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Human Health Implications of Vehicular Indoor Air Pollution for Commuters in Selected Road Routes in Port Harcourt Metropolis

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Abstract
This study was carried out to assess the human health implications of poor vehicular indoor air quality in selected road routes in Port Harcourt Metropolis. The descriptive survey research design was adopted for this study. Primary data were collected from questionnaire responses from commuters (drivers) who ply the selected road routes. Secondary data was also obtained from materials which have been previously documented and that relates to the study. Such documents include related research reports in the field of study from journals, textbooks and magazines. Results from questionnaire analysis revealed that vehicular indoor air pollution had significant effect on health status of the commuters. Questionnaire responses revealed that 42.7% of the total respondents were exposed to vehicular indoor air pollutants for 1-5 hours daily, 46.8% of the total respondents were exposed to vehicular indoor air pollutants for 6-10 hours daily while 10.5% of the total respondents were exposed to vehicular air pollutants for a duration of above 10 hours daily. The questionnaire responses also revealed that 74.9% of the total respondents reported cases of cough and shortness of breath while 25.1% of the total respondents did not report cases of cough and shortness of breath. The results also revealed that 35.1% of the total respondents suffered respiratory tract infections, 30.4% suffered stress disorders, 22.2% suffered heart ailments while 12.3% of the total respondents suffered pneumonia. The study recommends regular and periodic servicing of the vehicles plying the selected road routes.

Key words*: Human Health, Vehicular Indoor Air Pollution, Implications, Commuters*

1.0 Introduction

The major sources of air pollution have been identified to be through transportation sources, burning of fossil fuels and other industrial processes (Sharma *et al*., 2013).

Air pollution caused by emission from vehicles is as a result of incomplete combustion of hydrocarbon fuels. As countries develop, there is an enhancement in their transport systems which creates the need for increased vehicle ownership. The steady rise in vehicular volume has had negative impacts on the environment. However, the non-challant attitude of various agencies and parastatals of government towards enforcing environmental standards and regulations has helped worsen the situation (Diagi *et al*., 2022).

Vehicular emissions can be broadly classified into two main categories: exhaust and non-exhaust emissions. The vehicles exhaust emits directly particles as soot or particles result from the nucleation of exhaust gases. In this last case, oxides (CO, NOx, CO_2) and hydrocarbons are formed during incomplete fuel combustion, diluting, mixing and cooling of the exhaust gas in the environment; then particles are formed due to condensation and coagulation processes. On the other hand, non-exhaust emissions are produced due the abrasion of tires and breaks wearing, abrasion of the pavement, that result in the resuspension of particles (Pérez *et al*., 2010).

The study area, Port Harcourt metropolis has witnessed unprecedented growth and this has further exacerbated air quality within the city. Industrialization, urbanization and the onset of trade and commerce activities within the city is primarily responsible to frequent use of automobiles and other transport systems. Lack of maintenance and periodic servicing of these automobiles releases harmful toxic substances into the atmosphere (Asimiea *et al*., 2022).

The poor air quality situation of Port Harcourt is worsened by the lack of enforcement of environmental and transport regulatory laws in place as the city is littered with gory sights of poorly maintained automobiles releasing harmful pollutants at several road junctions (Emenike & Orjinmo, 2017).

Vehicular indoor air pollution has generated numerous concerns considering the amount of time commuters spend inside their vehicles. Research has shown that commuter spend 5 to 10% of the daily time inside their vehicles. The in-cabin environment could contain a mix of harmful pollutants emitted by the surrounding environment, the vehicle interior fitting, the fuel or the exhaust gas leakage (Xu *et al*., 2016).

The short-term and long-term exposure of children and adults to air pollutants has a significant influence on respiratory infections, severe asthma and reduced lung function (European Environment Agency, 2018). Drivers and passengers may be exposed to a variety of air pollutants that often do not meet air quality standards (Wong *et al*., 2018).

In striking contrast to the multitude of studies that address outdoor air pollution, only little is known about indoor air quality in cars. Although air quality while commuting has been well studied (Chaney *et al*., 2017; Moreno *et al*., 2019; Onat *et al*., 2019; Rivas *et al*., 2017), there is a

paucity of information on the vehicular indoor air quality in Nigeria (which the study area is a part). Furthermore, the scarcity of literature on the health implications of poor vehicular indoor air pollution on commuters in an industrialized city like Port Harcourt metropolis necessitated this study. This study attempts to fill this literature lacuna that hitherto existed.

It is therefore ideal for a study of this nature to be undertaken to ascertain the human health implications of vehicular indoor air pollution for commuters in the selected road routes in Port Harcourt Metropolis.

2.0 Materials and Methods

The study was carried out in Port Harcourt Metropolis which is situated between $04^0 51'30''$N and $04^0 57'30''$N and between longitude $06^0 50'00''$E and $07^0 00'00''$E (Figure 1).

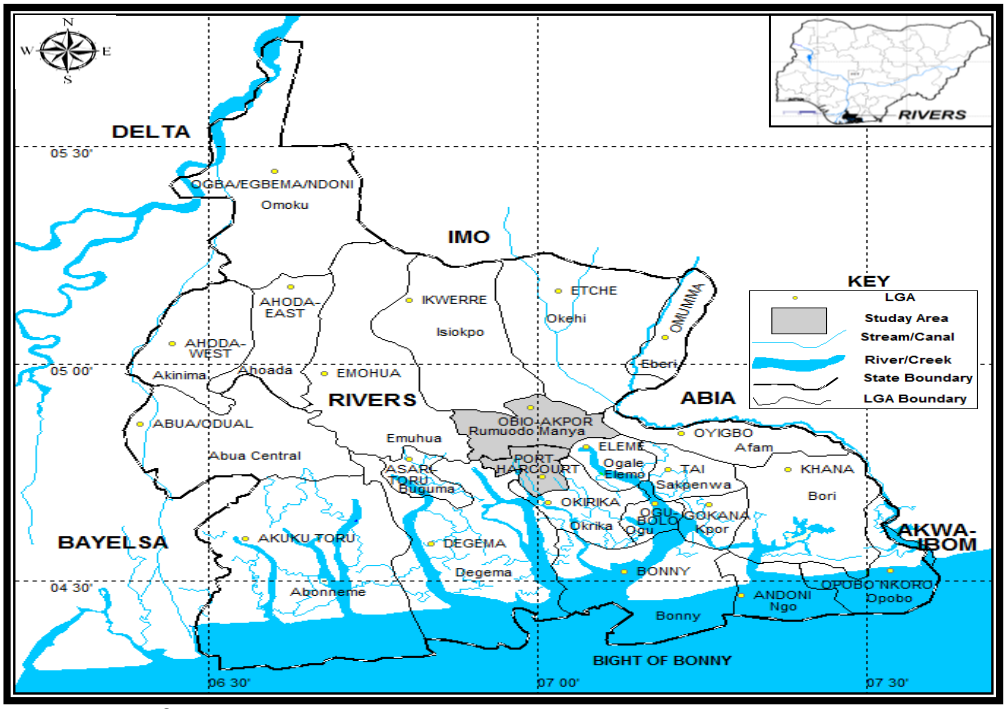

Fig. 1: Map of Rivers State Showing Port Harcourt Metropolis
Source: Cartography/GIS Laboratory, Department of Geography and Environmental Management, University of Port Harcourt, Choba.

The metropolis is surrounded by patches of islands and creeks of the Niger Delta at a height of approximately 12m above sea level. It is approximately 60km from the crest up stream of the Bonny River. The city experiences heavy rainfall of 2370.5mm while the annual temperature of the region is 28^{o}C and a relative humidity of 80%-100%. Two seasons are experienced in Port Harcourt: the wet season which starts around April to November ending and the dry season which begins in November and ends in March (Obisesan and Weli, 2019).

The rapid population growth and increasing commercial activities within the city accounts for the increase in vehicular volume and subsequent deterioration in air quality witnessed within the city (Emenike & Orjinmo (2017).

The target population of interest comprises the total number of drivers who ply the four selected road routes. The selected road routes include Choba Park to Rumuokoro, Rumuokoro Park to Mile 3, Choba Park to Mile 3 and Mile 1 Flyover Park to Eleme Junction. The population of drivers in these selected road routes is shown in Table 3.1 below.

Table 1: Population of Drivers in Selected Road Routes

S/No	Selected Road Routes	Authorized Bus Park	Number of Drivers
1	Rumokoro to Mile 3	Rumuokoro Modern Park	35
2	Choba to Rumuokoro	Choba Park	28
3	Choba to Mile 3	Choba Park	56
4	Mile 1 to Eleme Junction	Education Flyover Park	52
	Total		**171**

Source: National Union of Road Transport Workers (2023)

The sample size includes 171 bus drivers from the selected road routes within Port Harcourt. The purposive sampling technique was deployed to select the road routes within the city. The selection criterion is the accessibility of the road routes which must be a major route with high traffic density. The bus drivers for the questionnaire distribution were also selected using the purposive sampling technique. Only bus drivers who ply the selected routes on a daily basis were selected.

The information on the health implications of the traffic pollutants on the commuters in the selected road routes in Port Harcourt metropolis were collected using a well-structured close-ended questionnaire. The face and content validity of the questionnaire were achieved through the expertise of two (3) research professionals and academics. All items in the questionnaires were carefully cross-checked to ensure simplicity, clarity with understandable language and also in line with the research objectives. The test-retest method was adopted in determining the reliability of the research instrument. The reliability coefficients of the research instrument were determined using Cronbach's Alpha method using 20 participants outside the target population. The reliability coefficient of ≥0.7 was considered reliable for the study.

3.0 Results

Socio-economic characteristics of respondents

Table 2 shows the socio-demographic characteristics of respondents. The distribution of sampled respondents from the questionnaires analyzed shows that 11.1% were within the ages of 21-30, 20.5% were within the ages of 31-40, 42.1% were within the ages of 41-50 while 26.3% were within the ages of 50 and above. Furthermore, questionnaire analysis revealed that 98.8% of the respondents were males while 2.2% of the respondents were females. In the analysis of the marital

status of respondents, it was revealed that 22.2% of the respondents were single and 50.3% were married. The percentages of divorced, widower and separated respondents were 2.9%, 10.5% and 14.1 respectively. It was also revealed that 84.2% of the respondents were Christians, 6.4% practiced Islam while others accounted for 9.4% of the respondents. From the questionnaire analyzed, it shows that 13.5% of the respondents had no formal education. 40.9% had primary school education, 42.7% had secondary education while 2.9% had tertiary education.

Table 2: Socio-demographic characteristics of respondents

Variables	Frequency(n=171)	Percent (%)
Age(years)		
21-30	19	11.1
31-40	35	20.5
41-50	72	42.1
>50	45	26.3
Gender		
Male	169	98.8
Female	2	1.2
Marital Status		
Single	38	22.2
Married	86	50.3
Divorced	5	2.9
Separated	24	14.1
Widow/Widower	18	10.5
Religion		
Christianity	144	84.2
Islamic	11	6.4
Others	16	9.4
Level of education		
None	23	13.5
Primary	70	40.9
Secondary	73	42.7
Tertiary	5	2.9

Perception of the Health Impacts of Vehicular Indoor Air Pollutants.

(i) Exposure to Vehicular Indoor Air Pollutants in line of duty

Fig 2 presents the analysis of questionnaire responses on their exposure to vehicular indoor air pollutants. The results revealed that 106 respondents representing 62.0% of the total respondents opined that they were exposed to vehicular indoor air pollutants while 65 respondents representing 38.0% of the total respondents were of the opinion that they were not exposed to vehicular air pollutants.

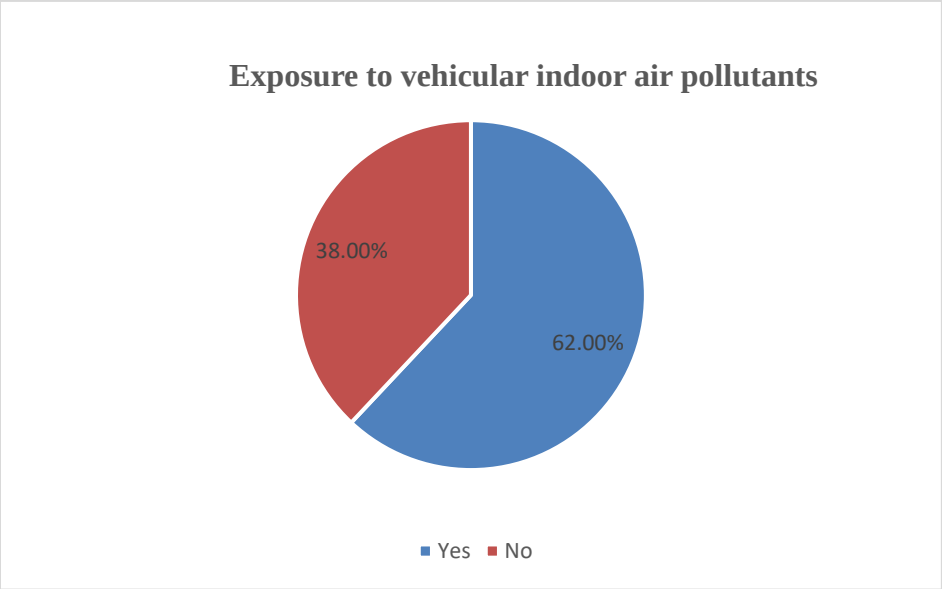

Fig 2: Exposure to Vehicular Indoor Air Pollutants in line of duty

(ii) Duration of Exposure to Vehicular indoor air pollutants

Fig 3 presents the analysis of questionnaire responses on their duration of exposure to vehicular indoor air pollutants. The results revealed that 73 respondents representing 42.7% of the total respondents stated that they were exposed to vehicular indoor air pollutants for 1-5 hours daily, 80 respondents representing 46.8% of the total respondents stated that they were exposed to vehicular indoor air pollutants for 6-10 hours daily while 18 respondents representing 10.5% of the total respondents were of the opinion that they were exposed to vehicular air pollutants for a duration of above 10 hours daily.

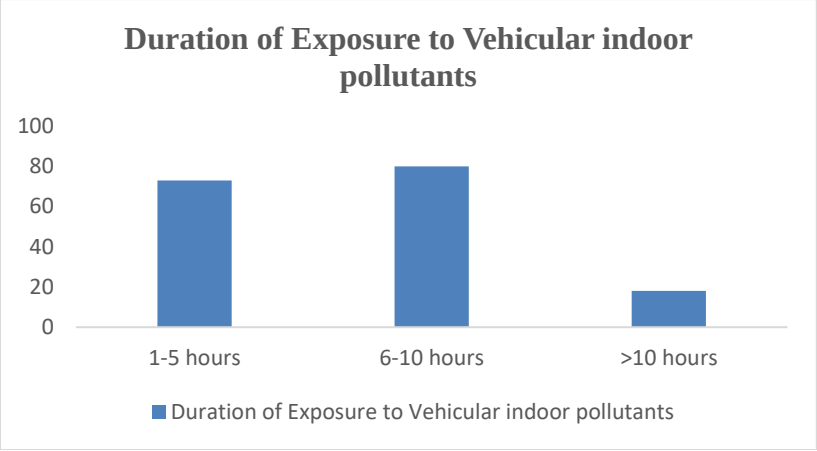

Figure 3: Duration of Exposure to Vehicular indoor air pollutants

(iii) Exposure to High Levels of Noise while commuting

Fig 4 presents the analysis of questionnaire responses on their exposure to high levels of noise in their vehicles while commuting. The results revealed that 102 respondents representing 59.6% of the total respondents opined that they were exposed to high levels of noise in their vehicles while commuting while 69 respondents representing 40.4% of the total respondents were of the opinion that they were not exposed to high levels of noise in their vehicles while commuting.

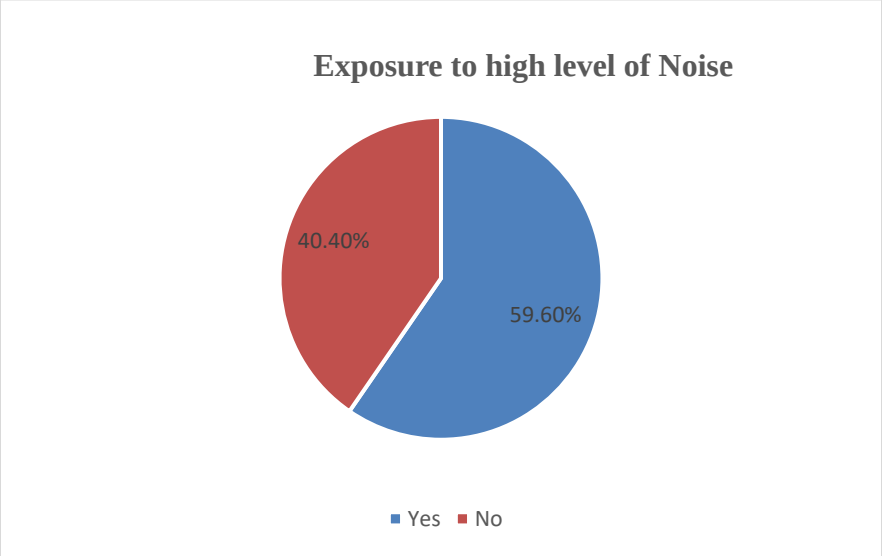

Figure 4: Exposure to High Level of Noise

(iv) Risk of Health Challenges while at work

Fig 5 presents the analysis of questionnaire responses on the risk of health challenges while at work. The results revealed that 121 respondents representing 70.8% of the total respondents opined that they were presented with risk of health challenges while at work, while 50 respondents representing 29.2% of the total respondents were of the opinion that they were not exposed to risk of health challenges while at work.

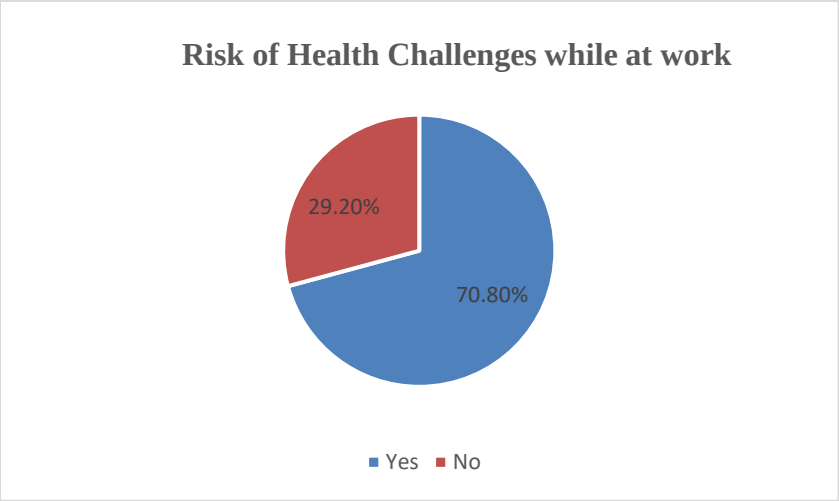

Figure 5: Risk of Health Challenges while at work

(v) Prevalence of Human Health Disorders Associated with Air Pollution

Fig 6 presents the prevalence of human health disorders associated with air pollution. The results revealed that 60 respondents representing 35.1% of the total respondents suffered respiratory tract infections, 52 respondents (30.4%) suffered stress disorders, 38 respondents (22.2%) suffered heart ailments while 21 respondents representing 12.3% of the total respondents suffered pneumonia.

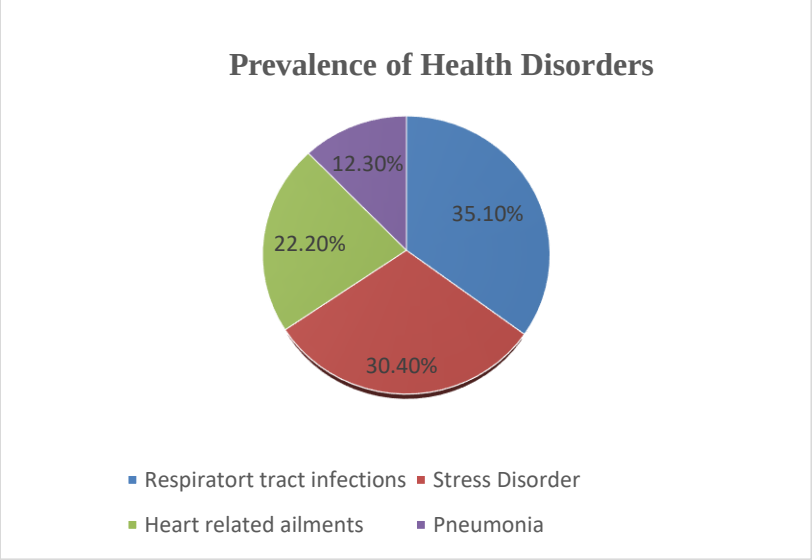

Figure 6: Prevalence of Health Disorders Associated with Air Pollution

(vi) Cases of cough and shortness of breath

Fig 4.7 presents the analysis of questionnaire responses on cases on cough and shortness of breath. The results revealed that 128 respondents representing 74.9% of the total respondents reported cases of cough and shortness of breath while 43 respondents representing 25.1% of the total respondents did not report cases of cough and shortness of breath.

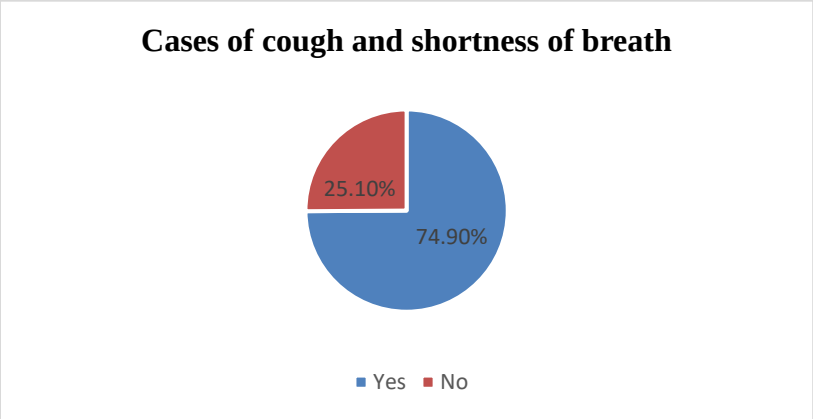

Figure 7: Cases of cough and shortness of breath

(vii) Cases of severe and frequent headache

Fig 8 presents the analysis of questionnaire responses on the cases of severe and frequent headache. The results revealed that 131 respondents representing 76.6% of the total respondents reported cases of severe and frequent headache while 40 respondents representing 23.4% of the total respondents did not report cases of severe and frequent headache.

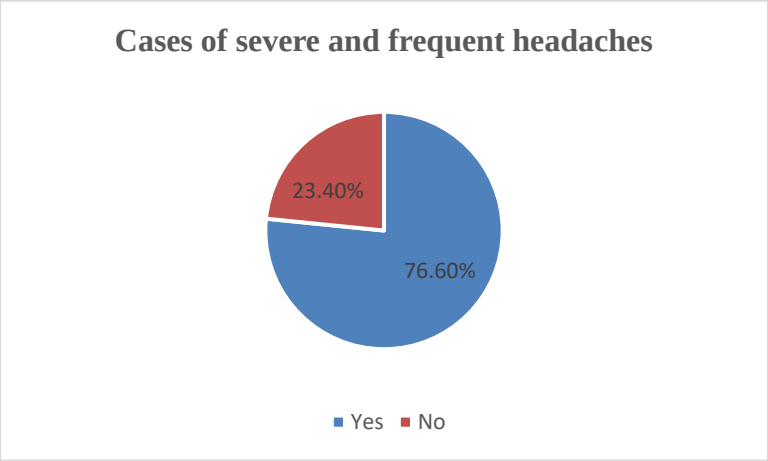

Figure 8: Cases of Severe and Frequent Headaches

(viii) Cases of heart-related ailments

Fig 9 presents the analysis of questionnaire responses on reported cases of heart-related ailments. The results revealed that 97 respondents representing 56.7% of the total respondents reported cases of heart ailments while 74 respondents representing 43.3% of the total respondents did not report cases of heart ailments.

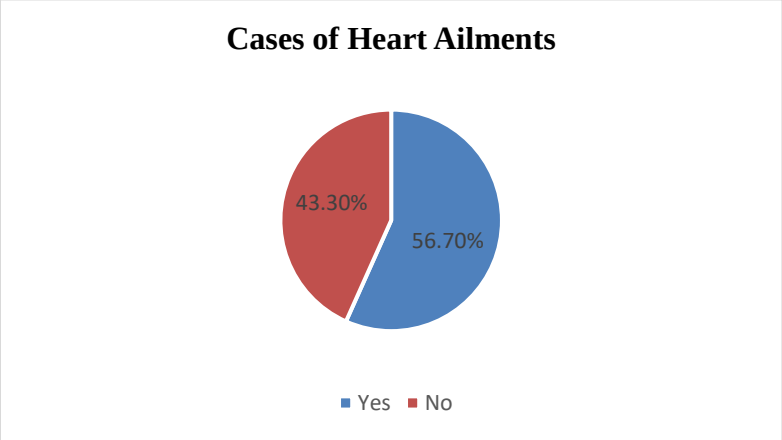

Fig 9: Cases of Heart Related Ailments

(ix) Cases of eye and skin irritations

Fig 10 presents the analysis of questionnaire responses on reported cases of eye and skin irritation. The results revealed that 140 respondents representing 81.9% of the total respondents reported cases of eye and skin irritations while 31 respondents representing 18.1% of the total respondents did not report cases eye and skin irritation.

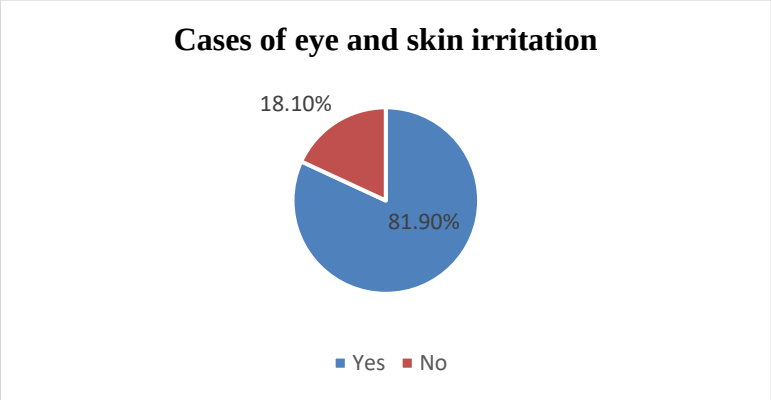

Fig 10: Cases of eye and skin irritation

(x) Cases of Hearing Loss

Fig 11 presents the analysis of questionnaire responses on cases of hearing loss. The results revealed that 89 respondents representing 52.0% of the total respondents reported cases of hearing loss while 82 respondents representing 48.0% of the total respondents did not report cases of hearing loss

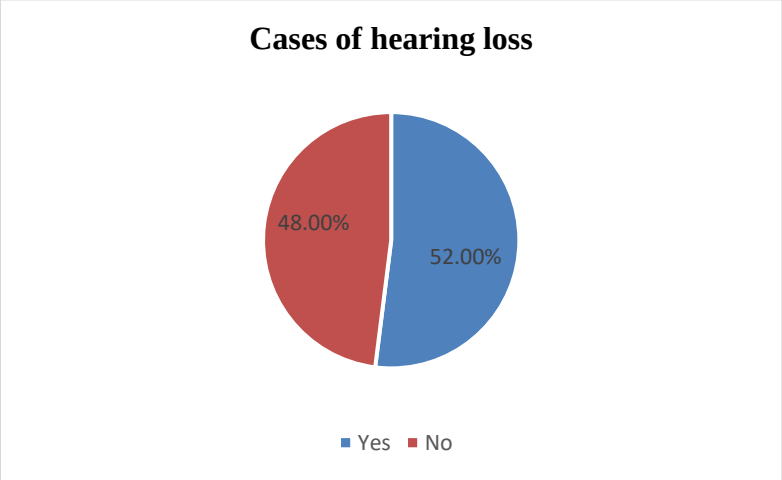

Fig 11: Cases of Hearing Loss

4.0 Discussion

The findings of this research revealed that commuters were exposed to vehicular indoor air pollutants while on transit. 89.5% of the commuters were exposed to the pollutants for a duration of 1-10 hours daily. The findings of this research with the findings of Chen *et al*. (2016) who in their study revealed that commuters were exposed to toxic air pollutants while commuting.

The finding of this research discovered that commuters suffered respiratory tract infections, stress disorders, suffered heart ailments, pneumonia etc. The study also reported cases of cough and shortness of breath, severe and frequent headache, heart-related ailments, cases of eye and skin irritations and cases of hearing loss. The finding of this study is in agreement to the findings of Nasir *et al*. (2016) who noted that vehicular emissions had significant impacts on the health of commuters resulting to heart diseases and eye irritations.
Questionnaire responses revealed that commuters were exposed to health risk and high level of noise while commuting through the selected road routes. This research finding is in consonance to the findings of Sharma *et al*. (2013) who revealed that traffic air pollutants had health impacts on commuters.

5.0 Conclusion

It is known that commuters' health is particularly affected by traffic-related air pollutants which can accumulate inside cabins, and interior materials can be a potential source of pollutants. The

study elaborated that vehicular indoor pollution had significant health impacts on commuters who spend most of the time in their vehicles.

Vehicles are among the major contributors to air pollution along road transport routes. The rising number of vehicle ownership has led to high traffic volume in urban areas and city centres. Most worrisome, is that older vehicles which are associated with higher emission rates of vehicular pollutants still ply our transport routes.

Furthermore, the lack of maintenance and periodic servicing of vehicle engines has further exacerbated the emission of these pollutants into the environment. When vehicles are poorly maintained, the resultant effect is the increase in emissions (Iwuala & Oriaku, 2019). The study therefore recommends regular and periodic servicing of the vehicles plying the selected road routes in the study location.

References

Asimiea, S. N., Fekarurhobo, G. K., Gobo, A. E, Ndukwe, G. I., & Wegbom, A. I. (2022). Evaluations of Air Quality in Port Harcourt City, Nigeria: How Safe is the City for Human Habitation? *Journal of Environment Pollution and Human Health*, *10*(2), 54-57.

Chaney, R. A., Sloan, C. D., Cooper, V. C., Robinson, D. R., Hendrickson, N. R., McCord, T. A., & Johnston, J. D. (2017). Personal exposure to fine particulate air pollution while commuting: An examination of six transport modes on an urban arterial roadway. PLoS ONE, 12(11), 1–15. https://doi.org/10.1371/journal.pone.0188053.

Chen, X., Feng, L., Luo, H. & Cheng, H. (2016). Health risk equations and risk assessment of airborne benzene homologues exposure to drivers and passengers in taxi cabins. *Environ. Sci. Pollut. Res. Int.*, 23, 4797–4811.

Diagi, B., Suzan, A., Nnaemeka, O., Ekweogu, C., Acholonu, C. & Emmanuel, O. (2022) An Assessment of Vehicular Emission in the Vicinity of Selected Markets in Owerri, Imo State, Nigeria. *Journal of Geoscience and Environment Protection*, 10, 1-12. doi: 10.4236/gep.2022.101001.

Emenike, G. C. & Orjinmo, C. (2017) Vehicular Emissions around Bus Stops in Port Harcourt Metropolis, Rivers State, Nigeria. *European Journal of Research in Social Sciences*, 5(3), 19-36.

European Environment Agency. (2018). Air quality in Europe — 2018 report. https://doi.org/10.2800/777411

Iwuala, I.S., & Oriaku, T. O. (2019). Assessment of Vehicular Carbon Dioxide Emission at Major Road Intersections in Benin City, Edo State Nigeria. Paper presented at the SPE

Nigeria Annual International Conference and Exhibition, Lagos, Nigeria, August 2019. doi: https://doi.org/10.2118/198780-MS

Moreno, T., Pacitto, A., Fernández, A., Amato, F., Marco, E., Grimalt, J. O., … Querol, X. (2019). Vehicle interior air quality conditions when travelling by taxi. Environmental Research, 172(February), 529–542. https://doi.org/10.1016/j.envres.2019.02.042

Nasir, Z. A., Campos, L. C., Christie, N., & Colbeck, I. (2016). Airborne biological hazards and urban transport infrastructure: current challenges and future directions. Environmental Science and Pollution Research, 23(15), 15757–15766. https://doi.org/10.1007/s11356-016-7064-8

Obisesan, A. & Weli, V. E. (2019). Assessment of Air Quality Characteristics across Various Land Uses in Port-Harcourt. Journal of Environmental Pollution and Management, 2, 2-7.

Onat, B., Şahin, Ü. A., Uzun, B., Akın, Ö., Özkaya, F., & Ayvaz, C. (2019). Determinants of exposure to ultrafine particulate matter, black carbon, and PM 2.5 in common travel modes in Istanbul. Atmospheric Environment, 206, 258–270. https://doi.org/10.1016/j.atmosenv.2019.02.015

Pérez, N., Pey, J., Cusack, M., Reche, C., Querol, X., Alastuey, A., & Viana, M. (2010). Variability of particle number, black carbon, and PM_{10}, $PM_{2.5}$, and PM_1 Levels and Speciation: Influence of road traffic emissions on urban air quality. *Aerosol Science and Technology*, 44(7), 487–499. https://doi.org/10.1080/02786821003758286

Rivas, I., Kumar, P., & Hagen-zanker, A. (2017). Exposure to air pollutants during commuting in London: Are there inequalities among different socio-economic groups? Environment International, 101, 143–157. https://doi.org/10.1016/j.envint.2017.01.019

Sharma, S.B., Jain, S., Khirwadkar, P., & Kulkarni, S. (2013). The Effects of Air Pollution on the Environment and Human Health. *Indian Journal of Research in Pharmacy and Biotechnology*, 1(3), 391-396.

Wong, L. P., Alias, H., Aghamohammadi, N., Sulaiman, N. M. N., Lin, H., & Zhao, J. (2018). Commuting on Public Transport: Health Risks and Responses. In J. Del Real Olvera (Ed.), *Air Pollution - Monitoring, Quantification and Removal of Gases and Particles* (pp. 35–53). IntechOpen. https://doi.org/10.5772/intechopen.79694

Xu, B., Chen, X., & Xiong, J. (2016). Air quality inside motor vehicles' cabins: A review. *Indoor and Built Environment*, 27(4), 452–465.