EVALUATION OF NOISE LEVELS IN MANUFACTURING SECTORS IN THIKA DISTRICT, KENYA

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Abstract
Noise is considered as any unwanted sound that may adversely affect the health and wel-lbeing of individuals or populations exposed. This study assessed the magnitude of occupational noise exposures to workers in different manufacturing sectors in Thika District-Kenya. Systematic random sampling was used to select 8 manufacturing companies (one per sector) from the Directorate of Occupational safety and Health Services (DOSHS) and Kenya Association of Manufacturers (KAM) registered workplaces in Thika District. Thika district was selected because of its high concentration of manufacturing companies. Data was collected through; Environmental noise survey, Questionnaire Survey, observation and secondary data for comparison. A sample size of 400 participants from the eight selected manufacturing industries was recruited in this study as per the table of maximum return of sample. The results showed that the males population ($\chi 2 = 14.7$; $p < 0.05$, $df = 7$) was high (82%) as compared to females (18%), hence gender had a significant association between the companies sampled. This study also found that the generator department recorded the highest value of dB(A) ($\chi 2 = 2.40$; $p < 0.05$, $df = 1.00$) while the office department recorded the lowest values ($p<0.05$) in all the 8 selected companies. The production department had the highest exposure magnitude in relation to employees ($p=0.041$). The companies' noise exposure levels had significant association in terms of departments. The magnitude of noise exposure to the workers in manufacturing industries in Thika District is high ($p<0.05$) and recommends strict enforcement of noise control regulations supported by necessary trainings, policies and personal protective equipments. The data obtained can be used by National Environment Management Authority (NEMA) and DOSHS to develop monitoring and evaluation mechanisms for enforcement and compliance.

Key words: Noise, exposure, compliance, manufacturing, Thika, pollution

1.0 Introduction

Noise, categorized as physical hazard, is known to cause workers hearing loss and affect body parts other than the hearing organ. Some reports revealed that it causes mental disturbances, masking of speech communications, disturbance of work performance, rest; sleep, etc, (Özer and Irmak, 2008). Studies conducted in various countries reveal that the effect of exposure to high noise levels with various frequencies causes noise induced hearing losses of exposed workers (Bies and Hansen, 1996; Yılmaz and Özer, 2005). Hearing loss is also caused by exposure to non occupational noise, collectively known as sociocusis. It includes recreational and environmental noises like loud music, guns and power tolls (NIOSH, 1998). Combined exposures to noise and certain physical or chemical agents (e.g., vibration, chemicals such as Styrene Toluene, Zylene, N-hexane, Carbon di-sulfide ,carbon monoxide, ototoxic drugs, and heavy metals) appear to have synergistic effects on hearing loss (Starck, 2006). Some sensorineural hearing loss occurs naturally because of aging; a condition termed as presbycusis. Conductive hearing losses, as opposed to sensorineural hearing losses, are usually traceable to diseases of the outer and middle ear (Zannin *et al.,* 2003; Tang and Tong, 2004; Abo-Qudais and Alhiary, 2004; Piccolo *et al.,* 2005; Zannin *et al.,* 2006; Pathak *et al.,* 2008; Özer *et al.,* 2009). This study evaluated the effect of noise pollution levels in manufacturing industries in Thika District, Kenya.

2.0 Materials and Methods

2.1 Study Area and Design

The study was carried out in Thika district which is an industrial hub with high concentration of manufacturing industries. The proximity of the workplaces to one another, transport infrastructure and the time scale of the study were some of the factors considered in choosing Thika.

2.2 Sample Size Determination and Sampling Method

The sample size was determined using Fischer *et al.,* (1998). A sample size of 384 was adequate for this study. A total of 400 questionnaires were administered for this study allowing 5% for attrition and distributed according to the levels of exposure to noise and the size of employees per company with a return rate of 100%.

2.3 Data Collection

Data was collected through; occupational noise survey, Questionnaire Survey, secondary data and observation methods.

2.4 Data Analysis

Data was analyzed using the SPSS version 16 statistical package for comparison of the occupational noise measurements against the standards of NIOSH, OSHA 2007 and Legal Notice number 25 of 2005. Five compliance items were identified from the standards as: permissible Noise levels, Noise prevention programme, Noise measurements records, information and training of workers, medical examinations

and hearing tests. The results of the statistical tests were analyzed at the 95% confidence level. Descriptive statistics was used to test research hypotheses. Data was interpreted for frequencies, percentage distributions, trends and comparisons on different aspects and then conclusions were draw.

3.0 Results and Discussions

A total of 400 participants from the eight selected manufacturing industries in Thika District were recruited in this study. The companies were coded from MC1 to MC8. The MC3 (85) had the highest number of employee recruited while MC8 (5) had the lowest number as shown in Table 1.

Table 1: Different categories of manufacturing industries that were sampled

	Category	Code	Total number of employees	Employees directly affected by noise	Sampled number
1	Chemical and allied	MC1	78	56	27
2	Food and beverages and tobacco	MC2	167	142	68
3	Texture and apparels	MC3	1355	177	85
4	Plastics and rubbers	MC4	126	97	47
5	Paper and paperboard	MC5	136	130	63
6	Motor vehicle and assembly and accessories	MC6	358	137	66
7	Metal and allied industries	MC7	150	80	39
8	Leather products and footwear	MC8	30	10	5
					400

Table 2: Analyzed noise levels in the production department of the selected companies

Company	Production department					
	Measured values		Standards	Statistical data analysis		
	2010	2009	OEL/TWA	df	f	P
MC1	91.6	84.0	90	1	2.00	0.0581
MC2	92.4	93.1	90	1	2.83	0.0981
MC3	95.3	95.3	90	1	2.83	0.0981
MC4	91.3	93.8	90	1	2.83	0.0981
MC5	94.7	94.5	90	1	2.83	0.0981
MC6	91.0	92.0	90	1	2.83	0.0981
MC7	90.0	88.2	90	1	2.03	0.0481
MC8	93.7	94.1	90	1	2.83	0.0981

3.1 Effect of Occupational Noise Levels on Communication and Work among Employees in the Manufacturing Sectors Sampled

A total of 125 (31.2%) of the respondents had no communication problems in a noisy environment while 225 (56.5%) agreed and 49 (12.2%) strongly agreed that communication was hard in a noisy environment. A question was also asked to ascertain the individuals who realize that it is noisy while communicating. The response was 45 (11.2%) strongly disagree and 179 (49.2%) disagree while 68 (17.0%) were not sure and 90 (22.5%) agree to this effect. On communications when machines were on 169 (42.2%) disagree that they do not communicate well while machines are on, 25 (6.2%) were not sure, 189 (47.2%) agreed and 17 (4.2%) strongly disagreed. A total of 202 (50.5%) agreed that industry noise interferes with conversation and 89 (22.2%) strongly agreed, 45 (11.2%) were not sure while 64 (16.0%) disagreed completely. On whether it was easy or hard to follow conversation while machines were on 184 (46.0%) agreed, 40 (10.0%) were not sure while 176 (44.0%) disagreed.

On whether loud noise in the industry makes one stops conversation 166 (29.0%) agreed, 25 (6.2%) strongly agreed, 15 (3.8%) were not sure while 222 (55.5%) disagreed and 22 (5.5%) strongly disagreed. On whether high levels of noise in the industry makes it hard to concentrate in conversation 207 (51.8%) agreed, 64 (16.0%) strongly agreed, 45 (11.5%) were not sure while 62 (15.5%) disagreed. The Pearson Chi-square for the workers who don't realize its noisy while in communicating is dependent on the type of organization. Pearson Chi-square value $X^2 = 67.387^a$, df = 21,p = 0.0001 thus the variable have significant dependency on the type of organizations since the p-value is less than p = 0.05. The Pearson Chi-square on workers concentration while machines are on is independent on the type of organization. Pearson Chi-square value $X^2 = 22.281^a$,df = 21,p = 0.383 thus those who do not communicate well while machines are on have insignificant dependency on the type of organizations since the p-value is greater than p = 0.05.

On the effect of high noise on the work environment 108 (27.0%) agreed, 129 (32.2%) strongly agreed that they need a peaceful and quite place to perform difficult jobs while the rest 129 (32.3%) had a contrary opinion. On doing routine work in a noisy environment 112 (28.0%) had problems, 49 (12.2%) were not sure while 218 (54.5%) were comfortable doing work in a noisy environment. On the need to have a quite work environment while performing new tasks 192 (48.0%) agreed, 38 (9.5%) strongly agreed, 69 (17.2%) were not sure while 101 (25.2%) disagreed. On doing work that required a lot of concentration when heavy and noisy machine are running 196 (49.0%) agreed, 42 (10.5%0 were not sure while the rest disagreed meaning it is hard for them to work while heavy machines are running. On the sensitivity to industry noise 138 (34.5%) agreed, 35 (8.8%) strongly agreed, 25 (6.2%) were not sure while 180 (45.0%) disagreed and 22 (5.5%) strongly disagreed. Half of the respondents' agreed that they were accustomed to industry noise while half of them disagreed. Worker's Performance is worse in

noisy places is independent on the type of organization. Pearson Chi-square value $X^2 = 20.979^a$,df = 21,p = 0.460 therefore it has insignificant dependency on the type of organizations since the p-value is greater than p = 0.05.

Family history on lose of hearing due to industrial noise 44 (11.0%) were not sure while the rest 356 (89.0%) disagreed. None agreed when asked whether industry noise had led to head injuries before. On whether industry noise had led to ear ache 123 (30.8%) agreed, 21 (5.2%) strongly disagreed, 24 (6.0%) were not sure while 190 (47.5%) disagreed and 42 (10.5%) strongly disagreed. When asked if industrial noise has resulted to ear allergies 15 (3.8%) agreed, 37 (9.2%) were not sure while the rest 348 (87.0%) disagreed. Another aspect that was evaluated was on whether industrial noise have lead to ear infections and trauma 21 (5.2%) strongly disagree, 15 (3.8%) were not sure while the rest either agreed or strongly agreed 364 (91.0%). On whether the industrial noise has lead one to be taking drugs, antibiotics or any other medication regularly 50 (12.5%) agreed, 20 (5.0%) were not sure while 202 (50.5%) disagreed and 128 (32.0%) strongly disagreed. The adverse effect of noise on hearing loss is categorized into; temporary threshold shift, permanent threshold shift and a coustic trauma (Miller *et al.,* 2006). In addition noise interferes with verbal communications leading to errors and failures to respond to warning signs. In this study 225 (56.5%) respondents agreed to having communication problems in noisy environment and 49 (12.2%) strongly agreed that communication was hard in a noisy environment. This is a big percentage hence in case of an accident; a big number of workers will be affected due to their inability to respond to warning signs. Members in a family who have lost hearing before age of 50 is dependent on the type of organization. Pearson Chi-square value $X^2 = 26.664^a$,df = 14,p = 0.021 thus it has significant dependency on the type of organizations since the p-value is less than 0.05. The Pearson Chi-square on the 'Have had head injuries before is dependent on the type of organization. The Pearson Chi-square. Value $X^2 = 26.968^a$,df = 14,p = 0.019 thus have a significant dependency on the type of organizations since the p-value is less than 0.05. Workers who have had ear allergies before has significant dependency on the type of organizations (Pearson Chi-square value = 67.264^a,df = 21,p = 0.0001) since the p-value is less than 0.05.

There were several questions asked to the respondents regarding communication in noisy environment, the response was overwhelming more than fifty percent agreed to have problems in communicating in a noisy environment. Rule 11 of the Kenya Subsidiary Legislation, 2005; Legal Notice No. 25 state that's 'The occupier shall install where noise gives rise to difficulties in verbal or sound communication, a visual warning system or any other means of communication'. In this study there were no such signs in all the companies sampled except one company which was compliant. On the effect of high noise on the work environment 239 out of 400 respondents agreed that they need a peaceful and quite place to perform tasks that required a lot of concentration. The pattern of induced hearing problems and

the need to use medication is consistence with the finding of Boateng and Amedofu, (2004) in their study on noise effects on hearing. Rule number 12 of the legal notice state that 'Where noise cannot be controlled by engineering measures and exceeds 90 dB(A), the employer shall provide and maintain suitable hearing protection to the affected workers: and ensure that the hearing protection is always worn correctly.

3.2 Noise Compliance Levels against Set Standard for the Manufacturing Sectors

The noise levels were measured against set standards of NIOSH, OSHA 2007 and Legal Notice number 25 of 2005. Five compliance items were identified from the standards as: permissible Noise levels, Noise prevention programme, Noise measurements records, information and training of workers, medical examinations and hearing tests. The results showed that all the 8 companies (100%) carry out noise surveys.

Before employment in a noisy environment employees should undertake pre employment hearing test as required by Legal Notice no. 25 of 2005. A total of 3 companies (37.5%) agreed to have done this test. On the compliance on permissible noise levels 5 companies (62.5%) were complying while the rest were not. On whether they have had any training regarding noise hazards at work only one company (12.5%) had carried such a specialized training. Only two companies (25%) had a noise control programme in place (Table 3). The law, legal notice 25 states that 'Where noise in a workplace exceeds the continuous equivalent of 85 dB(A) the occupier must develop and implement an effective noise control and hearing conservation programme; The programme must be in writing and should address; noise measurement; education and training: engineering noise control; hearing protection; posting of notices in noisy areas: hearing tests and annual programme review. There was significant association/relationship in all the companies studied regarding Rule No.6 with a p-value of 0.049. There was no significance association in compliance with the rules between MC7 and the other companies but within MC7 there was significant association in complying with all the rules with Pearson chi-square value of 0.024. In this study only one company MC7 was compliant with most of the requirements of the Legal Notice No. 25 of 2005 on Noise Rules. Non compliance has a significant effect on the health of the workers ($p< 0.05$).

Table 3: Companies compliance to the set standards/rules on noise

No.	Compliance items	Workplace complying with set standards	Percentage
1.	Permissible Noise levels	5	62.5%
2.	Noise prevention programme	2	25%
3.	Noise measurement records	8	100%
4.	Information and training of workers	1	12.5%
5.	Medical examinations and hearing tests	3	37.5%

In order to understand the magnitude of noise pollution in manufacturing industries, it is important to determine the health entry and exit levels of the workers. This can be assessed through pre employment and post employment hearing test. Rule 16. (1) The occupier shall provide medical examinations and hearing tests for workers to noise above 85dB(A) limit as follows: an initial test upon employment; annual tests thereafter or at such an interval as may be required by the directorate; Occupational hearing impairment shall be compensated as an occupational disease. This study shows that the employees exposed to high noise thresholds are not aware of the dangers they are exposed to and the management does not do anything about it. There is need for the management to involve the employees exposed to high noise thresholds in risk assessment, management and mitigations.

Different departments had different exposure levels. Three departments (offices, production area and the compound where the Generator is located) were identified as common in all the companies and their Noise levels measured to determine which department had the highest levels. The highest Noise level in each of the department was recorded as the measured level for that department. The results were compared with the previous year (2009). Employees in different departments were exposed to different noise levels. Those working in the production departments ($p = 0.041$)were exposed to noise above occupational exposure limits while those working in offices far away from the machinery were exposed to low noise levels.

4.1 Magnitude of occupational noise exposures of workers in different categories of manufacturing industries

The noise exposure levels in the eight companies were measured and compared with the set standards for the two years. Most of the workers were identified to be in the production area in all the companies studied. Noise levels in the production area were therefore used to assess the magnitude of occupational noise exposure to the workers. The MC3 had the highest number of employees (63) exposed while

MC8 (3) had the least number of employees exposed to high noise levels as shown in Table 4.

Table 4: Number of workers exposed to noise in 3 departments of the selected companies

Company	Number of employees			
	Office	Production	Generator	Total employees
MC1	5	20	2	27
MC2	8	55	5	68
MC3	15	63	7	85
MC4	6	37	4	47
MC5	10	47	6	63
MC6	12	48	6	66
MC7	6	30	3	39
MC8	1	3	1	5
TOTAL	**63**	**303**	**34**	**400**

Magnitude of noise exposure in terms of occupier per department in all the selected industries were measured and determined. The noise levels measured for 2010 were compared with those measured in 2009. The results in 2010 were generally lower than those of 2009 although there were a few departments which recorded high levels. The MC8 company exposure magnitude in terms of employees was very low in that 3 worked in production, 1 in the generator and 1 in the office. The MC3 had the highest number of employees exposed to noise in that 68 worked in production department, 7 worked in the generator while 15 worked in the offices. The p value for the exposure magnitude is 0.49 .If we compare all the companies therefore there is no association in terms of noise exposure from one company to the next. The p value for the number of employees exposed is 0.041 therefore the exposure level is dependent on the company one is working for while the exposure magnitude depend on the department and the company one is working in. Stansfeld and Matheson (2003) in their study on noise levels found out that the bulk of workers in industries worked in the production department thus being exposed to high noise levels. The results in this study confirm with their findings.

4.0 Conclusion

This study shows that majority of the employees in the selected industries are ignorant of the risk associated with excessive noise in their work environment and thus the organization should be conducting regular education on noise hazards and the need to use noise PPE. The companies studied were non- compliant on adapting the rules stated in the 'the factories and other places of work act' (Cap. 514) Kenya Subsidiary Legislation, 2005, Legal Notice No. 25. DOSHS should strictly

enforce the law in order to safe innocent employees who are being exposed to high levels of noise yet they are not aware of the dangers of high noise levels.

According to this study, it is clear that employees working in the generator department are exposed to noise levels far beyond the Occupational Exposure Limit while others in the office department enjoy low level noise environment.

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