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Evaluation of Workers Exposure to Noise Level in Delta Mall and Robinson Plaza, Delta State, Nigeria

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Abstract – This research aims to determine the noise exposure level and its implication to the health of workers/individuals in Delta Mall and Robinson Plaza. A sound level meter (SLM) of model 407736 was used to measure the noise level in Delta Mall and Robinson Plaza. At Robinson plaza, the noise was measured in 13 different locations and they are numbered Block A – N with an exception of Block I. The procedure was carried out in the morning (9:00am – 9:30am), afternoon (1:00pm – 1:30pm), and evening (6:00pm – 6:30pm) measurements for a period of 30 days. The noise exposure level of the entire study area for Robinson Plaza, revealed an average dose of 177.2% and equivalent Time weighted average (TWA) of 94.1 dBA for 12 hours' duration per day and when compared with Occupational Safety and Health Administration OSHA standard, it exceeded the exposure action value in the OSHA noise exposure limits (90 dBA for 8 hours duration per day), hence, a detailed risk assessment must be completed for the entire Robinson Plaza. While the noise exposure level of the entire study area for Delta Mall, revealed an average dose of 115.5% and equivalent TWA of 91.0 dBA for 12 hours' duration per day and when compared with OSHA standard, it exceeded the exposure action value in the OSHA noise exposure limits (90 dBA for 8 hours duration per day), hence, a detailed risk assessment must be completed for the entire Delta Mall. It's therefore concluded that the noise generated from both Delta Mall and Robinson Plaza can be harmful to the health of workers. It was recommended that due to these possible effects of noise pollution on the populace, the following action should be carried out: Isolate noise at source, using protection equipment, Urgent need for legislation to control noise pollution, and public awakening and education.

Keywords – noise, Nigeria, health risk, worker

Introduction

Hearing loss as a result of noise remains predominant in occupational settings, and is increasingly caused by social noise exposure (e.g., through personal music players). There is an increased understanding of molecular mechanisms involved in noise-induced hair-cell and nerve damage. Evidence of the non-auditory effects of environmental noise exposure on public health is growing (Basner *et al.*, 2014).

A study of noise pollution carried out in selected areas of Ilorin city, Kwara state revealed high noise levels at Road Junctions followed by commercial centers (Oyedepo and Sa'adu, 2009). Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can help correct this type of hearing loss. Short term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noise. However, repeated exposures to loud noise can lead to permanent tinnitus and/or hearing loss. Loud noise can create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals. The effects of noise induced hearing loss can be profound, limiting your ability to hear high frequency sounds, understand speech, and seriously impairing your ability to communicate (www.osha.gov).

Health wise, high level noise exposure in women during the development period of faetus is a stressor that may increase the risk of implantation failure, dysregulation of placentation or decrease of blood flow into the uterine (Ristovska *et al.*, 2014). Research has shown that, long-term exposure to environmental noise

may result in cardiovascular diseases such as high blood pressure, heart disease and stroke, annoyance; sleep disturbance, decreased school performance, besides hearing problems (Basner *et, al.,* 2014).

A study to investigate occupational noise in a textile plants in northern India conducted by Bedi, (2006) demonstrated the presence of gross occupational noise exposure in both the plants and he believes that occupation noise exposure and the related effects in India is a widespread problem. Noise at levels that do not damage hearing can have other adverse health effects. This can arise when noise chronically interferes with concentration and communication. Persistent noise stress can increase the risk of fatigue and cardiovascular disorders including high blood pressure and heart disease. Although safe levels to guard against these effects have not yet been fully determined, as a guide, the risk of adverse health effects can be minimized by keeping noise levels below: 50 dB(A) where work is being carried out that requires high concentration or effortless conversation. And 70 dB(A) where more routine work is being carried out that requires speed or attentiveness or where it is important to carry on conversations. Noise exposure levels vary between day and night, higher during the day and lower at night. The night time exposure levels serve as a recovery time for those who are exposed to high noise value during the day (Anomohanran, 2013).

The aim of this research is to determine the noise exposure levels and its implication to the health of workers/individuals in Delta Mall and Robinson Plaza.

Theory

The time weighted average (TWA) shows a worker's daily exposure to occupational noise (normalized to an 8-hour day), taking into account the average levels of noise and the time spent in each area. This is the parameter that is used by the Occupation safety and health administration (OSHA) Regulations.

The Time Weighted Average is calculated using the high noise levels measured that a worker is subjected throughout the normal working day together the amount of time that the worker is exposed to them.

First calculate the Noise Dose as:

$$D(\%) = 100\left(\frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} + \cdots \ldots . + \frac{C_n}{T_n}\right) \quad (1)$$

for n = 1, equation (1) becomes;

$$NoiseDoseD(\%) = 100\frac{C}{T} \quad (2)$$

Where C is the total length of the work-day in hours (8h), T is the reference duration corresponding to measure A-weighted sound level, L (dBA). T could be read off a standard table or calculated using the equation below:

$$T_n = \left(\frac{8}{2^{(L-90)/5}}\right) \quad (3)$$

Where L is the measured sound level

The moment D (%) is calculated the TWA can be calculated,

$$\text{TWA} = 16.61 log10\left(\frac{D}{100}\right) + 90 \quad (4)$$

Where TWA = is the 8-hour time weighted average sound level

D = is the dose % as calculated above (for measured with a dosimeter) and log10 is the logarithm to the base 10 (OSHA, 1999).

Materials and Methods

A sound level meter was used to measure the noise level in the various business places, because sound level meters are instruments capable of measuring the intensity of sound waves. Sound is a series of pressure waves that travel through a medium such as air or water. The stronger the pressure waves the louder the sound. These pressure waves are received via our ears and perceived by our brains. Sound ranges from the things we love to annoyances that can be harmful (Olayinka, 2013). The measurements were carried out in Delta Mall and Robinson Plaza. The instrument was held comfortably in hand with the micro phone pointing at the suspected noise source at a distance not less than 1m away.

Study Areas

Robinson plaza located along Deco Road, Warri, comprises of nine blocks with A-N arms. Block A comprises of 12 shops, block B comprises of 60 shops, block C comprises of 58 shops, block D comprises of 26 shops, block E comprises of 64 shops, block F has 56 shops, block G has 18 shops, block H has 32 shops, block J has 20 shops, block K has 40 shops, Block L comprises of 40 shops, block M comprises of 28 shops and block N has 20 shops.

Figure 1 Front View of Robinson Plaza (source:goole.co.uk)

Sources of noise around the plaza are: noise from power generating sets, noise from vehicles driving around the plaza, noise from human activities such as discussions, fighting, quarrelling, and noise from amplified music.

At Delta Mallis located at Effurun Round-about and has two main gates; one at refinery road and the other at NPA express way. The mall comprises of many shops and eateries all confined in one place with two main normal entrances/exits. The noise was measured in 5 different locations (Front of Shoprite store, fast food (eatery) stores, first walk-way entrance, second walk way entrance and the dynasty sport bar and lounge upstairs).

Figure 2 Internal View of Delta Mall Effurun (source:goole.co.uk)

Data Collection

The measurements were recorded at intervals of 2 minutes for time duration of 6 (six) minutes, giving 3 (three) meter reading per sampling location. The procedure will be carried out in the morning

(9:00am – 9:30am), afternoon (1:00pm – 1:30pm), and evening (6:00pm – 6:30pm) measurements for a period of 30 days so as to have an idea of the average noise exposures per month a worker is exposed to.

The focus of data collection was on five selected sites in Delta Mall: The first Entrance, The second Entrance, Eatery, Dynasty sport bar & lounge, and Front of Shoprite. Thirteen Blocks in Robinson Plaza: Block A – N with an exception of Block I were recorded of the noise.

Results and Discussions

The measured noise levels at different Sites/Blocks within Robinson Plaza and Delta mall are presented in table 1 & 2 below. The corresponding dose was calculated using equation (2) and the TWA (Time-weighted Average) was calculated using equation (4) but the values for the dose can be used to look up the equivalent Time-weighted Average in Table 4.

The dose can alternatively be calculated using equation (2) and the measured noise exposure from the fields in conjunction with the look-up table 3. The table 3 gives the reference time T corresponding to a noise exposure measured. As cited in (Olayinka, 2013), the environmental sound levels measured at a given location depend on a number of specific variables. In particular, many authors have found that the observed sound level are mainly related to road traffic characteristics, and especially traffic volume, vehicles horns, rolling stock an tired, un muffled vehicles. Several studies have demonstrated that the urban conditions of a given area are also a very important factor influencing the environmental noise levels (Mansouri *et al*., 2006).

Table 1 Noise Levels Measured (Averaged Over 30 days), Calculated Average Dose and Equivalent Time Weighted Average (TWA) ROBINSON PLAZA, Warri, Delta State.

Location	Morning	Afternoon	Evening	Dose (%)	Twa	Total Average Per Day
LOCK A	86.1	89.5	83.7	118.4	90.6	86.4
BLOCK B	86.2	89.8	87.1	127.9	91.6	87.7
BLOCK C	87.1	91.1	88.3	156.9	92.4	88.8
BLOCK D	86.9	90.6	87.7	152.8	91.8	88.4
BLOCK E	92.5	97.3	94.3	483.5	98.7	94.7
BLOCK F	92.7	97.5	93.6	468	98.8	94.6
BLOCK G	85.3	88.4	85.2	135.4	90.2	86.3
BLOCK H	86.9	91.2	87.2	157.3	92.0	88.4
BLOCK J	76.9	78.6	77.4	29.4	81.1	77.6
BLOCK K	83.1	87.4	84	102.1	88.9	84.8
BLOCK L	88.2	91.7	88.4	188.3	93.0	89.4
BLOCK M	80.6	82.4	82.1	62.8	86.1	81.7
BLOCK N	85.3	89.5	86.9	120.5	90.6	87.2

Table 2 Noise Levels Measured (Averaged Over 30 days), Calculated Average Dose and Equivalent Time Weighted Average (TWA). DELTA MALL, Effurun, Delta State.

Location	Morning	Afternoon	Evening	Dose (%)	Twa	Total Average Per Day
Irst Ent. (Site A)	79.0	83.0	84.6	61.3	86.0	82.2
Eatery (Site B)	83.3	87.8	91.5	135.9	92.0	87.5
Dynasty Sport Bar & Lounge (Site C)	77.7	80.2	97.2	225.0	94.9	85.0
Front Of Shoprite (Site D)	82.3	85.1	82.7	72.7	86.9	83.4

Table 3: Noise Exposures to Reference Time Duration

Noise Level, L	Reference Duration, T	Noise Level, L	Reference Duration, T
80	32.0	106	0.87
81	27.9	107	0.76
82	24.3	108	0.66
83	21.1	109	0.57
84	18.4	110	0.50
85	16.0	111	0.44
85	13.9	112	0.35
87	12.1	113	0.33
88	10.6	114	0.29
89	9.2	115	0.25
90	8.0	116	0.22
91	7.0	117	0.19
92	6.1	1118	0.16
93	5.3	119	0.14
94	4.6	120	0.13
95	4.0	121	0.11
96	3.5	122	0.095
97	3.0	123	0.082
98	2.6	124	0.072
99	2.3	125	0.063
100	2.0	126	0.054
101	1.7	127	0.047
102	1.5	128	0.041
103	1.3	129	0.036
104	1.1	130	0.031
105	1.0	131	0.027

Source:(www.lni.wa.gov

Table 4 Dose to Equivalent TWA for Given Dose

Dose	TWA8	Dose	TWA8	Dose	TWA8
10	<=70	350	99.0	670	103.7
20	78.4	360	99.2	680	103.8
30	81.3	370	99.4	690	103.9
40	83.4	380	99.6	700	104.0
50	85.0	390	99.8	710	104.1
60	86.3	400	100.0	720	104.2
70	87.4	410	100.2	730	104.3
80	88.4	420	100.4	740	104.4
90	89.2	430	100.5	750	104.5
100	90.0	440	100.7	760	104.6
110	90.7	450	100.8	770	104.7
120	91.3	460	101.2	780	104.8
130	91.9	470	101.3	790	104.9
140	92.0	480	101.5	800	105.0
150	92.4	490	101.6	810	105.1
160	92.9	500	101.8	820	105.2
170	93.4	510	101.9	830	105.3
180	93.8	520	102.1	840	105.4
190	94.2	530	102.3	850	105.4
200	94.6	540	102.3	860	105.5
210	95.0	550	102.4	870	105.6
220	95.4	560	102.6	880	105.7
230	95.7	570	102.7	890	105.8
240	96.0	580	102.8	900	105.8
250	96.3	590	102.9	910	105.9
260	96.9	600	103.0	920	106.0
270	97.2	610	103.4	930	106.1
280	97.4	620	103.2	940	106.2
290	97.7	630	103.3	950	106.2
300	97.9	640	103.4	960	106.3
310	98.2	650	10.5	970	106.4
320	98.4	660	103.6	980	106.5
330	98.6	670	103.7	990	106.5
340	98.8	680	103.8	1000	106.6

Source:(www.lni.wa.gov

In this study, noise exposure levels were compared with the OSHA standard guideline which is shown in Table 5 below.

Table 5: OSHA Noise Exposure Permissible Limits (OSHA, 1996)

Limits for Permissible Noise Exposure (according to OSHA)	
8 hours	90 dB
6 hours	92 dB
4 hours	95 dB
3 hours	100 dB
2 hours	102 dB
1 hour	105 dB
30 minutes	110dB
15 minutes	115 dB

Robinson Plaza

The noise level measured indicated relatively lower values in the morning ranging an average from 76.9 dBA in Block J to 92.7 dBA in Block F; these could be as a result of low activities in some shops, when Benin Electricity Distribution Company (BEDC) power was on, late arrival of some shop owners and fewer generators were on as at that time. The average highest noise level was measured in the afternoon at Block E & F (97.3 dBA & 97.5 dBA respectively) due to the heavy generator noise and large activities in some shop, while the average lowest afternoon noise level was recorded at Block J (78.6 dBA) this could be as a result that Block J shops are mostly used as store rooms for storing goods and it is at the extreme end. The average highest noise level measured in the evening was recorded at Block E (94.3 dBA), while the average lowest was at Block (77.4 dBA). The dose was computed for the three sessions (Morning, Afternoon and Evening) averaged over 12 hours working duration using equation (2). The highest percentage dose of 483.5% was recorded at Block E, whereas the lowest dose was 29.4% at Block J.

The values for TWA_8 were calculated using equation (4) but the respective doses can also be used to look up the corresponding values of TWA_8 (table IV) ranging from 81.1 dBA to 98.8 dBA. The workers and owners of shops in Robinson Plaza are exposed to average dose of 177.2% equivalent of 94.1 dBA for 12 hours every day Monday to Sunday, 84 hours for 7(seven) days, 360 hours for 30(thirty) days during peak period of commercial activities towards the last quarter of every year.

The noise exposure levels of the entire study area as summarized in table I, reveals an average of 94.1 dBA for 12 hours' duration per day and when compared with the values in table V, it exceeds the lower exposure action value in the OSHA noise exposure limits (90 dBA for 8 hours duration per day), hence, a detail risk assessment should be undertaken for the entire Robinson Plaza. Guideline values for community noise in specific environments for Industrial, commercial shopping and traffic areas, indoors and outdoors may result in critical health effect (Hearing impairment) for an exposure of 70dBA and 24hour time duration (Berglund and Lindvall, 1995). Comparing these exposure levels to the ones of this study, it can be deduced that hearing impairment is possible as a result of 94.1 dBA exposure for 84 hours per week at 177.2% dose.

Delta Mall

The noise level measured indicated relatively lower values in the morning ranging an average from 77.7 dBA in Dynasty Sport Bar & Lounge (Site C) to 83.3 dBA in the Eateries (Site B); these could be as a result of low activities in the morning, late arrival of some shop owners and is working hours. The average highest noise level measured in the afternoon at the Eateries (Site B) (87.8 dBA), these could be as a result of large activities in some shop due to the fact that it is within lunch time, while the average lowest afternoon noise level was recorded at Dynasty Sport Bar & Lounge (Site C) (78.6 dBA). This could be as a result of the people and the activities less during the afternoon. The average highest noise level was measured in the evening at Dynasty Sport Bar & Lounge (Site C) (97.2 dBA). This is as a result of loud noise for the musical instruments and other activities going on in the evening. While the average lowest was recorded at the Front

of Shoprite (82.7 dBA). The dose was computed for the three sessions (Morning, Afternoon and Evening) averaged over 12 hours working duration using equation A. The highest percentage dose of 225.0% was recorded at Dynasty Sport Bar & Lounge (Site C), whereas the lowest dose was 61.3% at the First Entrance (Site A).

The values for TWA_8 reveal an exposure of between 86.0 dBA and 94.9 dBA. The workers and owners of shops in Delta Mall are expose to average dose of 115.5% equivalent of 91.0 dBA for 12 hours every day Monday to Sunday, 84 hours for 7(seven) days, 360 hours for 30(thirty) days during peak period of commercial activities towards the last quarter of every year.

The noise exposure levels of the entire study area as summarized in table II, revealed an average of 91.0 dBA for 12 hours duration per day and when compared with the values in table V it exceeded the lower exposure action value in the OSHA noise exposure limits (90 dBA for 8 hours duration per day), hence, a detailed risk assessment must be completed for the entire Delta Mall. Guideline values for community noise in specific environments for Industrial, commercial shopping and traffic areas, indoors and outdoors may result in critical health effect (Hearing impairment) for an exposure of 70dBA and 24hour time duration (Berglund and Lindvall, 1995). Comparing this exposure levels to the ones obtained in this study, it can be deduced that hearing impairment is possible as a result of 91.0 dBA exposure for 84 hours per week at 115.5% dose.

Comparison between Robinson Plaza and Delta Mall

When comparing Robinson plaza with Delta Mall, it was noticed that the highest noise level measured for total average per day is 94.7 dBA at Robinson plaza and 87.5 dBA for Delta Mall, which shows that Robinson plaza noise level is higher than that of Delta Mall due to the noise emanating from the loud generators, loud equipment sounds, conversation and movement of people. The reading for total average per day exceeds 90 dBA over 8 hour duration. High exposure of about 86.9 ± 1.6 dBA has significantly higher risk of hypertension (Chang *et al.*, 2011).

From the result obtained at Robinson plaza, it can be seen that the noise exposure levels are higher or at their peak in the afternoon as a result of loud generators sound that run constantly from all shops and also lunch/break time rush hours where every workers and business men and women were in hurry to get things done.

The noise pollution levels are generally low in the morning when compared to afternoon and evening; this may be as a result of late arrival of some shop owners, which lead to fewer generators that is running at that period of time and the availability of Benin Electricity Distribution Company (BEDC) power supply.

From the result obtained at Delta mall, it can be seen that the noise pollution levels are higher or at their peak in the evening as a result of people taking out their friends and family out for shopping and fun after working hours. Dynasty sport bar and lounge has the highest noise level in the evening due to the fact that it is a place people visit for fun after working hours

The noise pollution levels are generally low in the morning when compared to afternoon and evening; this may be as a result of the late opening of shops in Delta mall. The shops are generally not opened until 9:00am. People coming to the mall during this time are very few, because some people are already in their work places.

Conclusion

The study revealed a noise exposure levels in Robinson Plaza of about 94.1 dBA for 12 hours' duration per day on the average. This exceeded OSHA standard limits of (90 dBA for 8 hours duration per day). The study also revealed a noise exposure level of about 91.0dBA in Delta mall for 12 hours' duration per day which exceeded the OSHA noise exposure limits of (90 dBA for 8 hours duration per day). It can be concluded that workers in both the Robinson Plaza and the Delta Mall are exposed to sound level above the OSHA exposure limits. It can be deduced that hearing impairment and hypertension are possible to occur to the workers at both Robinson Plaza and Delta Mall. Exposure to such noise level may increase the blood pressure and heart rate of workers/individuals who spend lot of time there. Hence, a detailed risk assessment must be completed for the entire Robinson Plaza and Delta Mall. It is recommended that due to these possible effects of noise pollution on the populace, a number of action plans can be taken to abate the noise pollution in Delta Mall and Robinson Plaza. These include the following; Engineering controls,

Administrative controls, Urgent need for legislation to control noise pollution, Public awakening and education,

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