Care (PHC) centres form the backbone of community-level healthcare delivery, yet their contribution to carbon emissions, and the awareness of this contribution among the personnel who run them, remains poorly documented (Walsh et al., 2024).

In Kano State, Nigeria, primary healthcare services are coordinated by the Kano State Primary Health Care Management Board (KSPHCMB) in collaboration with the National Primary Health Care Development Agency (NPHCDA). PHC centres in the state face growing operational demand, alongside challenges such as inconsistent power supply and healthcare waste management constraints, all of which generate indirect emissions through procurement, transportation, and outsourced services. Understanding whether frontline healthcare personnel are aware of these emission pathways, and identifying which operational activities contribute most, is a necessary first step toward developing realistic mitigation strategies for the sub-sector.

This paper reports findings from a larger dissertation study on operational and environmental practices related to carbon emissions in PHC centres in Kano Metropolis, focusing specifically on two of the study's objectives: (i) to assess the knowledge and awareness of healthcare personnel regarding carbon emissions, and (ii) to determine the major sources of carbon emissions in the selected PHC centres.

II. MATERIALS AND METHODS

A. Study Design and Area

The study adopted a descriptive cross-sectional survey design, appropriate for capturing a snapshot of current knowledge, awareness, and operational practices at a single point in time. The study was conducted in selected Primary Health Care centres within Kano Metropolis, Kano State, Nigeria.

B. Study Population and Sampling

The study population comprised PHC managers, Environmental Health Officers, health workers, and administrative staff working in the selected PHC centres, who had worked in the facility for at least six months and were directly involved in facility operations or environmental management. The minimum sample size was determined using the Taro Yamane formula for finite populations (Yamane, 1967), based on a total eligible population of 3,583, yielding a minimum of 360 respondents; after adjusting for a 10% non-response allowance, the final sample size was set at 396. A multistage sampling technique was used: Local Government Areas within Kano Metropolis were selected by simple random sampling (balloting); PHC centres within the selected LGAs were then selected by simple random sampling; and respondents were finally selected from each facility by simple random sampling, proportionate to facility staff strength, until the required sample size was reached.

C. Data Collection Instrument

Data were collected using a structured, researcher-designed questionnaire divided into sections covering socio-demographic characteristics, knowledge and awareness of carbon emissions, and sources of carbon emissions in the facility, among other sections addressing the wider study. Knowledge and awareness items were framed as True/False statements,

while sources of emissions were assessed using Yes/No items on whether specific operational activities occurred within the respondent's facility.

D. Data Analysis

A total of 396 questionnaires were administered, of which 394 were returned and analysed, giving a response rate of 99.5%. Data were analysed using descriptive statistics — frequencies and percentages — presented in line with the two objectives addressed in this paper.

III. RESULTS

A. Response Rate and Respondent Characteristics

Of the 396 questionnaires administered across the selected PHC centres, 394 were completed and returned, representing a response rate of 99.5%, which provided a sufficient basis for reliable analysis.

B. Awareness and knowledge of Carbon Emissions

Awareness was assessed using eight items (Table 1). Awareness that facility activities contribute to carbon emissions was high (96.2%), as was general awareness of what carbon emissions are (93.1%) and willingness to participate in future training (96.7%). In contrast, only 45.4% of respondents reported having received formal training or information on carbon emissions or climate change, and only 48.0% were aware of the health implications of carbon emissions.

Figure 1: Awareness of Carbon Emissions Among Healthcare Personnel (n = 394)

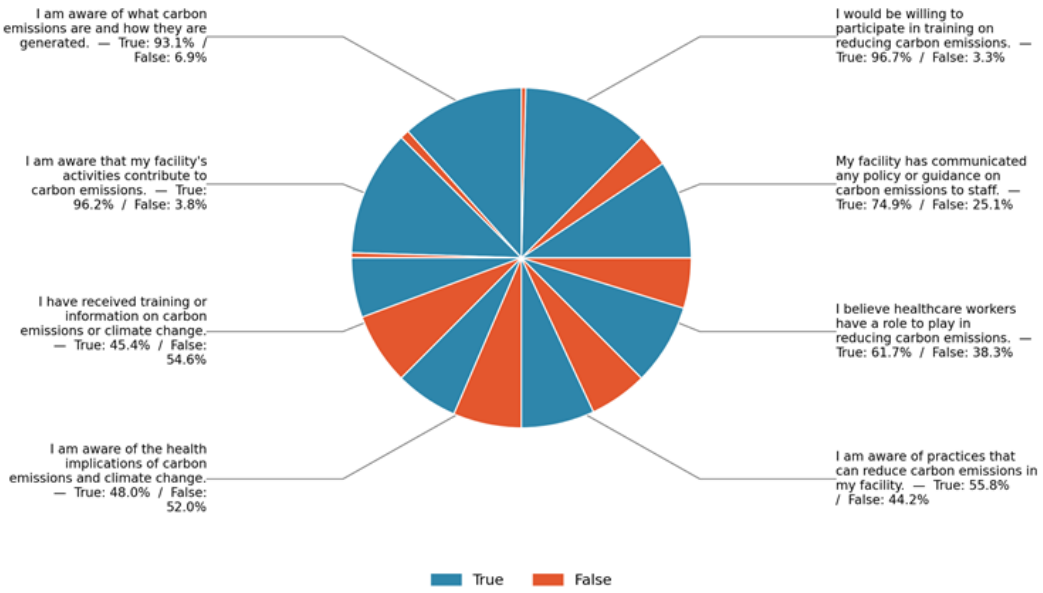

Figure 1: Awareness of Carbon Emissions Among Healthcare Personnel Using True or False options

Respondents, Awareness of policy-related aspects was weaker: only 34.3% of respondents correctly identified that national or international guidelines on carbon emissions in the health sector exist, and 31.7% incorrectly agreed that healthcare emissions have no effect on climate change. However, knowledge of carbon emissions was assessed using ten True/False statements (Table 2). A large majority correctly recognized staff commuting and patient transportation (97.2%), improper healthcare waste disposal (97.0%), facility daily operations (95.2%), and procurement/transportation of medical supplies (93.7%) as sources of carbon emissions.

Figure 2: Knowledge of Carbon Emissions Among Healthcare Personnel (n = 394)

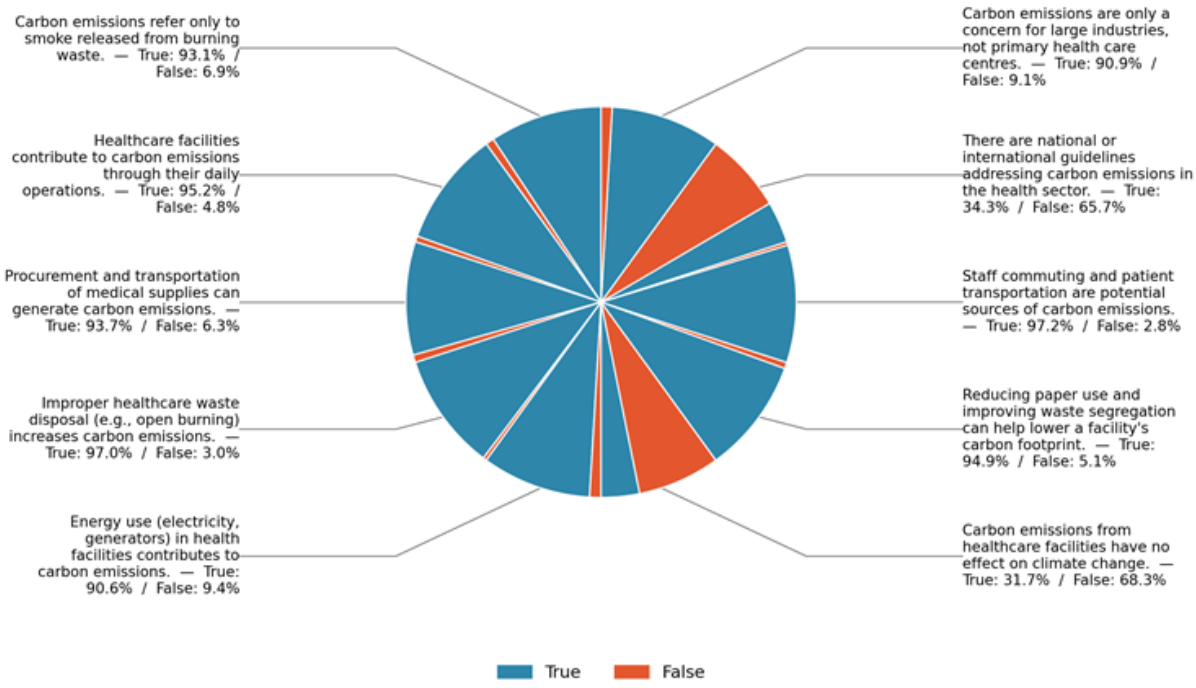

Figure 2: Knowledge of Carbon Emissions Among Healthcare Personnel Using True or False opinions

Overall, healthcare personnel demonstrated good basic knowledge and awareness of practical, everyday sources of carbon emissions, but notable gaps remained in formal training, awareness of health implications, and knowledge of relevant policies and guidelines. The high willingness to participate in training (96.7%) indicates a strong readiness among staff to build further capacity in this area.

C. Major Sources of Carbon Emissions

Respondents indicated whether specific operational activities linked to carbon emissions occurred within their facilities (Table 3). Transportation of medical supplies to the facility was the most commonly reported source (99.5%), followed closely by daily staff commuting from outside the facility (99.2%), procurement of office consumables from external suppliers (98.7%), and transportation of healthcare waste for treatment or disposal (98.5%). Transportation of patients for referral services (98.0%) and procurement of

medical supplies (96.7%) and pharmaceuticals (94.7%) from external suppliers were also widely reported. Community outreach activities involving transportation recorded the lowest, though still substantial, affirmative response (92.6%).

Figure 3: Major Sources of Carbon Emissions in Selected PHC Centres (n = 394)

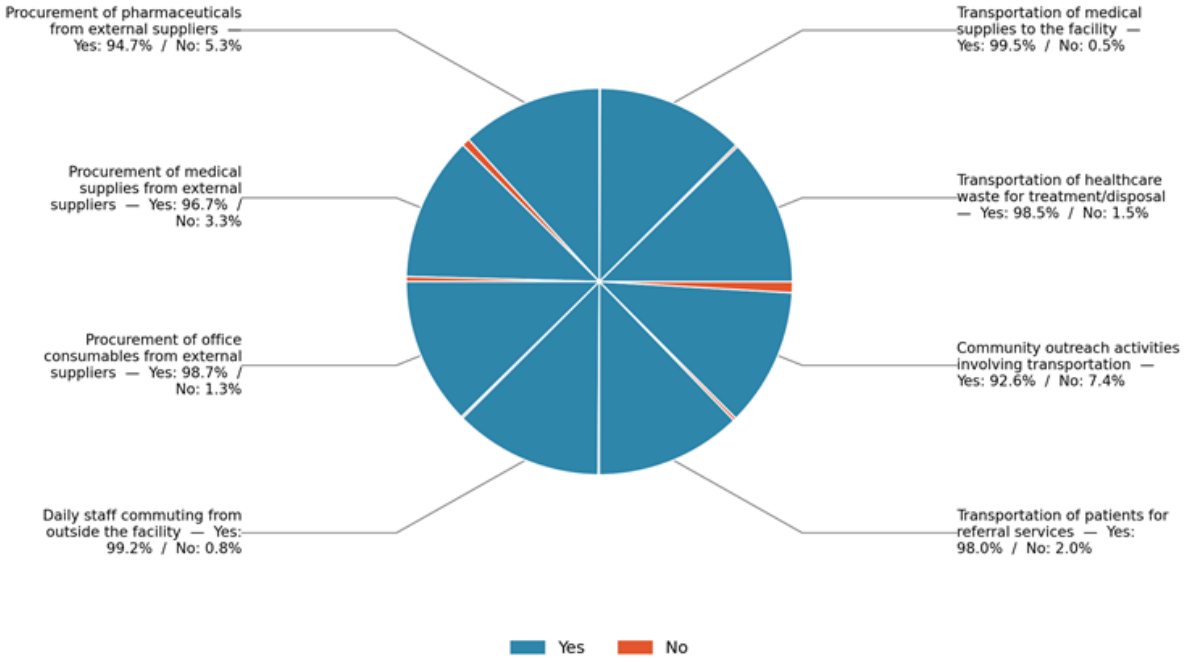

Figure 3: Major Sources of Carbon Emissions in Selected PHC Centres Using Yes or No options

Overall, procurement-related logistics, employee commuting, patient referrals, and healthcare waste transportation emerged as the predominant sources of carbon emissions across the selected PHC centres, indicating that transportation- and procurement-related activities are the major drivers of Scope 3 emissions in this setting.

IV. DISCUSSION

The finding that healthcare personnel possess good basic knowledge of practical sources of carbon emissions, such as waste disposal, staff commuting, and facility operations, but lag in awareness of formal training, health implications, and policy guidelines, suggests that everyday operational exposure builds intuitive awareness faster than structured environmental education does (Manyele et al., 2010). This pattern is consistent with the view that carbon-emission awareness in healthcare settings tends to be experiential rather than policy-driven, particularly where national guidelines specific to the health sector are limited or poorly disseminated (Walsh et al., 2024).

The identification of procurement logistics, staff commuting, patient referral transportation, and healthcare waste transportation as the dominant sources of emissions aligns with the broader recognition that Scope 3 emissions, arising indirectly from a facility's supply chain and workforce movement, often outweigh direct on-site emissions in healthcare settings

(NHS England, 2022). This has practical implications for PHC centres in Kano Metropolis: interventions aimed at reducing carbon emissions may achieve more impact by targeting procurement planning, supplier consolidation, and transportation efficiency than by focusing solely on on-site energy use (Azubuike et al., 2022).

The very high willingness of staff to participate in training (96.7%) despite low current training coverage (45.4%) represents an accessible entry point for health authorities and PHC management to close the awareness gap through structured, low-cost educational interventions (Sherman et al., 2020).

V. CONCLUSION AND RECOMMENDATIONS

Healthcare personnel in the selected PHC centres in Kano Metropolis demonstrated good basic knowledge and awareness of carbon emissions arising from everyday facility operations, but formal training, policy awareness, and knowledge of national or international guidelines remained limited. Transportation of medical supplies, staff commuting, procurement of office consumables, and healthcare waste transportation were identified as the major sources of carbon emissions in these facilities, pointing to procurement and transportation activities as priority areas for emission-reduction interventions (UNEP, 2024).

Based on these findings, it is recommended that: (i) the Kano State Primary Health Care Management Board and PHC management institute regular, structured training on carbon emissions and climate change for healthcare personnel; (ii) health authorities develop and disseminate clear guidelines on carbon emissions specific to the health sector; and (iii) PHC centres explore procurement and transportation-efficiency measures, such as supplier consolidation and coordinated logistics, to reduce Scope 3 emissions associated with medical supply and staff commuting activities.

DECLARATION

Ethical Approval: Ethical approval was obtained from Kwara State University Malete center for research and development securing authorization to conduct the study. All procedures involving data collection, handling, and analysis were done responsibly and in accordance with institutional academic standard and guidelines.

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