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Evaluation of Air-Condition Use and Its Health Effects

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Evaluation of Air Condition Use and Its Health Effects

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Abstract
The use of air conditioners (ACs) in homes has become a necessity in urban cities such as Lagos State. The rapid growth in the use of AC has been attributed majorly to protection from high thermal exposures. However, there have been controversies regarding physiological discomforts attributed to AC use. This study therefore seeks to elucidate the associations between AC use and some selected physical ailments using random samples from Lagos State. A structured questionnaire was administered to 200 randomly selected participants. The responses were scored, and the data were analyzed accordingly. The study showed that AC devices were mostly used in sitting room > bedroom > offices > vehicles. The frequency of cold, fever, headache, and chest pain significantly ($p < 0.01$) associate with the use of AC in both sitting room and bedroom. The prevalence of the associated ailments increased with increase in the AC contact duration (>6 h) among AC users evaluated in the study. Most of the participants (>70%) agreed that AC use brings thermal comfort and therefore is good to health. However, prolonged exposure in indoor AC environments increased the risk of physiological discomfort for the AC users in this study. The authors therefore suggest health workers to create awareness to educate AC users of the likely dangers with prolonged exposure.

Keywords: Air conditioner; Health effects; Physiological discomfort; Allergic symptoms; Physical ailment.

1. INTRODUCTION

Climate variability and change are issues of growing public health importance [1]. The increase in heat exposure level as a result of global climate change in urban areas is a health and productivity risk for millions of people. Inhabitants in the tropical and subtropical urban areas are at higher risk due to high population density [2-6]. Heat is the top weather-related killer in the United States [1]. In California, the July 2006 heat wave, which was of an unprecedented magnitude and humidity was responsible for over 600 excess deaths [7] and over 1200 hospitalizations for cardiovascular and other diseases [8]. Multiple disease categories that are known to be associated with complications from hot weather have also been reported [9]. Heat-related morbidity and mortality have also been reported [10]. Air conditioners (ACs) have however been used over time as a technical solution to this prevalent challenge worldwide.

ACs are indoor devices used to cool air by reducing the humidity following condensation of the water vapor [2, 11]. Anas *et al*. [12] further stated that the AC devices consisted of centralized equipment that provide an atmosphere with controlled temperature, humidity, and purity at all times regardless of the weather conditions. Because they provide thermally stable environments, it has been reported to have a profound effect on the quality of breathable air and on the respiratory system than just lowering the temperature [3, 13].

The use of ACs is growing rapidly in the urban regions due to income growth and the need to protect from high heat exposures [2]. People spend 80% of their time indoors such as homes and offices equipped with AC for various reasons, including good operational output of equipment and comfort [14-16]. However, the increasing AC use combined with the global trends in urban and building design enforces a growing urban vulnerability as well as increased emission of greenhouse gases [3]. Its use has also been frequently pinned down with some form of physiological discomforts and allergic symptoms (also referred to as sick building syndrome) that were noticed only when users spent considerable time indoors [12]. These include headache, nasal and skin irritations, and breathing problems among others [17]. Apart from the fact that studies on the effects of AC use associated with related health outcomes are limited [16], Schahzad *et al*. [18] argued against the reliability of this claim due to inconsistent findings on whether the air-conditioning system results in sick building syndrome or not. Hence, the primary objective of this study was to evaluate the association between AC use and selected physical ailments among the populace from Lagos State, Nigeria.

2. METHOD(S)

2.1. Study Area
This study was carried out in Lagos State that lies in the southwestern geopolitical zone of the Federal Republic of Nigeria at latitude 6°35'N and longitude 3°45'E. The high urbanization and industrial growth rate in Lagos have made it the nation's largest urban area with a population of ~9.1 million according to 2006 Census [19, 20].

2.2. Design of Questionnaire
The questionnaire method used in the study consisted of both closed-ended and Likert-scaled questions. The structure interview was adopted in this study to allow the researcher explain each terminology used to the participants. The questionnaire was divided into four (4) sections: Section A dealt with the respondents' sociodemographics, Section B dealt with the respondents' AC possession and frequency of use, Section C dealt with the respondents' personal health status, and Section D dealt with the respondents' perception of AC use health impact.

2.3. Sampled Participants
Two hundred (200) participants comprising 100 adult males and 100 adult females were selected to participate in this study. They were randomly selected among the populace of Lagos State from various locations and works of life.

2.4. Selection of Ailments Used in the Study
A pilot survey was done on thirty (30) random participants with medical background on likely ailments associated with AC use. The sampled participants for the pilot survey were physicians from local, private, and state clinics and hospitals. Six most suggested ailments were selected for use in the questionnaire used in the study (result not included in this study). These ailments include cold, headache, fever, itchy throat, chest pain, and cough.

2.5. Data Collection
Each participant was interviewed by the researcher, after the contents of the questionnaire had been read and explained to them in their native tongue (illiterate participants) or English (literate participants) for their understanding. The completed questionnaires were collected and analyzed. Confidentiality was assured by not including the names of the participants, while the participants who declined to be part of the study were excluded.

2.6. Analysis of Data
Responses from the participants were scored accordingly. Scored data were analyzed using IBM SPSS v23. Analyzed data were expressed in counts (responses) and percentages. The chi-square test of independence was used to test for the association between AC use and selected ailments. The significant level of 1% was used because of the stringency of the study implications to health studies. Entries with any missing data were not considered in the analysis. Participants with any double or unmatched entries among responses in Section B (possession and use of AC) were not included in the data for analysis.

3. RESULTS

3.1. Sociodemographics of Sampled Respondents
A total of 189 respondents who fully completed the questionnaire and met the criteria highlighted earlier were analyzed of the 200 participants sampled for the study, giving the response rate of 94%. Most respondents were between 18 and 25 years (53.7%), single (62.4%), Christians (56.6%), and had tertiary education (80.3%). The status of the respondents was well distributed with majority being students (43.9%) followed by employed (22.8%) and private enterprise (15.9%) with few unemployed (3.7%) (Table 1).

3.2. AC Usage Among Respondents
In this study, 74.1% of the respondents had ACs in their sitting room, 25.9% had ACs in their bedrooms, and 38.6% had ACs in their vehicles, while 42.3% had ACs in their offices. All respondents used in the study who possess AC in their sitting rooms, bedrooms, vehicles, and offices made use of it (Table 2).

3.3. Perceived Implications of AC Use on Health from Respondents
Perceptions of respondents in this study regarding health implications from AC use are itemized in Table 3. Most sampled participants agreed (86.7%) that AC was good to the body for cooling the body temperature (74%). Interestingly, the study also observed that respondents believed that the use of AC does not cause any discomfort to the body (64.9%), though 38.8% still consider the use of AC to cause some ailments. In total, 69.8 and 47.3% agreed that the use of AC was associated with cold and feverish conditions, respectively. In addition, 56.9 and 51.1% believed that the use of AC can increase catarrh incidence

Table 1: Demographics of respondents included in the study.

Demography	Frequency	Percent (%)
Age		
18-25 years	101	53.7
26-40 years	61	32.4
41-60 years	23	12.2
≥61 years	3	1.6
Gender		
Male	92	48.7
Female	97	51.3
Marital status		
Single	118	62.4
Married	69	36.5
Divorced/Widowed	2	1.1
Religion		
Christianity	107	56.6
Islamic	78	41.3
Traditional	4	2.1
Education		
None	7	3.7
Primary	4	2.1
Secondary	26	13.8
Tertiary	151	80.3
Occupation		
Student	83	43.9
Civil servant	23	12.2
Private enterprise	30	15.9
Employed	43	22.8
Unemployed	7	3.7
Retired	3	1.6

Table 2: Possession and usage of AC by respondents.

Possession of AC device	Usage of AC device			
	Response	Yes	No	Total (%)
Do you have AC in the sitting room at home?	Yes	140	0	140 (74.1)
	No	0	49	49 (25.9)
Do you have AC in the bedroom at home?	Yes	83	0	83 (43.9)
	No	0	106	106 (56.1)
Do you have AC in your vehicle?	Yes	73	0	73 (38.6)
	No	0	116	116 (61.4)
Do you have AC in the office at work?	Yes	80	0	80 (42.3)
	No	0	109	109 (57.7)

AC: air conditioner.

and pneumonia, respectively. However, majority disagreed that AC use could cause headache (57.5%), cough (57.4%), increase cough (52.2%), or high blood pressure (61.2%) (Table 3).

3.4. Association of AC Use and Selected Ailments in the Study

Association of AC use in the sitting room, bedroom, vehicle, and offices with the prevalence of cold conditions is reported in Table 4. A significant association between the use of AC in the sitting room ($\chi^2 = 40.42$, $p < 0.01$) and bedroom ($\chi^2 = 27.71$, $p < 0.01$) at home with cold prevalence was observed. There was a gradual increase in the prevalence of cold among those respondents with increase in AC contact hours. The highest cold complaint was observed among 91.8% of respondents with 12-17-h AC contact in the sitting room (Figure 1A). Similarly, complaints of cold increased with increased use of bedroom AC

Table 3: Perception of respondents in the study.

Perceived AC effects	SA	A	U	D	SD
AC is good to the body	45.5	41.2	4.8	5.9	2.7
AC cools the body temperature	46.3	27.7	14.4	10.6	1.1
AC does not cause any discomfort to the body	36.7	28.2	18.1	13.8	3.2
AC causes some illness	6.4	32.4	13.3	33.5	14.4
AC increases cold conditions	19.5	50.3	9.6	13.9	7.0
AC increases feverish conditions	7.5	39.8	14.0	29.6	9.1
AC increases headaches	6.4	23.9	12.9	41.0	16.5
AC increases itchy throat	5.3	15.0	18.2	42.8	18.7
AC increases catarrh	6.9	50.0	13.3	22.9	6.9
AC causes pneumonia	12.8	38.3	17.6	22.9	8.5
AC causes cough	4.8	23.9	13.8	46.8	10.6
AC increases cough	5.9	29.3	12.8	37.8	14.4
AC causes high blood pressure	6.4	12.2	20.2	26.1	35.1

Values are represented in percentages (%); AC: Air conditioning; SA: Strongly agree; A: Agree; U: Undecided; D: Disagree; SD: Strongly disagree.

Table 4: Association between AC use and selected ailments.

Location of AC use	Cold	Headache	Fever	Itchy throat	Chest pain	Cough
Sitting room	$\chi^2 = 40.42$	$\chi^2 = 18.42$	$\chi^2 = 6.03$	$\chi^2 = 5.60$	$\chi^2 = 6.28$	$\chi^2 = 6.30$
	$p < 0.01$	$p < 0.01$	$p = 0.20$	$p = 0.23$	$p = 0.18$	$p = 0.18$
Bedroom	$\chi^2 = 27.71$	$\chi^2 = 25.06$	$\chi^2 = 15.14$	$\chi^2 = 6.71$	$\chi^2 = 15.53$	$\chi^2 = 2.85$
	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p = 0.15$	$p < 0.01$	$p = 0.58$
Vehicle	$\chi^2 = 7.12$	$\chi^2 = 6.31$	$\chi^2 = 3.30$	$\chi^2 = 3.72$	$\chi^2 = 2.96$	$\chi^2 = 2.78$
	$p = 0.13$	$p = 0.18$	$p = 0.51$	$p = 0.45$	$p = 0.57$	$p = 0.60$
Office	$\chi^2 = 2.86$	$\chi^2 = 11.86$	$\chi^2 = 0.83$	$\chi^2 = 2.42$	$\chi^2 = 7.62$	$\chi^2 = 5.05$
	$p = 0.58$	$p = 0.02$	$p = 0.94$	$p = 0.66$	$p = 0.11$	$p = 0.28$

among all (100%) respondents in contact with bedroom AC >18 h complaining of cold in the study (Figure 1B). However, the use of AC in vehicles and offices did not show any significant association with the prevalence of cold conditions ($p > 0.01$) among sampled respondents (Table 4).

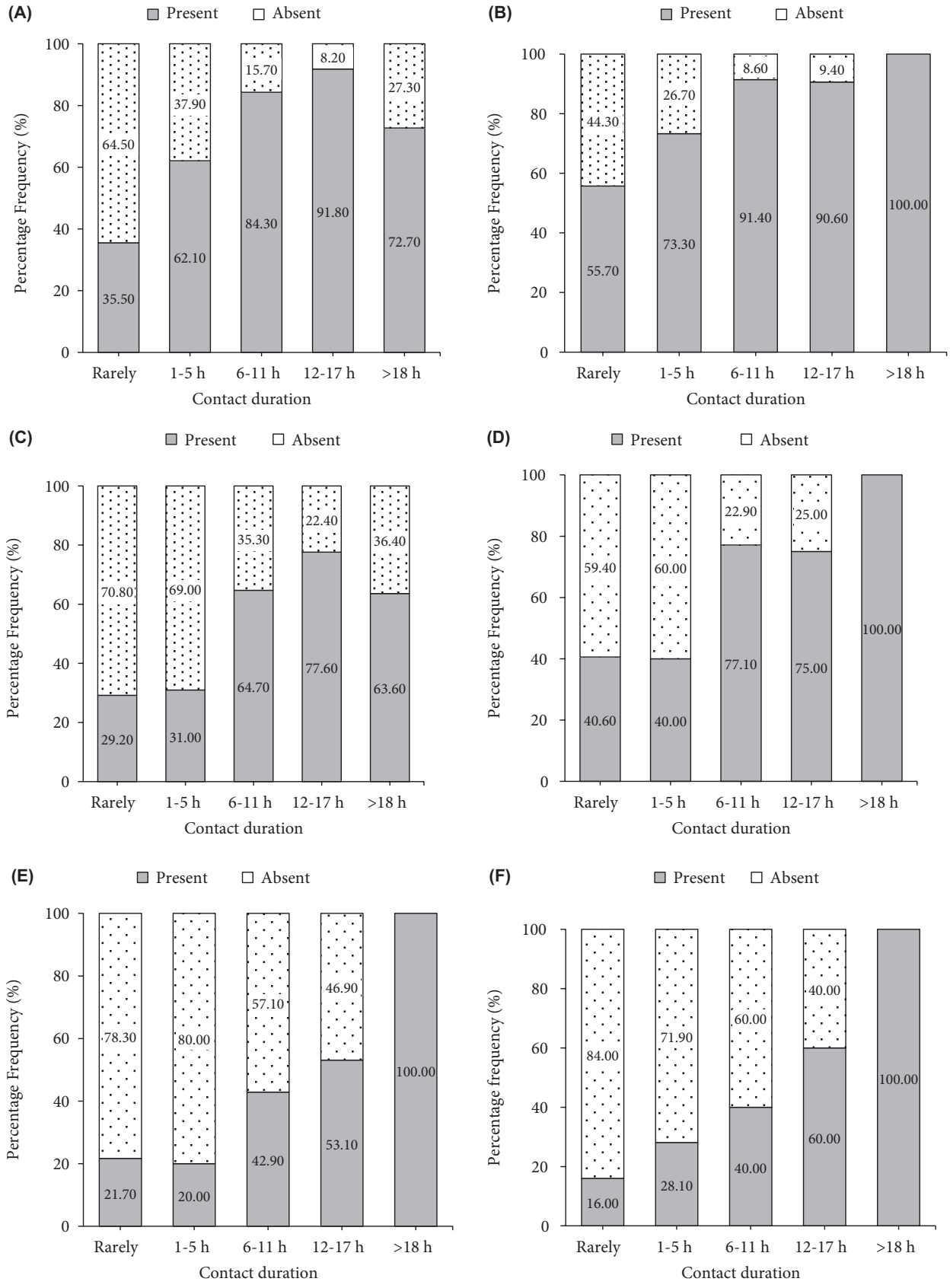
The prevalence of headache was observed to be significantly associated with the use of AC in both sitting room ($\chi^2 = 18.42$, $p < 0.01$) and bedroom ($\chi^2 = 25.06$, $p < 0.01$) in the home. The frequency of headache complaints was highest among respondents with 12-17-h AC contact in the sitting room (Figure 1C), while all (100%) respondents who had >18-h AC contact in the bedroom complained of frequent headaches (Figure 1D). There was a gradual increase in the frequency of headache complaint with increase in AC contact hours in both the sitting room and bedroom (Figure 1C and 1D). However, the use of AC devices in the vehicle and offices was not significantly associated with prevalent headaches in this study among respondents (Table 4).

Feverish conditions in the study were observed to be only significantly associated with the use of AC devices in the bedroom ($\chi^2 = 15.14$, $p < 0.01$) in the home. The use of AC devices in the sitting room, vehicle, and offices did not significantly associate with prevalent headaches in this study (Table 4). There was an increase in headache reports with increasing time spent in AC environment (Figure 1E). There was no significant association between the use of AC in the sitting room, bedroom, vehicle, and offices with the prevalence of feverish conditions, itchy throat, chest pains, and cough symptoms among sampled respondents (Table 4).

The study showed a significant association between prevalent chest pain with the use of AC in the bedroom ($\chi^2 = 15.53$, $p < 0.01$). Although almost all those without AC in their bedroom did not complain of chest pain (84%), 39.9% of the respondents using bedroom AC complained of chest pains. There was an increasing prevalence of chest pain with increasing time spent in the bedroom AC environment (Figure 1F). The use of AC in the sitting room, vehicle, and office did not significantly associate with chest pain in this study (Table 4).

Shaded bar indicates the presence of ailment, while the dotted bar indicates the absence of ailment. (A) Duration of AC use in the sitting room is associated with prevalence of cold among respondents. (B) Duration of AC use in the sitting room is associated with prevalence of headache among respondents. (C) Duration of AC use in the bedroom is associated with prevalence of cold among respondents. (D) Duration of AC use in the bedroom is associated with prevalence of headache among respondents. (E) Duration of AC use in the bedroom is associated with prevalence of fever among respondents. (F) Duration of AC use in the bedroom is associated with prevalence of chest pain among respondents.

Figure 1: Duration of contact with AC associated with evaluated ailments.



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4. DISCUSSION

The use of an item, goods, or equipment depends not only on its availability but also on users' perspectives and beliefs. The study showed that most of the AC users believed that the use of AC is safe for their health. AC devices have been used in many parts of the world mostly for thermal comfort and an acceptable indoor air quality for occupants. However, health problems associated with AC systems and indoor air quality occur more frequently [21]. Common ailments evaluated in the study corroborate with highlighted complaints reported by Vidya *et al*. [11], which include mucous membrane irritation, breathing difficulties, irritated skin, and constitutional/neurological symptoms such as headache and fatigue.

Yu *et al*. [21] stated that indoor environment problems still exist in many AC buildings, even though existing standards may be met. In this study, cold, feverish conditions, headaches, and chest pain were found to be associated with the duration of AC use in both the sitting room and bedroom. Similar result was reported in the work of Ostro *et al*. [16] among some hospitalized patients in California, USA. These discomforts may likely be attributed to indoor air pollutants that may include particle pollutants and gaseous pollutants [21]. Particle pollutants endanger the human body through three approaches, namely respiration canal, skin, and alimentary canal. It is dangerous approach that particle pollutants enter human body through respiration canal [22]. The degree of harm by particle pollutants to the human body was related to the chemical characteristic, diameter, magnitude, and quantity. The chemical characteristic of particle pollutants is the main factor because the chemical characteristic determines the degree and speed of biochemistry processes that particle pollutants participate in and disturb in human body. Most of the particle pollutants in air are quite small. They have difficulty in settling and being captured. Conversely, it is easy for them to enter respiration canal deeply together with inhaled air [23, 24]. These are circulated in a close environment with the aid of the AC device. Moreover, the surface of particle pollutants can adsorb harmful gases, liquids, and microbes, which increases the harm to human body [23, 24].

It was observed in the study that AC use between 12 and 17 h in the sitting room was associated with 91.8 and 77.6% of cold and headache complaints among AC users, while the prevalence of cold, headache, feverish conditions, and chest pain was observed to increase with increasing time spent in bedroom AC among respondents in the study. This high prevalence of discomfort among AC users who spent a considerable amount of time indoors (in the AC environment) might be due the effect of prolonged AC exposure on their thermal adaptation. The works of Cao *et al*. [25] revealed that people who tend to stay for a long period of time in an air-conditioned environment tend to have weakened thermal adaptation and have weaker ability to endure hot environment. Graudenz *et al*. [26] also reported that people spend 80-90% of their time indoors, and indoor environments have important effects on the human health.

One major factor that can predispose AC users to diverse health discomfort as observed in this study is the nonmaintenance or servicing of AC devices at regular intervals. These devices over time harbor dust and pathogenic microorganisms that are redistributed and circulated indoor any time the ACs are used. The presence of these organisms poses health risk through nasal entries. Anas *et al*. [12] in their study isolated and identified pathogenic microorganisms such as *Aspergillus niger, Aspergillus flavus, Aspergillus versicolor, Bacillus alvei, Providencia stuartii, and Bacillus lentus* in some AC devices evaluated. The works of Zhang *et al*. [27] and Sun *et al*. [28] have shown that indoor airborne microorganisms' contamination may have a role in the causation of certain ailments associated with sick building syndrome.

5. CONCLUSION

In this study, several beliefs have made the use of AC devices a necessity in metropolitan cities such as Lagos. Some of these beliefs contradict the outcome of association study between AC use and prevalence of some selected ailments. Cold, fever, headache, and chest pain were associated with the duration of exposure to indoor AC environment. However, with the increased frequency of physiological discomfort experienced by the users, there is a need to find ways to address this issue. We therefore suggest that awareness should be made to educate the populace about the likely dangers of prolonged exposure to indoor AC environment.

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Author Contributions
O.O. Eleyowo: Design, Acquisition of data, Drafting of article.
O.D. Amusa: Conception and Design, Analysis of data, Revising article critically for important intellectual content, Final approval of article for publication.

Conflict of Interest
There is no conflict of interest.

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