

Industrial Noise and Its Effects on Humans

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Abstract

The problem of noise in the industries around Sivas has been examined in this study; and noise measurement and survey studies have been carried out at concrete traverse, cement, iron and steel and textile factories located in this region. A questionnaire was completed by 256 workers during this study in order to determine the physical, physiological, and psycho-social impacts of the noise on humans and to specify what kind of measurements have been taken both by the employers and workers for protection from the effects of noise.

It has been specified, during the surveys, that the noise levels detected in all the industries are much above the 80 dBA that is specified in the regulations: 73.83% of the workers in these industries are disturbed from the noise in their workplaces, 60.96% of them have complaints about their nervous situations, 30.96% of these workers are suffering hearing problems although they had not had any periodical hearing tests and they are not using ear protection equipment.

Keywords: noise, industrial noise, Sivas, exposure to noise

Introduction

Noise is one of the physical environmental factors affecting our health in today's world. Noise is generally defined as the unpleasant sounds which disturb the human being physically and physiologically and cause environmental pollution by destroying environmental properties [1].

The general effect of noise on the hearing of workers has been a topic of debate among scientists for a number of years [2, 3, 4]. Regulations limiting noise exposure of industrial workers have been instituted in many places. For example, in the U.S., the Occupational Noise Exposure Regulation states that industrial employers must limit noise exposure of their employees to 90 dBA for one 8-h period [5, 6]. This permitted maximum noise exposure dose is similar to the Turkey

Standard, which is less than 75 dBA for one 7.5 h period [7].

Exposure to continuous and extensive noise at a level higher than 85 dBA may lead to hearing loss. Continuous hearing loss differs from person to person with the level, frequency and duration of the noise exposed [8]. Negative effects of noise on human beings are generally of a physiological and psychological nature. Hearing losses are the most common effects among the physiological ones. It is possible to classify the effects of noise on ears in three groups: acoustic trauma, temporary hearing losses and permanent hearing loss [9]. Blood pressure increases, heart beat accelerations, appearance of muscle reflexes, sleeping disorders may be considered among the other physiological effects. The psychological effects of noise are more common compared to the physiological ones and they can be seen in the forms of annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception [10, 11,12].

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A great majority of people working in industry are exposed to noise. Therefore, in this study, the effects of noise on human beings have been investigated with respect to the level of noise they are exposed to. In this context, measurement and questionnaire studies have been conducted at concrete traverse, cement, iron and steel and textile industries around Sivas.

Material and Methods

Industrial Noise Measurement Technique

This study has been carried out at concrete traverse, iron and steel, cement and textile factories around Sivas. Actual noise levels in these industries have been measured and their maximum and minimum values have been placed in the associated Tables. A sound level measuring instrument (TES 1350 Sound Level Meter) was used in these measurements. Measurements results have been recorded by holding the instrument at a height of 1.5m from ground in living and working environments of the workers in order to determine the noise levels to which the workers are exposed.

Iron and steel industry was not operating during this study, but a survey has to be conducted also in this industry due to the high level of noise incorporated and large number of workers involved in the iron and steel industries. For this purpose, noise levels corresponding to the iron and steel industry have been taken from a similar study made in the past. A survey also has been carried out at the iron and steel factory at Sivas to determine the effects of noise on human beings.

A 29-question questionnaire has been applied in the context of the study.

Purpose of the Questionnaire

1. To learn whether hearing losses in workers originate from any factors other than noise (a hereditary illness, effect of medication, exposure to sudden non-professional sources of noise, etc.)
2. To determine effects and complaints other than permanent hearing loss that may occur due to the noise.
3. To determine rates of using ear protection equipment used to decrease the level of noise influencing workers at workplaces, and expressing the complaints and positive comments on using them.
4. To determine the factors that are effective on workers exposed to noise.
5. For specifying worker comments on protection from noise.

Questionnaire Studies (Surveys) in the Industry

- A questionnaire has been applied on a one-to-one basis at the cement factory.
- Not to cause any work loss in the textile industry, the questionnaire forms were distributed during the day shift and collected the next day while it has been done on a one-to-one basis during the night shift.
- At the iron and steel industry, the survey has been conducted on a one-to-one basis as the factory was not running without any time and job losses.
- At the concrete traverse factory, forms have been distributed during the day and collected at the end of working hours.

Questionnaire results were compiled using Minitab statistical program software. The data were evaluated using the χ^2 test. Additionally, some important results have been also demonstrated in the associated Tables and Figures.

Measurement and Questionnaire Results

Noise Measurement Results

As shown in Table 1, the highest noise among these industries was detected at the cement (106 dBA) and concrete traverse (107 dBA) factories. Comparison of these results with the standards taking place in the Noise Control Regulation shows that none of the industries subject to this survey are meeting the associated standards.

Questionnaire Results and Evaluation

The questionnaire has been applied to 256 workers selected from all the industries. Distribution of the participants has been examined with respect to their ages, servicing periods, educational situations and departments. Distribution of the workers according to their industries is: 30% concrete traverse, 15% cement, 37% iron and steel, and 18% textile factories (Fig.1). It has been determined that their distribution with respect to their service periods is: 45% 5-10 years, 39% 11-15 years, 15% 15-20 years and 1% more than 20 years (Fig. 2). Distribution of the workers according to their educational level

Table 1. Industrial noise measurement results.

| Industries | Max(dBA) | Min(dBA) |
|-------------------|----------|----------|
| Textile | 99 | 75 |
| Iron & Steel | 100 | 77 |
| Cement | 106 | 70 |
| Concrete Traverse | 107 | 80 |

is: 1% literate, 30% primary school, 13% secondary school, 41% high school and 15% university education (Fig. 3).

Age distribution of the workers is: 17% 20-30 years, 60% 31-40 years and 22% 41-50 years (Fig. 4).

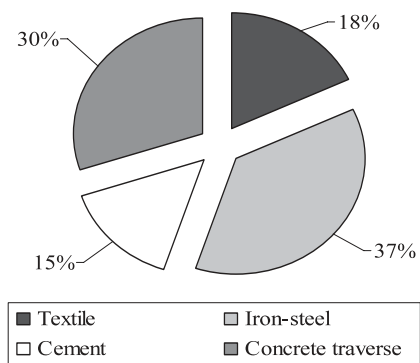


Fig. 1. Industrial distribution of workers.

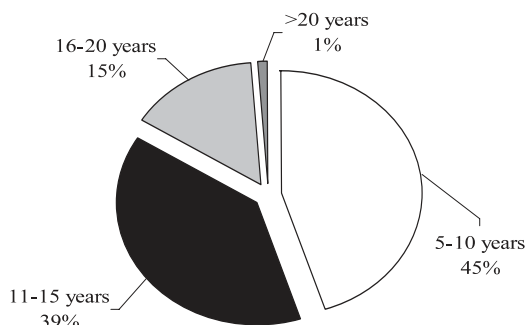


Fig. 2. Working period of workers worked in industries.

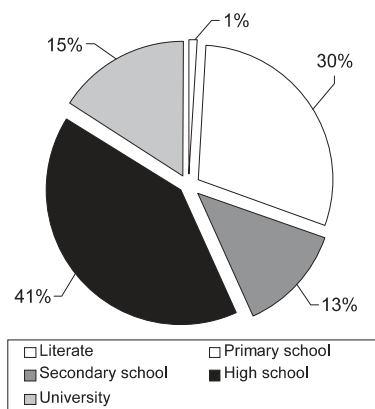


Fig. 3. Education level of workers.

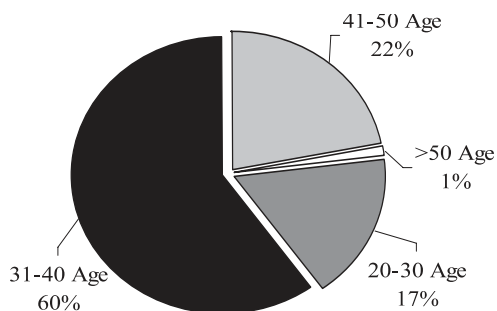


Fig. 4. Age distribution of workers.

When the ages, working periods and education levels were compared, it has been specified that the majority of the workers were from service period range of 5-10 years, age range of 31-40 years and are generally high school graduates.

The following points have been determined during the studies;

- In the concrete traverse factory, 28% of the workers in the production department are exposed to a noise level of 107 dBA while 74% of the workers in the whole factory also were exposed to a noise level much above the standards specified in the Noise Control Regulations.
- In the textile factory, 60% of the workers were exposed to a noise level of maximum 106 dBA and they are working at the mill department.
- At textile and cement factories, the majority of the workers are working in very noisy environments.

Looking at the level of disturbances from industrial noise in these industries, 73.83% of the workers (189 participants) have complaints about high level of noise in general. As shown in Table 2, the concrete traverse factory among these industries is the one with the highest level of disturbance from noise (maximum of 107 dBA). The rate of disturbance was never below 60% in any one of the factories, indicating that the problem of noise exists in all these industries.

By examination of the rates of disturbance in the workers depending on their working periods, it has been observed that there is no significant relation between the working periods and the disturbances from noise. As shown also in Table 3, the rate of disturbance from noise among the workers working for 5-10 years is 73.68% while this rate is 100% among workers working for more than 21 years. These results are considered to be statistically important, but they are not yet convincing. The workers have been asked about the type of their complaints, and 60.96% of the 228 workers responding to this question have complained about nervousness.

When all the industries are considered individually, it has been specified that maximum level of nervousness complaint was determined at the cement factory having a noise level of 105 dBA (67.65%) (see Table 4). Carelessness is the disturbance type with the lowest rate of appearance (3.07%). Looking at Table 2, it is possible to state that the most significant disturbance caused by noise is nervousness.

Examinations made on the type of hearing problems indicate that 30.86% of the workers are generally complaining about illnesses like ringing and leakage in the ears as well as hearing loss (Table 5). Distribution of hearing problems according to industries is 30.86% concrete traverse, 33.33% cement, 23.96% iron and steel, and 40% textile factories. As seen in these results, the textile industry was the one where the highest level of complaints (40%) determined with regard to the hearing complaints among the industries at Sivas.

Looking at the relationship between hearing problems and noise disturbance, it has been observed that com-

Table 2. Annoyance levels of industrial workers.

| Industries | Annoyance from noise | | | | | |
|-------------------|----------------------|-------|----|-------|-------|------|
| | Yes | | No | | Total | |
| | N | % | N | % | N | % |
| Textile | 35 | 77.78 | 10 | 22.22 | 45 | 17.6 |
| Iron & Steel | 70 | 72.92 | 26 | 27.08 | 96 | 37.5 |
| Cement | 24 | 61.54 | 15 | 38.46 | 39 | 15.3 |
| Concrete Traverse | 60 | 78.95 | 16 | 21.05 | 76 | 29.8 |
| Total | 189 | 73.83 | 67 | 26.17 | 256 | 100 |

$$X^2 = 4.484, D. F = 3, P > 0.05$$

N*: Working number, D. F*: Degrees of freedom

Table 3. The relationship between working periods and level of annoyance of workers.

| Working period (Years) | Annoyance of noise at working place | | | | | |
|------------------------|-------------------------------------|-------|----|--------|-------|-------|
| | Yes | | No | | Total | |
| | N | % | N | % | N | % |
| 5-10 | 81 | 71.68 | 32 | 28.32 | 113 | 44.66 |
| 11-15 | 77 | 77.78 | 22 | 22.22 | 99 | 39.13 |
| 16-20 | 28 | 73.68 | 10 | 26.32 | 38 | 15.02 |
| 20 -- | - | - | 3 | 100.00 | 3 | 1.18 |
| Total | 186 | 73.52 | 67 | 26.46 | 253 | 100 |

$$X^2 = 9.447, D. F = 3, P < 0.05$$

Table 4. Annoyances observed by workers in different industries.

| Annoyance | Industries | | | | | | | | | |
|--------------|------------|-------|------------|-------|--------|-------|-------------------|-------|-------|-------|
| | Textile | | Iron&Steel | | Cement | | Concrete Traverse | | Total | |
| | N | % | N | % | N | % | N | % | N | % |
| Nervousness | 27 | 64.29 | 46 | 57.50 | 23 | 67.65 | 43 | 59.72 | 139 | 60.96 |
| Dizziness | 5 | 11.90 | 7 | 8.75 | 7 | 20.59 | 4 | 5.56 | 23 | 10.09 |
| Insomnia | 6 | 14.29 | 8 | 10.0 | 3 | 8.82 | 17 | 23.61 | 34 | 14.91 |
| Tiredness | 3 | 7.14 | 15 | 18.75 | 0 | 0 | 7 | 9.72 | 25 | 10.96 |
| Carelessness | 1 | 2.38 | 4 | 5 | 1 | 2.94 | 1 | 1.39 | 7 | 3.07 |
| Total | 42 | 18.42 | 80 | 35.08 | 34 | 14.91 | 72 | 31.57 | 228 | 100 |

$$X^2 = 22.278, D. F = 12, P < 0.05$$

plaints of 34.9% of the workers disturbed from noise are related to hearing problems, indicating that noise is affecting the hearing members.

When workers were asked to answer the question "did you have any hearing tests before?" it was determined that 44.92% of the workers had hearing tests; and, with regard to the distribution to industries, it has also been determined

that most of the tests had been carried out at the concrete traverse factory (Table 6). Factory manager's expressions about having such tests each year support this fact. The rate of hearing tests made in the iron and steel industry is 19.79% and it indicates that these tests are not carried out there on a yearly basis. These results have also been found statically important ($p < 0.05$).

Table 5. Hearing complaints at different industries.

| Industries | Hearing complaints | | | | | |
|-------------------|--------------------|-------|-----|-------|-------|-------|
| | Yes | | No | | Total | |
| | N | % | N | % | N | % |
| Textile | 18 | 40 | 27 | 60 | 45 | 17.57 |
| Iron & Steel | 23 | 23.96 | 73 | 76.04 | 96 | 37.5 |
| Cement | 13 | 33.33 | 26 | 66.67 | 39 | 15.23 |
| Concrete Traverse | 25 | 32.89 | 51 | 67.11 | 76 | 29.68 |
| Total | 79 | 30.86 | 177 | 69.14 | 256 | 100 |

$$X^2 = 4.164, D. F = 3, P > 0.05$$

Table 6. The level of hearing test in industries.

| Industries | Hearing test | | | | | |
|-------------------|--------------|-------|----------------|-------|-------|-------|
| | to be done | | not to be done | | Total | |
| | N | % | N | % | N | % |
| Textile | 21 | 46.67 | 24 | 53.33 | 45 | 17.57 |
| Iron & Steel | 19 | 19.79 | 77 | 80.21 | 96 | 37.5 |
| Cement | 18 | 46.15 | 21 | 53.85 | 39 | 15.23 |
| Concrete Traverse | 57 | 75.00 | 19 | 25.00 | 76 | 29.68 |
| Total | 115 | 44.92 | 141 | 55.08 | 256 | 100 |

$$X^2 = 52.372, D. F = 3, P < 0.05$$

Examination of the hearing test results indicated that 77 workers (30.70) have hearing loss and, according to these results, distribution of these workers with hearing problems to industries is: 37.66% in concrete traverse factory, 25.97% textile factory, 20.77% iron and steel factory, and 15.58% cement factory (Table 7). These results have not been statistically important ($p > 0.05$).

As indicated by the results, the cement factory has the lowest noise level value (15.58%) among the industries with high noise levels. The cement factory has a 30.76% rate of hearing loss in its process. As can be understood from this result, the workers have refrained from giving correct answers to the questions on their hearing problems due to the factory being a private sector organization. It is very normal to observe that 37.68% of the workers with hearing losses are working at the concrete traverse factory having a maximum noise level of 107 dBA.

As shown in Table 7, 85.94% of the workers in the above industries do not have annual hearing tests. The rate of annual hearing tests in concrete traverse factory is 35.53%. This rate in the other industries is much under 10%. It shows us that hearing tests are made only at the concrete traverse factory each year or at least once in every two years.

It has been observed that there are noise problems in all the industries at which these measuring and question-

naire studies have been conducted. For this reason, it has been necessary to make a survey on the level of using the ear protection accessories for protection against noise and it has been determined that the rate of using them was 32.94%.

According to the survey results, the rates of using ear protection accessories are: 7.69% in the cement factory and 60% in the concrete traverse factory ($p < 0.05$). This subject has not been reviewed as there was no relationship between usage of ear protection accessories and the level of noise in the factories.

When workers were asked what kind of measurements should be required to protect them from noise, a great majority of them pointed out that measurements should be taken at the sources of noise. The rate of 9.31% supporting the use of ear protection accessories indicates that workers do not prefer the use of such protection devices.

Results

It has been determined during our measurements that the noise levels in all the above industries are much above the noise level of 80 dBA specified in Noise Control Regulation.

Table 7. The condition of periodical hearing tests done by workers working different industries.

| Industries | The condition of periodical test done by worker | | | | | |
|-------------------|---|-------|----------|-------|-------|-------|
| | done | | not done | | Total | |
| | N | % | N | % | N | % |
| Textile | 1 | 2.22 | 44 | 97.78 | 45 | 17.57 |
| Iron & Steel | 5 | 5.21 | 91 | 94.79 | 96 | 37.5 |
| Cement | 3 | 7.69 | 36 | 92.31 | 39 | 15.23 |
| Concrete Traverse | 27 | 35.53 | 49 | 64.47 | 76 | 29.68 |
| Total | 36 | 14.06 | 220 | 85.94 | 256 | 100 |

$X^2 = 41.730$, D. F = 3, P < 0.05

According to results of the questionnaire applied to the above industries:

1. 73.83% of workers in the industries are disturbed from the noise in their workplaces.
2. Noise causes the problem of nervousness on workers at a rate of 60.96%.
3. 30.86% of the workers have ailments like ringing in the ear, hearing losses, etc.
4. 85.94% of the workers do not have periodical hearing tests.
5. Ear protection accessories are being used in the industries by a rate of 32.94%. The rate of using ear protection accessories at the cement factory at which the noise level is the highest is at 7.69%. As indicated, the industries at Sivas have the problem of noise.

Recommendations

1. The problem of noise should be taken into consideration during their establishment phases (construction of the building, allocation of the machinery, etc.).
2. Use of the latest technology should be provided in the industries.
3. Authorized persons should arrange the working periods for workers according to the level of noise in workplaces.
4. New workers who will work at noisy workplaces should be subject to hearing tests and other tests regarding related illnesses.
5. Suitable protection accessories should be provided for the workers who will work in noisy environments and they should be trained on regular usage of such accessories.
6. Hearing tests should be performed periodically each year at noisy workplaces.
7. Employers and workers should be trained on noise and its effects on human health.

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