Electric Generator Characteristics, Pattern of Use and Non-Auditory Health Effects Experienced by Commercial Workers in Agbowo and Ajibode areas of Ibadan, Nigeria

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ABSTRACT

Background: In Nigeria, the utilization of electric generators as alternative source of power is common practice especially among those who use it for commercial activity.

Objectives: Therefore this research was designed to compare the pattern of generator use and the non-auditory health effects experienced by generator users in two areas of Ibadan.

Methods: The frequency of power outage as well as the intensity of generator were used to purposively select Agbowo (AG) and Ajibode (AJ) commercial areas of Ibadan for this comparative cross-sectional study. Information on generator characteristics were obtained using an observation checklist, a calibrated AEMC sound meter and a measuring stick. A semi-structured interviewer administered questionnaire was used to elicit information on the pattern of generator use and non-auditory health effects experienced. Engine capacity was categorized as (Small: ≤ 1kW, Medium: 2.0-3.0kW and Large: ≥4kW). Data were analyzed using descriptive statistics and chi-square at 5% level of significance.

Results: Diesel engines in AG(65.0%) exceeded those in AJ(10.0%). Mean generator sound level in AG and AJ were 100.5±7.5dB(A) and 91.2±4.86dB(A) respectively (p<0.05). Engine capacities were (Small:14.3%, Medium:63.5% and Large:22.2%) in AG and (Small:76.6%, Medium:19.1% and Large:4.3%) in AJ respectively. Majority (AG: 57.9% and AJ: 53.1%) were male. Mean age in AG and AJ were 25.4±5.4 and 24.8±5.8 years respectively. Mean daily
generator use in AG (5.5±1.7 hours/day) and AJ (2.1±1.1 hours/day) respectively. Indoor generator placement was AG (60.0%) and AJ (19.0%) respectively (p<0.05). Generator distance to user was AG (1.9±1.5m) and AJ (5.6±4.1m) respectively (p<0.05). Sleeplessness (AG: 64.5%; AJ: 35.5%) and annoyance (AG: 60.3%; AJ: 39.7%) were among the experienced non-auditory health effects.

Conclusions: Generator users in Agbowo utilize generators for longer hours than their counterparts in Ajibode and the burden of non-auditory health problems experienced is high in Agbowo. Health education is advocated to ameliorate the potential non-auditory effects of generator use on public health.

Keywords: Generator characteristics, Non-auditory health effects, Commercial areas

INTRODUCTION

Energy of any form is the major engine of growth around which all sectors of the economy revolve. Electricity as a form of energy is a major motivation for human and technological development.\(^1\) Electricity interacts with human development at different levels. It helps to facilitate economic development and poverty reduction by underpinning industrial growth and enhancing productivity. It contributes to social development by helping to fulfill the basic human needs of nutrition, warmth and lighting, in addition to education and public health.\(^2\) The availability and the reliability of electricity supplies have always been a vexed issue in Nigeria\(^3\), as the demand is higher than supply needed. This has contributed to the search for an alternative energy source in the form of electric generators. The proliferation of generator’s has increased rapidly over the past decade at home and work.

A whopping sum of about $103.1 million was spent importing generators into Nigeria, between January and June 2010.\(^3\) According to statistics released by the Nigerian Customs Service (NCS) in an issue published in THE NIGERIAN COMPASS\(^4\), Nigeria assumed the unenviable position for the past five years since 2007, as the leading importer of generators in Africa. Nigeria has also been spending $8 billion annually running generators. During the period under review, countries in Africa such as Angola, Egypt, Algeria and Libya, which follow in the lead, respectively, came near almost half of Nigeria’s import levels. It is worrisome that due to the unsatisfactory performance of the power sector, virtually every household, as well as a considerable number of corporate bodies and manufacturers now rely heavily on generators to ensure smooth operations.

Electric generators produce noise at very high levels when in operation. The association between high noise levels and experience of negative subjective responses (annoyance, dissatisfaction and
disturbance) is strong. However, there is no clear noise level threshold for measuring community reaction which is likely due to considerable variation in people’s tolerance to noise levels and the different types of noise, making it difficult to quantify direct health effects. Individual physiological and psychological responses to noise are also influenced by susceptibility. Noise sensitive people attend more to noises, discriminate between noises, find more noises threatening and out of their control, and react to, and adapt to noises more slowly than less noise sensitive people.

Many people are often ignorant of the hazards posed by electric generator use, as they often expose themselves to the deleterious effects while utilizing the generator. Studies on the pattern of electric generator use and the non-auditory health problems experienced by users in Nigeria are few and almost non-existent. Therefore, an assessment of pattern of generator use and non-auditory health problems experienced by generator users can help guide policy and focus future intervention research on this problem, given that practical measures for noise control at workplace can be put in place to reduce exposure to noise at work. Our study assessed the characteristics of generators as well as the pattern of their use. The potential non-auditory effects among generator users in the Agbowo and Ajibode areas of Ibadan, Nigeria were also documented.

MATERIALS AND METHODS

This study was conducted in Agbowo and Ajibode commercial areas of Ibadan, Nigeria after proper compulsory ethical review by the University of Ibadan (UI) and University College Hospital (UCH) Ethical review committee, Ibadan. Participants in these commercial locations were duly informed and consent was obtained. This study also went through proper required institutional review board procedures at the College of Medicine, University of Ibadan prior to its initiation.

Study Design

A comparative cross-sectional design was used which involved observation, repeated field measurements of noise levels from generators at specific identified shops and questionnaire survey to obtain non-auditory health problems experienced.

Study Area

Agbowo and Ajibode are both located in Ibadan, the capital of Oyo State in Nigeria. Ibadan, one of the largest metropolitan cities in West Africa, is primarily an indigenous city with millions of
inhabitants, most of which are Yorubas; other ethnic groups constitute smaller proportions of the population. The Agbowo business area is situated directly opposite the University of Ibadan and is a high commercial activity area encouraging small scale businesses. The Ajibode business area is also at close proximity to the University of Ibadan campus, but experiences relatively lower daily business activity.

**Study Population**

The general population included generator users above 14 years of age in Agbowo and Ajibode who had given informed consent to participate in the study. The total sampling technique, i.e., maximized convenience sample, was employed. There were 515 participants in all comprising Agbowo (n=304) and Ajibode (n=211).

**Surveys**

An observational checklist was used to collect data on generator characteristics focusing on engine type and capacity. The semi-structured questionnaire elicited information on demographic characteristics, pattern of generator use and non-auditory health problems experienced.

**Generator sound and Distance Measurements**

The electric generator sound levels were measured using a factory calibrated TECPEL Model 330 series sound level meter (SLM), which was set at the slow response mode with A-weighting (A-weighted decibels or dBA). This was obtained at 5m above ground level and away from other noise sources. The sound level from generators was obtained during 6-8am. The distance of generator to user (in meters) while in operation was obtained using a measuring stick graduated in meters.

**Statistical Analysis**

Data were entered into Microsoft Excel and then managed and analyzed using the Statistical Package for Social Sciences (SPSS) version 15. Data were analyzed using descriptive statistics, Chi-square, T-test and logistic regression at 5% level of statistical significance.
Ethical Consideration

The protocol for the study was reviewed and approved by the Joint University of Ibadan and University College Hospital Ethics Review Committee. The nature, purpose and processes involved in the study were explained to the participants. Participants were assured of confidentiality, privacy and anonymity of information provided. Only participants who provided written informed consent were interviewed.

RESULTS

Generator Characteristics:

A total of 110 electric generators were sampled from 110 respondents, which comprised 47 in Ajibode and 63 in Agbowo. Tiger electric generators was the most commonly used generator by respondents in Agbowo (20%) and Ajibode (32%). This was followed by Elepaq generator (Agbowo: 18.3% and Ajibode: 20%), Sumec generator (Agbowo: 15% and Ajibode: 18%) Yamaha, (Agbowo: 16.7% and Ajibode: 5%). Sifang diesel generators were more in number in Agbowo (21.7%) than Ajibode (4.0%). Out of the 63 generators sampled in Agbowo; 9(14.3%) were small (≤1kW), 40(63.5%) were medium (2.0-3.0 kW) and 14(22.2%) were large (≥4kW). In Ajibode; 36(76.6%) were small (≤1kW), 9(19.1%) were medium sized (2.0-3.0 kW) and 2(4.3%) were large (≥4kW). The mean noise level produced by generators in Agbowo and Ajibode were 100.5 ± 7.5 dB(A) and 91.2 ± 4.8 dB(A) respectively.

![Figure 1: Product Names of Electric generators in Agbowo and Ajibode](image-url)
Figure 2: Electric Generator engine capacity used in Ajibode and Agbowo

Table 1a: Background Noise Levels when Electric Generator is in idle mode

<table>
<thead>
<tr>
<th>Business Location</th>
<th>Cases</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agbowo</td>
<td>63</td>
<td>68.9</td>
<td>5.9</td>
<td>56.7</td>
<td>98.7</td>
</tr>
<tr>
<td>Ajibode</td>
<td>47</td>
<td>58.5</td>
<td>4.2</td>
<td>50.0</td>
<td>69.8</td>
</tr>
</tbody>
</table>
Table 1b: Background Noise Levels when Electric Generators are in operation

<table>
<thead>
<tr>
<th>Business Location</th>
<th>Cases</th>
<th>Noise levels (dBA)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Agbowo</td>
<td>63</td>
<td>100.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Ajibode</td>
<td>47</td>
<td>91.2</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Occupational Characteristics of Respondents

Agbowo business area comprised 175 (57.9%) male and 129 (42.4%) female whose age range was between 14-39 years and a mean age of 25.3±5.3 years. While Ajibode business area comprised 112(53.1%) male and 99(46.9%) female whose age range was between 14-39 years and a mean age of 24.8±5.8 years. Most respondents in Ajibode (179, 84.8%) and Agbowo (216, 71.1%) had spent 4-8 years in their present occupation as compared to few respondents in Agbowo (16, 5.3%) and Ajibode (11, 5.2%) had spent less than a year in their present occupation.

Pattern of Utilization of Electric Generator

Majority of the electric generators 42(70.0%) in Agbowo and 34(68.0%) in Ajibode were kept outdoors. The mean distance of generator to users was significantly lower in Agbowo (1.9±1.5m) than in Ajibode (5.6±4.1m). The mean number of hours of generator use in Agbowo was 5.49±1.69 hours while in Ajibode it was 2.1±1.07 hours respectively. The mean cost of generator maintenance in Agbowo was 6,946 ± 3,628.6 Naira, while in Ajibode it was 3,476 ± 1,598.7 Naira. Majority of the respondents in both business areas Agbowo 172(58.3%) and Ajibode 100(72.5%) maintained their generators at least twice a month, while few in Agbowo 20(6.8%) and Ajibode 2(1.4%) maintained their generators daily.
Figure 3: Age Distribution of the Participants in Agbowo and Ajibode Commercial Areas

Figure 4: Level of Generator Maintenance in Agbowo and Ajibode
Non-auditory Effects Experienced

A larger proportion in Agbowo (58.1%) and Ajibode (41.9%) indicated that they experienced headache while the generator was in use. Of those who experienced symptoms, more than half (66.1%) and slightly less than half (33.9%) of participants in Agbowo and Ajibode experienced tiredness while the generator was active. Majority of the participants in Agbowo (64.5%) and slightly less than half of those in Ajibode (35.5%) indicated that they experienced sleeplessness. Above half of the respondents in Agbowo (66.9%) and less than half of the respondents in Ajibode (33.1%) had experienced irritability. Above half of participants in Agbowo (67.3%) and one third those in Ajibode (32.7%) experienced lack of concentration and a majority of the participants in Agbowo (60.3%) and few in Ajibode (39.7%) experienced aggressive response (annoyance) during working hours. Slightly less than half of the respondents in Agbowo (43.5%) and above half in Ajibode (56.5%) had ever experienced speech interference while working with generator. Poor social interaction was recorded for 56.3% and 43.8% of participants in Agbowo and Ajibode respectively.

Figure 5: Comparison of non-auditory health effects experienced among Respondents at Agbowo and Ajibode
DISCUSSION

Petrol engine generators (Tiger electric generators) are the most popular brand of generators used in both Agbowo and Ajibode commercial areas. A recent study\(^\text{10}\), found out that the urban incidence of diesel generators is between 96% to 98% and constitutes the major source of alternative power supply as compared to petrol engines. Another study\(^\text{11}\) also described diesel engine generators as widely used in industrial plants and facilities in official residential buildings. This preference for petrol over diesel generators in this study may be due to the rising and unstable cost of diesel in Nigeria, which makes it unaffordable for commercial purposes.

Respondents in Agbowo reported high running cost for their generators (in-terms of fueling and servicing) as compared to their counterparts in Ajibode. This could be attributed to the rising and unstable cost of diesel fuel in Nigeria as price range between 1.5 to 4 times the official prices and thus a large disparity in price of what can be obtained in reality.\(^\text{12}\) Overuse and poor conditions of generators in Agbowo may be responsible for the high cost of generator maintenance (in-terms of servicing and repairs).

Mean noise level emitted from electric generator in operation in Ajibode 91.2dB(A) and Agbowo 100.5 dB(A) has serious public health implications and could result in deleterious auditory conditions such as hearing impairment.\(^\text{13,14,15}\) Non auditory conditions such as annoyance may also occur. A recent study\(^\text{16}\) revealed highest noise level of 99 dB(A) from generator houses in quarries and neighbouring communities. They author further reported over 80% of respondents experienced frequent annoyance episodes.

The findings from this study revealed that, the mean age of participants in Agbowo and Ajibode was 25.3±5.3 years and 24.8±5.8 years. The age range was between 14 to 39 years. This mean age of respondents in both commercial areas is indicative of a relatively young population under forty years that constitutes the working population in this study. A previous study conducted among Nigerian traders revealed a mean age of 24 ± 1.3 years with age range between 14 to 40 years.\(^\text{17}\) Similarly another study\(^\text{18}\) among operators of grinding machine revealed mean age of 31.2 ± 1.83 years with age range of between 14 to 60 years. The large proportion of male respondents in Agbowo and Ajibode commercial areas may be due to the nature of the job, which requires more physical exertion such as standing for long hours and operating the generator. Similarly, other studies have reported large proportion of male respondents as compared to females.\(^\text{17,18}\)

The proportion of respondents in Agbowo and Ajibode who had experienced sleep disturbance had also experienced irritability. Similar studies\(^\text{7,19}\) revealed that high noise levels can cause insufficient sleep and rest which can also lead to mood shifts, irritability, and tertiary annoyance on members of the community. Similarly, another study\(^\text{14}\) corroborated these findings and revealed that few people, who were exposed to day time noise levels of 55 dB, reported that they had experienced sleep disturbance and mood shifts as compared to those who were exposed to noise levels below 50 dB. This may be
responsible for the sleep disturbance and aggressive responses observed among respondents in our study, especially in Agbowo where it was high as compared to Ajibode. This aggressive response could cause conflict among neighbours as majority of the respondents agreed to that fact.

**CONCLUSIONS**

This study has revealed increased utilization of electric generators in the two commercial locations of Ibadan, Nigeria. The dependence on electric generators as alternative energy source is higher in Agbowo as compared to Ajibode, this was reflected by the duration of generator utilization (hours) which was significantly higher in Agbowo as compared to Ajibode office work environments. Although, non-auditory effects were reported among respondents in Agbowo and Ajibode commercial areas, it was higher among Agbowo respondents. Therefore, as Nigeria struggles to achieve a steady power supply for its urbanizing populations, individuals must see the need to protect themselves from the harmful effect of continuous exposure to generator noise, particularly at small businesses adjacent to homes.

Furthermore, those who use generators should endeavour to take precautionary measures to protect themselves, such as: using ear muffs to protect their ears, locating generators at considerable distance from their workplace but away from esidential areas. This would go a long way in protecting users and preventing friction between neighbours. The absence of action from regulatory agencies have further compounded the problem of generator use. This is often the case in many developing countries like Nigeria, posing serious threat to the Public’s health.

There is a need to expand the scope of this pilot work by carrying out an in-depth longitudinal investigation which would involve a follow up of respondents before and after working with electric generators.

**Competing interest:** The authors declare that they have no competing interest

**Authors’ contributions**

All the authors contributed to this study in ways consistent with ICJME authorship criteria. All the authors read and approved the final version of this manuscript.

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Conflict of Interest: None to declare

REFERENCE


