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ESTIMATES OF WORKERS WITH NOISE-INDUCED HEARING LOSS AND POPULATION AT RISK

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Towards the goal of protecting workers from damage due to noise exposure, a vast store of knowledge has been generated about its nature, etiology and time course. There still exists, however, a strong need to reclarify the locations, nature and magnitude of the problem of noise-induced hearing loss (NIHL). Based on the rate of positive results in a hearing screening test in the workplace, this paper presents an attempt to estimate the total number of workers with more than 40 dB hearing loss at 4 kHz caused by occupational noise exposure. The estimated values in major industry groups were as follows: about 780 000 in manufacturing; 410 000 in construction; 360 000 in agriculture; forestry and fishing; and around 2 million in total. Although it is rather difficult to estimate the number of workers exposed to noise above 85 dB(A), it may be reasonable to believe that at least several million workers exposed to noise should be covered by the 1992 guidelines for the prevention of noise hazards.

1. INTRODUCTION

Various factors, such as aging, lifestyle, ear diseases, head injury, heredity, drugs and Meniere's disease, are involved in the development of hearing loss [1]. When one focuses on workers of middle or advanced age, most hearing loss is associated with excessive exposure to workplace noise as well as with aging and lifestyle or such ear diseases as otitis media [2, 3]. On the basis of the Labor Safety and Health Act revised in 1989, a hearing screening test has become a regular part of a medical check-up, with the rate of positive results among major industrial groups being reported by the Ministry of Labor. In addition, guidelines for preventing noise hazards were made public and a systematic hearing conservation program in noisy workplaces was started in 1992. From the viewpoint of protecting workers from damage due to noise exposure, various counter-measures have been taken, but the rate of workers with positive results in medical check-ups for workers in noisy workplaces is still high [4]. In addition, the need to prevent hearing impairment is not felt by the majority of the people in noisy industry. Misperception and underestimation of the effects of hearing loss make the workers affected by work-related hearing loss unaware of its consequences in everyday life until they suffer from a very serious impairment. For these reasons, there still exists a strong need to reclarify the locations, nature and magnitude of the problem of NIHL [5, 6]. The number of workers in major industry groups with NIHL was estimated by using the results of a hearing screening test in the workplace.

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TABLE 1

Implementation of screening audiometry (1993)

	1 kHz	4 kHz	Others
No. of workers examined	8 078 527	7 975 175	1 984 411
No. of workers with positive results	400 446	794 284	17 817
Rate of the workers with positive results (%)	5·0	10·0	0·9

Source: Survey on the Periodical Medical Examinations (Ministry of Labor)

2. METHODS

Step 1. The rate of workers with positive findings in the screening audiometry among the major industry groups (Rt) was clarified. The data source is the Survey on the Periodical Medical Examination by the Ministry of Labor [7].

Step 2. The number of employed persons by age (five-year groups) and sex in major industry groups (Pmi, Pfi) was tabulated. The data source is the 1990 Population Census of Japan by the Statistic Bureau, Management and Coordination Agency [8].

Step 3. The rate of subjects with positive findings in the hearing test by age and sex among a typical unscreened population in Japan (Smi, Sfi) was investigated. The rates are based on the results obtained in hearing tests performed on 17 053 healthy men and women aged 30 to 59 years.

Step 4. On the basis of the data obtained in steps 2 and 3, an estimation was made of the rate of workers with positive findings resulting from age, ear disease or non-occupational noise exposure:

$$\mathrm{Ra} = \left(\sum (\mathrm{Smi} \times \mathrm{Pmi}) + \sum (\mathrm{Sfi} \times \mathrm{Pfi})\right) \Big/ \left(\sum \mathrm{Pmi} + \sum \mathrm{Pfi}\right).$$

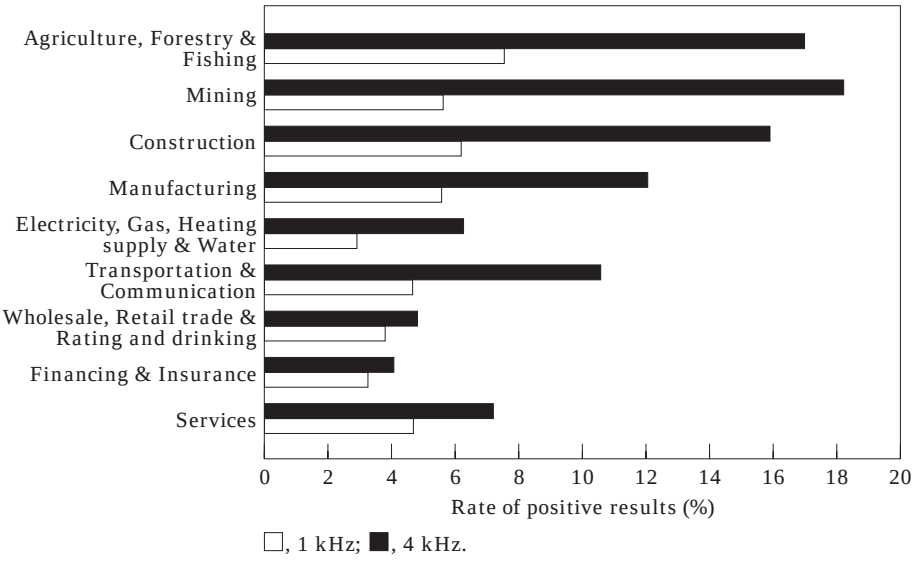

Figure 1. Rate of workers with positive results in screening audiometry by industry.

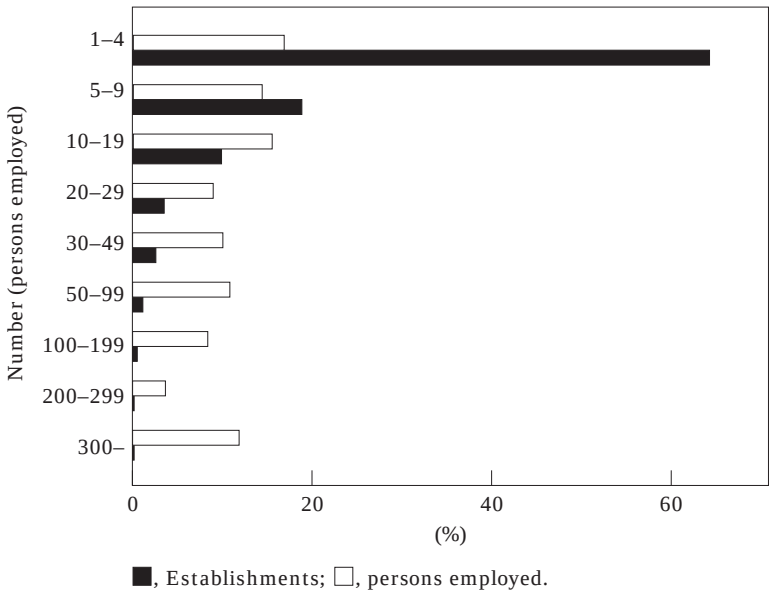

Figure 2. Distribution of establishments and number of persons employed by size of private enterprise.

Step 5. To estimate the total number of workers with a greater than 40 dB hearing loss, caused by an occupational noise exposure at 4 kHz by industry group, the difference in the rate of positive findings obtained in step 1 (Rt) and step 4 (Ra) is multiplied by the total number of employed persons in each industry.

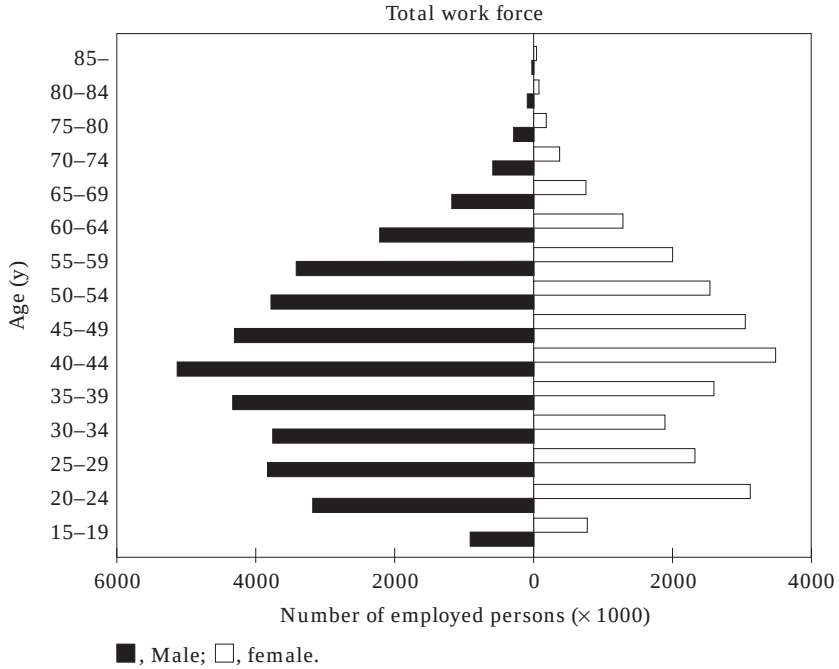

Figure 3. Number of employed persons by age (five-year groups) and sex in the total workforce.

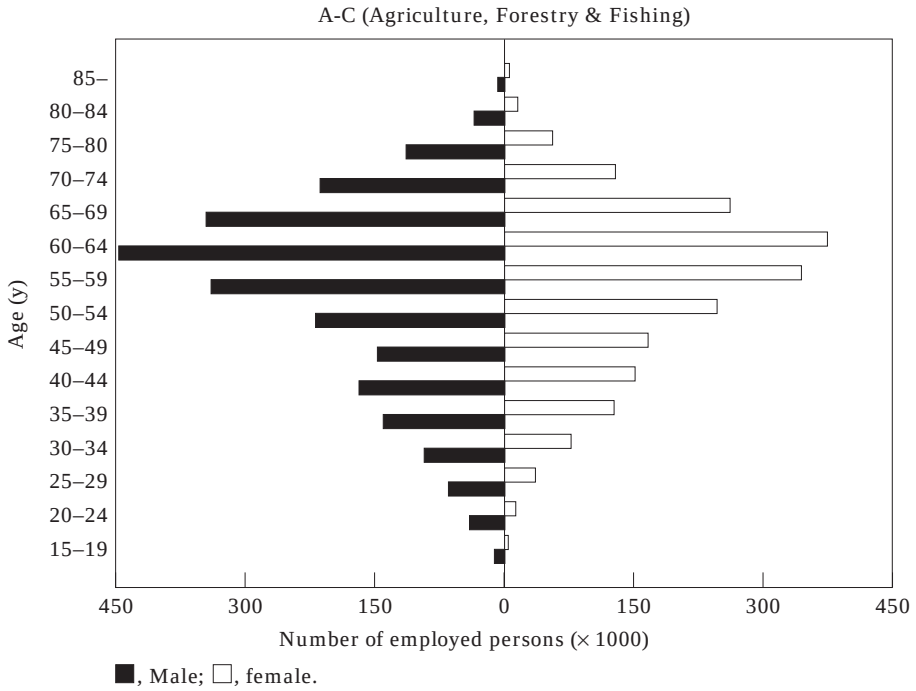

Figure 4. Number of employed persons by age (five-year groups) and sex in agriculture, forestry and fishing.

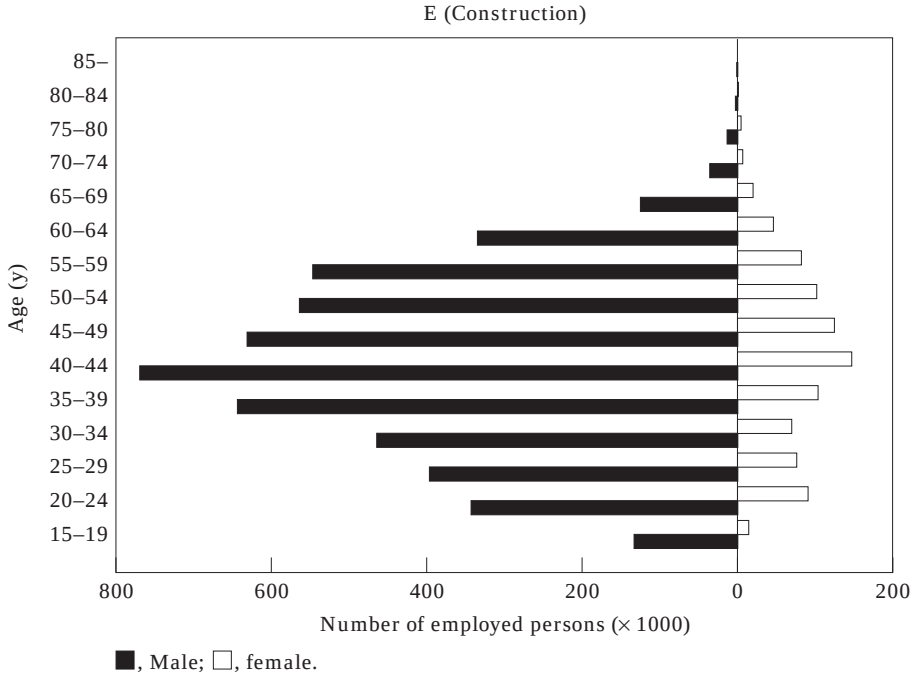

Figure 5. Number of employed persons by age (five-year groups) and sex in construction industry.

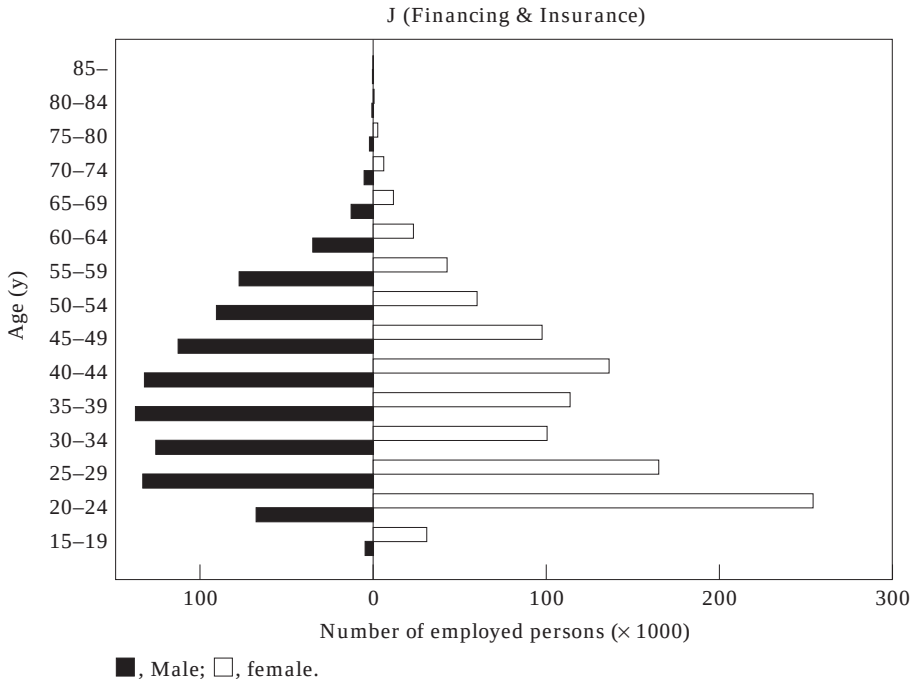

Figure 6. Number of employed persons by age (five-year groups) and sex in financing and insurance industry.

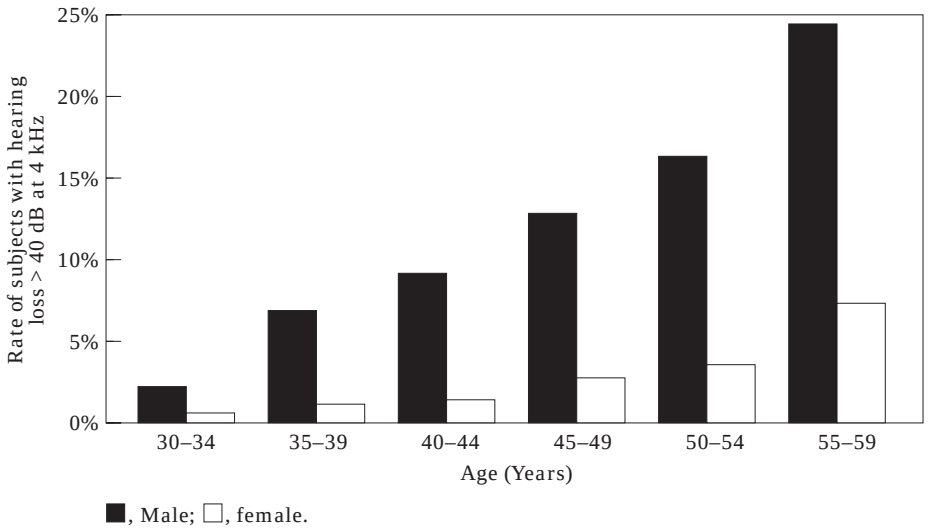

Figure 7. Rate of subjects with hearing level (HL) > 40 dB at 4 kHz among the general population by age and sex.

3. RESULTS AND DISCUSSION

3.1. EVALUATION OF THE RATE OF POSITIVE FINDINGS

Table 1 shows the results of the screening audiometry in 1993 [4]. Of 7 975 175 workers receiving the screening test at 4 kHz, 794 284 workers, or 10%, showed positive results.

TABLE 2

Estimation of the number of workers with hearing loss > 40 *dB at* 4 *kHz due to occupational noise exposure*

	(1) Rate of workers with positive results in screening audiometry at 4 kHz (Rt) (%)	(2) Rate of subjects with positive findings due to age *et al*. (Ra) (%)	(3) (1)–(2) (Rt)–(Ra) (%)	(4) Total number of employed persons	(3) × (4) Estimated number of workers with mild to severe HL
Agriculture, forestry etc.	17·2	9·0	8·2	4 391 281	360 000
Mining	18·2	10·4	7·8	63 381	5 000
Construction	16·0	9·0	7·0	5 842 027	410 000
Manufacturing	12·1	6·8	5·3	14 642 678	780 000
Electric, gas etc.	6·3	8·0	−1·7	333 614	0
Transport, communication	10·6	8·7	1·9	3 674 717	70 000
Wholesale, retail trade etc.	4·8	5·4	−0·6	13 801 675	0
Financing, insurance	4·0	4·9	−0·9	1 969 207	0
Services	7·3	5·2	2·1	13 886 738	290 000
Total					1 915 000

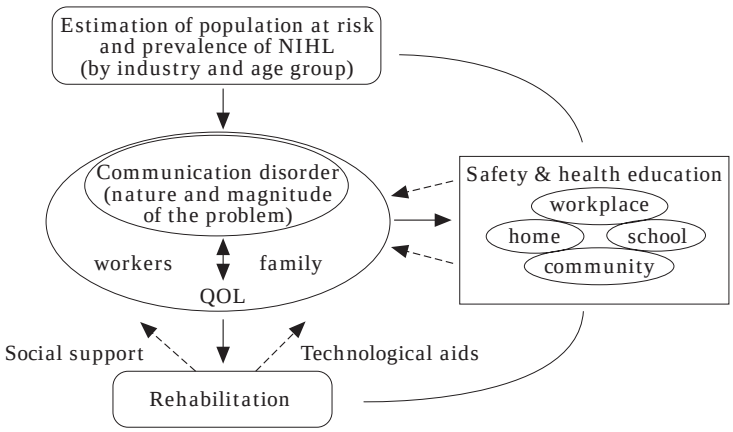

Figure 8. Diagram summarizing the preventive and rehabilitative approaches for communication disorders associated with work-related hearing loss.

The rate of workers with positive results at 1 kHz was 5%. The percentage of workers showing positive results varies greatly among industries (see Figure 1). Industries showing high percentages, in excess of 10%, were agriculture, forestry and fishing, mining, construction and manufacturing.

Several factors must be taken into account in evaluating this rate. First, reports of the results of medical examinations are mandatory only for those enterprises with more than 50 employees [9]. Figure 2 shows the distribution of establishments and persons engaged by size in the private sector. Establishments with more than 50 employees account for only 2·1% in terms of actual number, and about 35% in terms of work force [10].

The second factor one must take into account is the fact that, at most, the percentage of employees taking hearing tests is around 40% [7].

The third factor, which seems to be critical, is that the gender ratios and age distributions, which may affect the rate of positive results, differ largely among industries. Figure 3 shows the number of employed persons by five-year age groups and gender in the total work force [8]. The ratio of males to females is 6 : 4. In men one can see one big peak around the 40's while women show a bimodal distribution. In agriculture, forestry and fishing (see Figure 4), there are few young workers and the age peak at around 60 is striking. In the construction industry (see Figure 5), there is a significant difference in the number of male and female workers. The same tendency was found in the mining, transportation and communication industries. On the other hand, in the financing and insurance industries (see Figure 6), the number of female workers in the younger age groups far exceeds that of male workers. With account taken of this gender ratio and age distribution, as it may affect the rate of positive results, an estimation was made of the total number of workers with more than 40 dB hearing loss at 4 kHz caused by work-related noise exposure.

3.2. ESTIMATION OF THE TOTAL NUMBER OF WORKERS WITH MORE THAN 40 DB HEARING LOSS AT 4 KHZ

As a first step, the rate of workers with positive findings in the screening audiometry among the major industry groups is clarified (see Figure 1). In the second step, the number of employees is tabulated by age and sex and major industry group (see, e.g., Figures 4–6).

In the third step, the rate of subjects with positive findings in the hearing test is investigated by age and gender among a typical, unscreened population in Japan. As shown in Figure 7, significant differences exist between men and women in the rate of subjects with hearing loss greater than 40 dB at 4 kHz. For those in their early 40's, the positive rate was 9·4% for men and 1·5% for women. For those in the latter half of their 50's, the positive rate was 24·8% for men and 7·5% for women.

In the next step (step 4), on the basis of data obtained in steps 2 and 3, the rates of workers with positive findings due to age, ear disease or non-occupational noise exposure were estimated in each industry. This rate can be called here an ''age and gender adjusted rate of positive findings''.

In the fifth step, the difference in the rate of positive findings obtained in step 1 and step 4, which was considered to be the estimated rate of workers with hearing loss caused by occupational noise exposure, was multiplied by the total number of employed persons in each industry. Table 2 summarizes the five steps and shows the results. As shown in the column on the right, the number of workers in major industry groups with incipient NIHL was estimated as 780 000 in manufacturing, 410 000 in construction and 360 000 in agriculture, forestry and fishing. Eventually, at a moderate and rough estimate, about 2 million workers in the total work force suffer from NIHL.

3.3. ESTIMATION OF POPULATION AT RISK

Although it is rather difficult to estimate the number of workers at risk for NIHL, that is, workers exposed to noise levels above 85 dB(A), it may not be mistaken to suggest that at least several million workers exposed to noise should be covered by the 1992 guidelines for the prevention of noise hazards. Hearing impairment that is caused by occupational noise exposure and stressful lifestyles, and which manifests itself during the process of aging, results in communication difficulties in the activities of daily living. Furthermore, communication disorders are closely connected with a lowering of the quality of life, especially regarding social interaction, in both the workers affected with hearing impairment and their significant others [11, 12]. For these reasons, it is necessary to re-emphasize the importance of hearing conservation in the workplace and to implement effective hearing conservation programs based on the 1992 guidelines.

As regards the estimates of workers with incipient NIHL and the population at risk in the workplace, there are no conclusive observations to be made at this time. Not only is it necessary to implement a nationwide occupational exposure survey on noise to establish a precise population based data, but it is essential that we extend our understanding of the hearing disabilities and handicaps from an ecological viewpoint in order that appropriate preventive and rehabilitative approaches may be organized [13, 14] (see Figure 8).

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