

AMBIENT NOISE LEVELS IN BASIC SCHOOLS AND IMPACTS ON THE PRODUCTIVITY OF TEACHERS

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Abstract

Elevated ambient noise levels have a negative impact on human capital and the productivity of teachers. This study determined the levels of ambient noise in selected basic schools using the calibrated Sound Level Meter (SLM-814) and used a set of questionnaires to evaluate the perception of 276 full-time basic school teachers in the Old Tafo Municipality, Ghana, on the effects of noise on their productivity and workability from January to October 2023. Descriptive statistics, Pearson's Chi-square analysis, and the Ordinal regression analysis were performed on the data. The highest Weighted Equivalent Sound Pressure Level (LAeq) was 68.5 dBA, and the lowest was 55.7 dBA. All 20 selected basic schools recorded LAeq beyond the Environmental Protection Agency (EPA) and World Health Organization's (WHO) threshold (55 dBA). Twenty-two (8%) of the teachers encountered a low effect on productivity. Two hundred and twenty (79.7%) of the teachers encountered a moderate effect, while the remaining 34 (12.3%) experienced a high effect of noise on their productivity. The model fitting information from the ordinal regression analyses showed a Chi-square and p-value of 14.5 and 0.15, respectively, indicating that the regression model was statistically insignificant and the predictors could not improve the model. The Goodness-of-Fit had a Pearson's Chi-square and p-value of 87.399 and 0.32, respectively, and suggested the model fit well. Nagelkerke's R-squared was 0.071 and suggested that 7.1% of the variance in the impact of noise on teachers' productivity was explained by the model. Holding other variables constant, teachers with 16 – 20 years of experience reduced the odds of the higher effect of noise on productivity (OR = 0.14 and p = 0.04). All other variables were statistically insignificant and did not influence productivity. Future studies should conduct a longitudinal study to establish causality and determine the influencing variables on productivity.

Keywords

Noise, Productivity, Employees, Schools.

Introduction

Noise pollution refers to excessive or unwanted sounds in an environment. It refers to any unwelcome noise from people, machinery, or animals that disturbs regular activity and equilibrium (Moses and Donovan, 2016). It mimics an atmospheric pollutant similar to any gaseous pollutant, posing a threat to human health and overall quality of life (Wang et al., 2005). Urbanisation, industrialisation, and population growth contribute to the noise generation (Essandoh et al., 2011). Usually, environmental sound increases in volume, intensity, frequency, and length of occurrence (Oseji, 2016). According to Kanu (2022), noise pollution has emerged as the third most prevalent environmental pollutant in urban settings, ranking after air and water pollution. The evolution of civilization has led to a gradual and consistent increase in diversity and intensity of ambient noise (Obafemi and Ofondu, 2015; Owojori et al., 2017).

Ambient noise refers to any sound that is audible at any given time in a specific environment and comes from a variety of sources (Templeton, 2017). Excessive ambient noise has a detrimental influence on human capital and work productivity (Dickens, 2014). When humans are exposed to noise during school hours, it hinders their ability to understand what was said. Noise leads to distraction, irritation, discomfort, stress, and poor performance (Nedojedlá, 2018). It causes the 'Lombard Effect', the propensity of any speaker to maintain an unchanging yet consistent relationship between speech level and

any competing noise. Noise disrupts lessons and causes humans to strain their voices. Loss of attention, communication problems, increased task duration, and absences from work are consequences of environmental noise influencing work productivity (Dickens, 2014). Exposure to excessive noise levels disrupts sleep, causes frustration and distraction, and impairs cognitive development in school children (Manohare et al., 2022). Noise saps the enthusiasm and interest of teachers in their work, which results in poorer motivation and subpar teaching effectiveness (Mogas-Recalde et al., 2021). These effects of noise made the study relevant to conduct.

Several studies have been done in Ghana on noise pollution at social events like funerals, church services, and markets. The findings indicated significant noise levels that were beyond the World Health Organization's (WHO) threshold of 55 dBA (Quartey et al., 2021; Sowah et al., 2014). Loud music from churches, vendors, drinking establishments, and mills caused a spike in noise nuisance in Ghana and Accra in particular (Sowah et al., 2014). Even in the presence of regulatory guidelines set forth by the Environmental Protection Agency (EPA) in Ghana, noise pollution persists. Moreover, few studies have been done with little attention given to how noise levels affect the productivity of basic school teachers (Quartey et al., 2021; Sowah et al., 2014). Even though schools serve as their workplaces and teachers' performance has an impact on student outcomes (Gupta et al., 2017), little attention has been given to them in previous studies. No such studies have been done

in Ghana, and therefore, this study addresses the geographical and sectoral limitations (Osei and Effah, 2022). Unlike developed countries, which have sound insulation techniques and advanced technologies to reduce the ambient noise levels in schools, Ghana adopts light sandcrete blocks with low sound insulation potential for classroom blocks, which are unable to block the intensity of penetrating noise (Quarthey et al., 2021). Regular noise exposure contributes to burnout and attrition rates among teachers, causing teacher shortages (Osei et al., 2024). These problems and gaps in knowledge necessitated an inquiry into noise pollution in basic schools, focusing mainly on its impacts on teachers' productivity.

The rationale for this study was grounded in the need to improve the productivity of teachers, who play a vital role in the training and education of future generations. By determining the noise levels and the impact on productivity of the basic school teachers, this study fills the knowledge gap and contributes empirical data to support the implementation of interventions and policies. It adds to the previously established knowledge regarding noise levels in schools and their impacts on human capital. The research hypothesis was that ambient noise levels in basic schools exceed permissible limits and have a negative influence on teachers' productivity, with specific noise-related variables serving as significant predictors of this impact. The aims of this study were: (1) to assess whether ambient noise levels in the selected basic schools exceed the permissible limits, (2) to examine the impact of ambient noise levels on teachers' productivity and determine the extent of this impact, (3) to identify the variables that significantly predict and influence the productivity of teachers in relation to ambient noise levels. It addressed the following research questions: i) Do the ambient noise levels in the selected basic schools exceed the permissible limits? ii) Do the noise levels impact the productivity of the teachers, and at what level? iii) Which variable(s) significantly predict and influence the productivity of teachers? Subsequently, recommendations were given for future studies. The next sections include materials and methods, results, discussion, conclusion, acknowledgements, and references.

Materials and Methods

Study design

A quantitative research design was used in this cross-sectional study. Quantitative designs are specific, properly structured, and well-defined. A cross-sectional study considers a section of the population and inquires in a relatively short period (Kumar, 2011).

Study area

The Old Tafo Municipality (Figure 1) was found in the Ashanti Region of Ghana. It shares boundaries with Kumasi Metropolitan Assembly on the east, and Suame Municipal Assembly, Afigya Kwabre North, and Kwabre East Municipality on the west, south, and north, respectively. The municipality covers

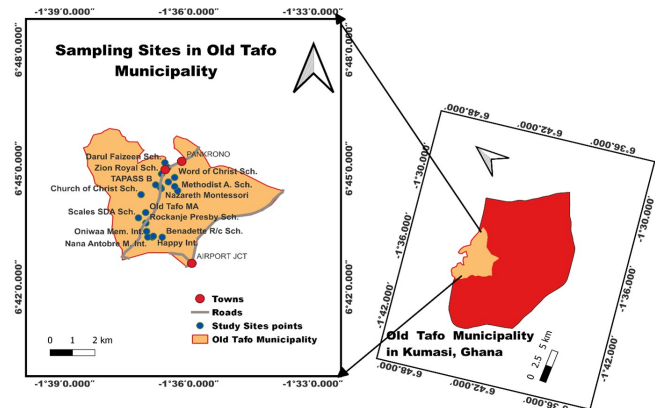


Figure 1. Map of Old Tafo Municipality showing selected schools.

31.13 square kilometers of land, situated between the longitude of 1.35°W and 1.37°W, and the latitude of 6.42°N and 6.45°N. It was elevated 250 to 300 m above sea level and nearly 270 km north of Greater Accra in Ghana (Old Tafo Municipality, 2023). The following schools were involved in the study: God's Time Preparatory, TAPASS A, Old Tafo M/A, Zion Royal, Scales SDA, Rockanje Presbyterian, McNeilus SDA, Oniwa Memorial International, Nana Antobre Memorial International, Action, Church of Christ, Happy International, Methodist A, Nazareth Montessori, TAPASS B, Calvary International, Darul Faizeen, St. Bernadette R/C, Pankrono R/C, and Word of Christ. The study was carried out in the area from January 2023 to December 2023.

Study population, sampling techniques, and sample size

A total population of approximately 1,160 basic school teachers was in the Old Tafo Municipal's Ghana Education Service (GES). Schools were purposively sampled for the study. These were those sites along active areas such as traffic zones, market areas, mechanic shops, musical shops, etc. Schools situated in quiet areas were exempted. According to Essandoh et al. (2011), the range of traffic noise index TNI at high-density residential areas was averagely 87.5 dB (A), and that of low-density residential areas was 27dB (A). Therefore, this study assumed a low noise level in schools isolated or sited away from noise sources. Noise levels were determined at several points within each school, and the average continuous sound levels were detected. The respondents to the questionnaire on the impact of noise on productivity were full-time teachers who had worked for at least 3 years before this study was conducted. This was to ensure respondents had a substantial duration of exposure to respond well to the survey questions. The sample size was determined with Yamane's simplified formula:

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

'N' is the population size, 'n' was the sample size, and 'e' was the precision level (Singh and Masuku, 2014). The assumed

confidence level is 95%, corresponding to a 5% significance level ($p < 0.05$). This threshold controls the probability of wrongly rejecting a true null hypothesis at only 5%, which was widely accepted as reasonable. P (estimated standard deviation of the scale) = 0.50, and $\pm 5\%$ precision level.

Data collection

A digital sound level meter (Brand: SLM-814; manufactured in Hong Kong, China; Specifications: 40 – 130dB with level selecting button switches, Accuracy: ± 2 dB, Frequency range: 31.5Hz – 8.5kHz, Linearity: 30dB, working environment: temperature: 0-40°C, humidity: 10-70%RH, Microphone: 1/2-inch electret condenser microphone), calibrated according to manufacturer’s guidelines was used to record the noise levels of the study sites over a month. The average equivalent continuous sound level (LAeq) was determined. A set of questionnaires was used to gather responses on the impacts of noise on productivity from the teachers. The demographic section covered gender (male/female), years of teaching (0 – 5 years, 6 – 10 years, 11 – 15 years, 16 – 20 years, and > 20 years), and age range (18 – 29 years, 30 – 39 years, 40 – 49 years, 50 – 59 years, and ≥ 60 years). The section on the impact of noise on productivity was scored on a scale (No = 1, Do not know = 2, and Yes = 3). Participants were recruited from February 27 to March 10, 2023. The key considerations adopted in the study to ensure accurate, consistent, and valid measurement of noise levels in the school environment included carefully calibrating the SLM before and after each reading of the maximum noise level. The SLM was held to the side at a height of 1.3 meters above ground, and extended at arm’s length, orienting the microphone toward the noise source to minimise sound reflection off the body (Bruel and Kjaer, 2012). Noise level readings were taken during daytime (6 am – 10 pm) and especially when schools were in session for 5 days in each week for 1 month (August 2023). Readings were taken at different locations, including playgrounds, corridors, and sides of the school’s building (EPA, 2008). In each day and in each school, three replicate measurements were taken per point, and mean values were recorded. The study was done during the dry season.

Data analysis

The IBM SPSS version 25 was employed for the analysis of data. The internal consistency represented by Cronbach’s alpha (α) of 0.9 indicated that the questionnaire was very strong and reliable. Exploratory Factor Analyses (EFA) using the rotated component matrix of the Principal Component Analysis (PCA) method showed items with loadings ≥ 0.5 for all variables, indicating that these items were valid. Descriptive statistics were presented as means, frequencies, percentages, stacked bar charts, and pie charts. The outputs of the analysis were presented in figures and tables. A chi-square test was used to analyze the association between indicators of productivity and selected demographics (both categorical variables). Also, ordinal regression was used for categorical outcome variables to assess the influencing and risk factors of the tri-

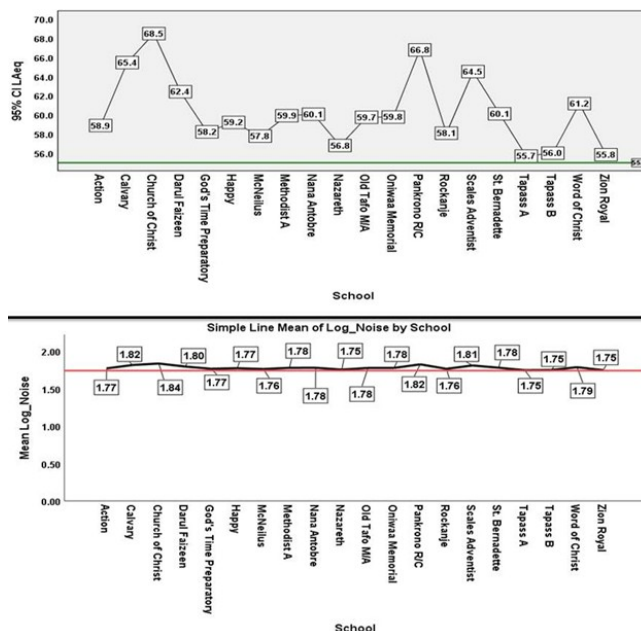


Figure 2. A graphical representation of error bars by path and transformed noise levels (LAeq and Log_noise) in schools. Source: Field data (2023)

chotomized productivity (low, moderate, and high). Average productivity score < 1 = low productivity, $1 - 2$ = moderate productivity, and > 2 = high productivity.

Results and Discussion

Results

Day-time Noise Measurement

The highest equivalent continuous sound level (LAeq) was 68.5 dBA, and the lowest was 55.7 dBA. All twenty (20) selected basic schools recorded LAeq beyond the EPA/WHO permissible limit of 55 dBA. They were acoustically polluted since their noise levels were higher than the EPA, Ghana, and WHO permissible limit by 0.7 – 13.5 dBA. However, the noise levels were transformed (normalized) using Log10 (LAeq) as shown in Figure 2 below:

Demographic features of respondents

A total of 276 teachers, comprising females ($n = 149, 54\%$) and males ($n = 127, 46\%$) were involved in the study. The frequencies of the years in teaching were in the order: 0 – 5 years > 6 – 10 years > 11 – 15 years > more than 20 years > 16 – 20 years. Most of the teachers ($n = 135, 48.9\%$) had zero to five years of teaching experience, while a few of them ($n = 17, 6.2\%$) had sixteen to twenty years of experience in teaching. Most of the respondents were thirty to thirty-nine years old, indicating a youthful population engaged in the survey (Table 1).

Impacts of Noise Levels on Teachers’ Productivity

The percentage frequencies of responses on the effects of noise exposure on teachers’ productivity were depicted in Figure 3. Elevated noise levels in the basic schools caused disturbances (69.9%), disrupted communications (67.8%), and

Table 1. Demographic characteristics of respondents

S/N	Categories	Frequency	Percent (%)
1.	Gender		
	Female	149	54.0
	Male	127	46.0
	Total	276	100.0
2.	Years of teaching		
	0 - 5 years	135	48.9
	6 - 10 years	62	22.5
	11 - 15 years	40	14.5
	16 - 20 years	17	6.2
	> 20 years	22	7.9
	Total	276	100.0
3.	Age range		
	18 - 29 years	97	35.1
	30 - 39 years	113	40.9
	40 - 49 years	43	15.6
	50 - 59 years	17	6.2
	≥ 60 years	6	2.2
	Total	276	100.0

Source: Field data (2023)

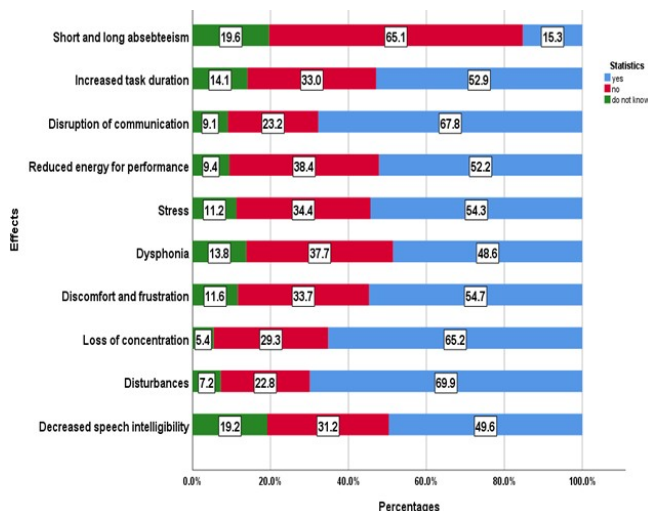


Figure 3. Percentage frequencies of responses on the effects of noise exposure on teachers' productivity.

made teachers lose concentration (65.2%) while teaching. Additionally, discomfort and frustration (54.7%), stress (54.3%), increased task duration (52.9%), and reduced energy for performance (52.2%) were recorded. All these effects reduced the productivity of teachers in the basic schools. Only a few teachers reported short and long absenteeism (15.3%) due to the noise. Most of the teachers (69.9%) rated disturbances as the key effect on teachers' productivity.

Significant Variables Affecting the Productivity of Basic School Teachers

The output of the Pearson's Chi-square analyses, which determine the significance of the association between the variables, was shown in Table 2. Decreased speech intelligibility and

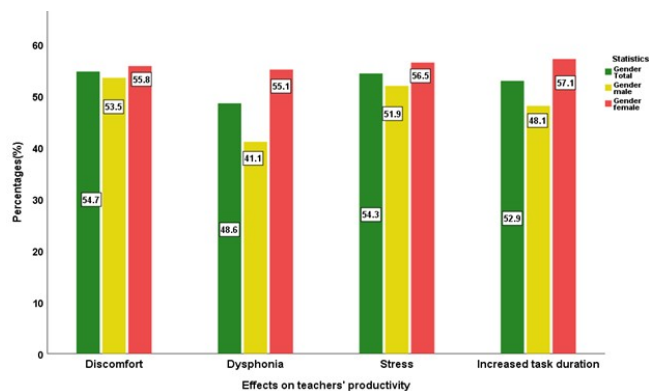


Figure 4. The frequency of association of effects with the gender of teachers.

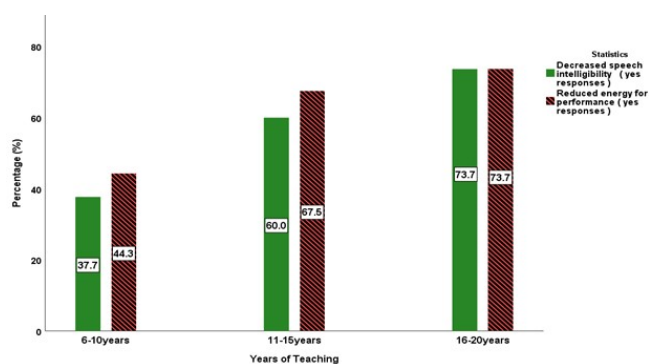


Figure 5. The frequency of association of effects on productivity with years of teaching.

reduced energy for performance were significantly associated with years of teaching in the basic schools. Also, discomfort, dysphonia, stress, and increased task duration were significantly associated with the gender of teachers.

The percentage frequencies of the association and dependence of the effects of noise exposure on teachers' productivity with gender were shown in Figure 3. In all four (4) instances, the female teachers outnumbered the males in terms of percentages. This indicated that the female teachers experienced greater impacts as compared to their male counterparts. The claim that female teachers experienced greater impacts was not based solely on raw counts but on the proportional responses (percentages) within each gender group. The analysis compared the relative frequencies of reported effects across males and females, which accounts for group size differences. Thus, the findings reflect differences attributable to gender rather than sample imbalance. Out of 54.7% of the respondents who experienced discomfort and frustration, 53.5% were male teachers, while 55.8% were female teachers. Again, out of the 48.6% of the respondents (276 teachers) who reported dysphonia, 41.1% were male teachers, while 55.1% were female. A total of 54.3% of 276 basic school teachers indicated stress, of which 51.9% were males and 56.5% were female teachers. Lastly, out of 52.9% of the respondents who reported increased task duration as affecting their productivity, 48.1% were male, while 57.1% were female teachers.

The percentage frequencies of the association and dependence of the effects of noise exposure on teachers' productivity with

Table 2. Output of Pearson’s Chi-square analyses of variables

S/No.	Variables	Category	Chi-square	P-value
1.	Decreased speech intelligibility	Gender	3.150	0.207
		Years of teaching	17.584	0.025*
		Age range	5.904	0.658
2.	Disturbances	Gender	1.527	0.466
		Years of teaching	14.214	0.076
		Age range	4.323	0.827
3.	Loss of concentration	Gender	0.530	0.767
		Years of teaching	9.279	0.319
		Age range	2.503	0.962
4.	Discomfort and frustration	Gender	6.971	0.031*
		Years of teaching	11.450	0.177
		Age range	9.444	0.306
5.	Dysphonia (strained voice)	Gender	7.012	0.030*
		Years of teaching	14.066	0.080
		Age range	11.673	0.166
6.	Stress	Gender	7.289	0.026*
		Years of teaching	9.337	0.315
		Age range	14.377	0.072
7.	Reduced energy for performance	Gender	0.810	0.667
		Years of teaching	15.608	0.043*
		Age range	2.768	0.948
8.	Disruption of communication	Gender	0.653	0.721
		Years of teaching	12.442	0.133
		Age range	6.723	0.567
9.	Increased task duration	Gender	6.101	0.047*
		Years of teaching	13.171	0.106
		Age range	7.751	0.458
10.	Short and long absenteeism	Gender	2.584	0.275
		Years of teaching	13.016	0.111
		Age range	4.727	0.786

p-value* = the significant probability values ($p < 0.05$). Source: Field data (2023)

years of teaching are shown in Figure 4. Decreased speech intelligibility and reduced energy for performance were involved. The trend of the association was observed in Figure 5. Thus, decreased speech intelligibility and reduced energy for performance intensified with increasing years of teaching.

Ordinal Logistic Regression of the influencing factors of the impacts

The percentage frequencies of the trichotomized impact of noise on teachers’ productivity are shown in Figure 5. 22 (8%) teachers encountered a low effect on productivity. Another 220 (79.7%) teachers encountered a moderate effect on productivity. The remaining 34 (12.3%) teachers encountered a high effect of noise on their productivity.

Outputs of the Ordinal Regression Analyses

The model fitting information from the ordinal regression analyses showed a Chi-square and p-value of 14.5 and 0.15, respectively. These showed that the regression model was statistically insignificant, and the predictors could not improve the model. The Goodness-of-Fit had a Pearson’s Chi-square and p-value of 87.399 and 0.321, respectively. The p-value was > 0.05 and suggested the model fit well. Nagelkerke’s R-squared was 0.071 and suggested that 7.1% of the variance in the impact of noise on teachers’ productivity was explained by the model. Holding other variables constant, teachers with 16 – 20 years of experience reduced the odds of the higher effect of noise on productivity (OR = 0.14 and $p = 0.04$). All other variables were statistically insignificant and did not influence productivity (Table 3).

Table 3. Output of the Ordinal Regression Analyses

S/N	Dependent variable	Categorical variables	N	OR	p – value	95% CI
1	Gender	Male	129	1.41	0.29	-0.290, 1.982
		Female	147	1	(Reference)	
2	Years of teaching	0 – 5 years	134	0.32	0.20	-2.903, 0.600
		6 – 10 years	61	0.77	0.76	-1.952, 1.417
		11 – 15 years	40	0.20	0.06	-3.289, 0.420
		16 – 20 years	19	0.13	0.04*	-3.779, 0.134
		> 20 years	22	1	(Reference)	
3	Age range	18 – 29 years	97	0.84	0.87	-2.384, 2.026
		30 – 39 years	113	0.66	0.71	-2.576, 1.742
		40 – 49 years	43	1.03	0.98	-2.117, 2.173
		50 – 59 years	17	0.35	0.37	-3.375, 1.256
		≥ 60 years	6	1	(Reference)	

N = frequency, OR = odds ratio, CI = confidence interval, * = statistically significant association
 Source: Field data (2023)

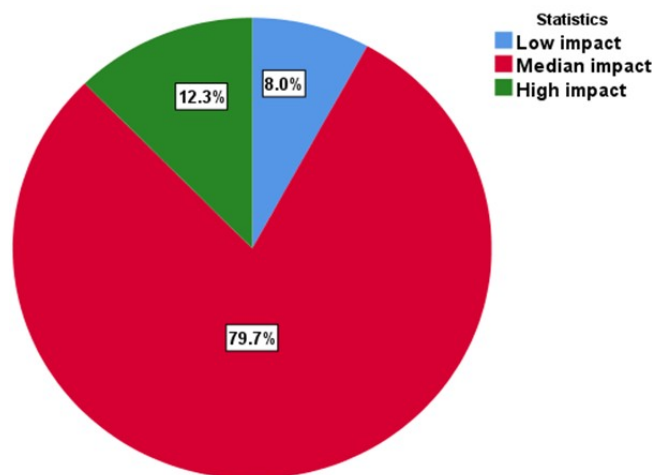


Figure 6. The percentage frequencies of the trichotomized impact of noise on teachers' productivity.

Discussion

The study found that all the selected basic schools were exposed to noise levels beyond the EPA, Ghana, and WHO's permissible ambient noise level of 55 dB for daytime measurement of noise in schools. This meant that the noise levels in the selected basic schools were unacceptable; therefore, long exposure to these levels would likely affect the well-being of the basic school teachers. The schools purposively selected for the study were located around or near busy and active areas (Kumar, 2011). This accounts for the elevated noise levels in all such schools, with noise emanating from commercial activities, vehicles, and other anthropogenic causes. Additionally, teaching and learning, including other activities like bell ringing and students' conversations from nearby classrooms, contributed to the high noise levels (Ochiabuto et al., 2021). Therefore, necessary measures need to be put in place to curb the menace in the schools to safeguard the basic school teachers who are exposed daily. Since the basic school teachers are employed for a lifetime until retirement, exposure to these

levels of noise would make them less productive. The findings of this study corroborate that of (Debnath et al., 2012), who assessed noise pollution in educational facilities in one of the largest districts in India and found that the output noise levels exceeded the normal range of 40 dB (A) to 50 dB (A) in all schools, which was unsuitable for learning and teaching. The schools selected for the study were located near busy areas where noise was generated regularly. Similarly, Ana et al. (2010) and Owojori et al. (2017) discovered that noise levels during the school day ranged from 68.3 to 84.7 dBA and 51.2 dBA, respectively. These values were higher than the recommended limits in their respective countries and, therefore, they suffered the impacts thereof. Again, Quarthey et al. (2021) studied the indoor and ambient noise levels in basic schools in Kumasi, Ghana. They found the average indoor and ambient noise levels were higher than the WHO allowable limits, 30 – 40% and 90 – 107% for schools located near highways and in commercial zones, respectively. Ambient noise levels ranged from 54 to 79 dB, while the indoor mean was 57 to 73 dBA. These findings were consistent with the findings of the present study. The Methodist Cluster of Schools located in commercial areas had elevated noise levels both outdoor and indoor from sources such as vehicles, motorbikes, music vans, music shops, and trading and hawking. In most of the studies on noise levels in basic schools, the observed noise levels have been higher than the recommended limit set by the EPA and the WHO permissible limit (Ochiabuto et al., 2021; Sowah et al., 2014). These findings were consistent with the findings of the present study.

Generally, the study found that elevated noise levels negatively impacted the basic school teachers' productivity at work. This meant that most of the teachers were less productive, and the findings were consistent with those of Manohare et al. (2022) and Essandoh et al. (2011). The introduction of preventive measures would help improve their performance at work when serene environments with acceptable noise levels are attained

(Said, 2014). Additionally, the study found decreased speech intelligibility and reduced energy for performance to be significantly associated with years of teaching in the basic schools. This means that decreased speech intelligibility and reduced energy for performance intensify with increasing years of teaching. The findings are consistent with those of Nedojedlá (2018). Again, discomfort, dysphonia, stress, and increased task duration were significantly associated with the gender of the teachers. This means that the female teachers experienced greater impacts as compared to their male counterparts, and that was confirmed by Nedojedlá (2018). Yet, Anino et al. (2010) prove otherwise, which contradicts the findings of this study. Irrespective of the above, these interrelated variables should be given attention to improve the productivity of basic school teachers. Elevated noise levels in the basic schools caused disturbances to most of the basic school teachers. The finding was consistent with the findings of Debnath et al. (2012) and Osei and Effah (2022). Similar to the findings in this study, Obafemi and Ofondu (2015) discovered that noise exposure led to interference with communication and loss of attention. However, their findings report tension and fatigue in addition to the abovementioned effects, which this present study did not identify. Other related studies show that when children are exposed to noise during school hours, it reduces their ability to understand what they are saying and causes distraction, decreased focus, irritation, discomfort, stress, and poor performance (Dickens, 2014; Nedojedlá, 2018). These findings are consistent with those of this present study and show that the effects of increased noise levels on children may not differ from those on the basic school teachers studied. Noise saps the enthusiasm and interest of teachers in their work, which reduces their energy for performance (Mogas-Recalde et al., 2021). This finding was also in line with that of the present study since 52.2% of the basic school teachers reported that. Obafemi and Ofondu (2015) identified that high noise levels negatively affect the performance of Physics teachers. The study reports interference in the communication process between the teacher and students during physics lessons and poor job performance of the teachers. Students lost concentration and performed poorly in their academics. These findings corroborate the findings of this study. Teachers, irrespective of their qualifications and preparedness toward lessons, suffer disturbances and interferences in communication if noise pollution persists. A serene environment was needed to enhance their effectiveness and performance. Lack of which may affect the job performance of teachers and subsequently culminate in the weak performance of their students. The place of gender (male or female) should not be underestimated when accounting for interrelated factors with the effects of noise pollution on the productivity of basic school teachers. This study identified that discomfort, dysphonia, stress, and increased task duration were significantly associated with the gender of the teachers. The female teachers had a high prevalence of such effects as compared to their male counterparts. The findings are consistent with those of

Said-Abubakar (2021), who explained that females are more sensitive by nature than males. However, the genetic basis of this argument was not proven in this study. On the other hand, the scarcity of literature reporting on the interrelated factors of years of teaching with the effects of noise pollution on the productivity of basic school teachers persists. The ordinal regression analysis indicates that teachers with 16 – 20 years of experience were less likely to report higher noise impacts on their productivity. This aligns with a study that highlighted that high school noise levels could lead to rising stress levels and reduced concentration among teachers (Tomek and Urhahne, 2021). However, the small explanatory potential of the model and the lack of significance for other variables suggest that factors beyond those included may have a more vital role in influencing their productivity. This was consistent with a study that emphasized the interplay of noise with other stressors in the educational sector (Temam et al., 2021). The study used a cross-sectional approach, involving just one contact with the population. This made the study relatively easy to undertake and analyse. However, the cross-sectional approach does not measure change (Kumar, 2011). The data gathered through a cross-sectional survey and self-reports indicate a subjective assessment that does not establish causality. There was always bias, though they can provide insightful data and respond to research problems and questions. Moreover, the study was restricted to schools located near active or busy zones and no other areas. Therefore, a comparative evaluation of the results with quiet zones did not apply. The study was limited to the Old Tafo Municipality in Ghana and not others, which could limit the generalizability of findings unless findings from other districts confirmed the present study.

Conclusion

The study assessed the ambient noise levels and their effects on the productivity of basic school teachers within the Old Tafo Municipality in Ghana. In response to the research questions, all 20 selected basic schools recorded LAeq beyond the EPA/WHO threshold (55 dBA). Most of the teachers 220 (79.7%) encountered a moderate effect of noise exposure on their productivity, while a few 22 (8%) teachers encountered a low effect on productivity. Holding other variables constant, teachers with 16 – 20 years of experience reduced the odds of the higher effect of noise on productivity (OR = 0.14 and $p = 0.04$). All other variables were statistically insignificant and did not influence productivity. Therefore, there was a need to implement awareness programs to sensitize teachers on the issue. Future longitudinal studies are recommended to establish causality and determine other influencing variables on productivity.

Acknowledgement

We acknowledge all supervisors and heads of department. Also, we acknowledge the Old Tafo Municipality branch of the Ghana Education Service, the head teachers of the selected

basic schools, and the teachers who voluntarily participated in this study.

Ethical statement

The Committee for Human Research and Population Ethics at the Kwame Nkrumah University of Science and Technology's School of Medical Sciences approved the study with ethics code 2377183231. Additionally, the Ghana Education Service (GES), Old Tafo Municipality, Ghana, approved the study in their jurisdiction. The participants consented to the study by endorsing consent forms. The authors undertake that the data gathered during the study were presented in this manuscript and not elsewhere.

References

- Ana, G. R., Brown, G. E., Sridhar, M. K., and Shendell, D. G. (2010). Assessment of Noise and Associated Health Impacts at Selected Secondary Schools in Ibadan, Nigeria. *Journal of Environmental and Public Health*, pages 1–4. <https://doi.org/10.1155/2009/739502>.
- Anino, J. O., Afullo, A., and Otieno, F. (2010). Occupational noise-induced hearing loss among workers at Jomo Kenyatta International Airport, Nairobi. *East African Medical Journal*, 87(2):49–57. <https://doi.org/10.4314/eamj.v87i2.60599>.
- Bruel and Kjaer (2012). Environmental noise measurement.
- Debnath, D., Nath, S. K., and Barthakur, N. K. (2012). Environmental noise pollution in educational institutes of Nagaon town, Assam, India. *Global Journal of Science Frontier Research Environment & Earth Sciences*, 12(1):1–5.
- Dickens, R. e. a. (2014). DEFRA: Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity, and quiet. Technical report, Department for Environment, Food & Rural Affairs.
- EPA (2008). Ambient Noise Level Guidelines, Ghana.
- Essandoh, P., Armah, F. A., and Essandoh, P. K. (2011). Determination of Ambient Noise Levels in the Main Commercial Area of Cape Coast, Ghana. *Research Journal of Environmental and Earth Sciences*, 3(6):637–644. <https://www.researchgate.net/publication/267946918>.
- Gupta, A., Gupta, A., Jain, K., and Gupta, S. (2017). Noise Pollution and Impact on Children's Health. *Indian Journal of Paediatrics*, pages 1–10. <https://doi.org/10.1007/s12098-017-2579-7>.
- Kanu, M. O. e. a. (2022). Assessment of Noise Pollution in a Hospital and a Tertiary Institution in Taraba State, Nigeria. *Journal of Material and Environmental Science*, 13(10):1137–1154.
- Kumar, R. (2011). *Research Methodology: a step-by-step guide for beginners*. SAGE Publications Ltd., 3rd edition.
- Manohare, M., Rajasekar, E., Parida, M., and Vij, S. (2022). Bibliometrics analysis and review of auditory and non-auditory health impact due to road traffic noise exposure. *Noise Mapping*, 9(1):67–88. <https://doi.org/10.1515/noise-2022-0005>.
- Mogas-Recalde, J., Palau, R., and Marquez, M. (2021). How classroom acoustics influence students and teachers: A systematic literature review. *Journal of Technology and Science Education*, 11(2):245–259. <https://doi.org/10.3926/jotse.1098>.
- Moses, T. and Donovan, M. (2016). Air, Noise and Water Pollution Handbook. Revised.
- Nedojedlá, P. e. a. (2018). A study evaluating noise levels at selected schools in the Czech Republic. *Central European Journal of Public Health*, 26(4):316–320. <https://doi.org/10.21101/cejph.a4805>.
- Obafemi, D. T. A. and Ofondu, N. F. (2015). Noisy School Environments in Port Harcourt Metropolis: Implications for the Performance and Health of Physics Teachers and Students. *Journal of Environment and Earth Science*, 5(14):76–82.
- Ochiabuto, O. M., Abonyi, I. C., Ofili, R. N., Obiagwu, O. S., Ede, A. O., Okeke, M., and Eze, P. M. (2021). Assessment of Noise levels in primary and secondary schools in Nnewi, Anambra State. *European Journal of Environment and Public Health*, 5(1):1–3. <https://doi.org/10.29333/ejeph/8425>.
- Old Tafo Municipality (2023). Composite Budget for 2023–2026, Programme-Based Budget Estimates.
- Osei, F., Sulemana, A., Effah, E., and Hlordzie, B. (2024). Noise Exposure, Auditory Ailments, and Non-auditory Effects that Influence the Workability of all Teachers: A Scoping Review. *J Occup Health Epidemiol*, 13(2):144–154.
- Osei, F. A. and Effah, E. A. (2022). Health Effects caused by Noise - The Case of Africa: Evidence in Literature from the Past 25 Years. *Asian Journal of Advanced Research and Reports*, 16(2):19–27. <https://doi.org/10.9734/ajarr/2022/v16i230452>.
- Oseji, J. O. (2016). Investigation of Environmental Noise Within Campus 2, Delta State University, Abraka, Nigeria. *International Journal of Recent Research in Applied Studies*, 2:14.
- Owojori, A. A., Gadzama, I. M. K., and Sow, G. J. (2017). Acoustic Indoor Noise Level of Unoccupied Classrooms in Selected Schools in Zaria Metropolis, Nigeria. *Journal of Health and Environmental Studies*, 1(1):1–9.

- Quartey, L. N., Amos-Abanyie, S., and Afram, S. O. (2021). Noise exposure levels in basic school environments in a City in Ghana. *Open Journal of Civil Engineering*, 11:0181. <https://doi.org/10.4236/ojce.2021.111006>.
- Said, K. M. e. a. (2014). Occupational noise exposure among road construction workers. *Jurnal Teknologi*, 70(7):15–19. <https://doi.org/10.11113/jt.v70.3571>.
- Said-Abubakar, A. e. a. (2021). Assessment of The Effects of Noise Pollution on Students' Performance in Kano Metropolitan Local Government Areas. *International Journal of Environmental Pollution and Environmental Modelling*, 4(2):76–84.
- Singh, A. S. and Masuku, M. B. (2014). Sampling techniques & determination of sample size in applied statistics research: An overview. *International Journal of Economics, Commerce and Management*, 2(11):1–22.
- Sowah, R. A., Alfred, Y. A., Carboo, D., and Adaboh, R. K. (2014). Noise Pollution in Teshie-Nungua Schools. *Journal of Natural Sciences Research*, pages 90–98.
- Temam, S., Billaudeau, N., Kab, S., Zins, M., and Ver-cambre, M. (2021). Occupational noise, work-related stress, and teachers' health in the French Constances study. *Noise & Health*, 26(123):523–534. https://doi.org/10.4103/nah.nah_10_24.
- Templeton, N. (2017). *Noise Pollution and Control*. Library Press.
- Tomek, R. and Urhahne, D. (2021). Effects of student noise on student teachers' stress experiences, concentration and error-correction performance. *Educational Psychology*, 42(1):64–82. <https://doi.org/10.1080/01443410.2021.2002819>.
- Wang, L. K., Pereira, N. L., and Hung, Y. (2005). Advanced Air and Noise Pollution Control-Handbook of Environment Engineering. *Handbook of Environment Engineering*, 2:441–495.