OCCUPATIONAL NOISE-INDUCED HEARING LOSS AMONG DIRE-DAWA TEXTILE WORKERS

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Occupational Noise Induced Hearing Loss Among Dire Dawa Textile Workers

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Abstract

Although dangerous noise levels have been previously measured in Ethiopian factories, no studies have documented the importance of noise-induced hearing loss (NIHL). This study was designed to assess the prevalence and risk factors for NIHL in a Dire Dawa textile mill.

After a random start, a systematic sample of 630 workers were selected from among the 5900 factory employees. Data were collected through interviews, otologic examinations, pure tone audiometry and environmental noise surveys to document noise exposures. Noise levels as high as 110 dB(A) were detected, with average of 99.5±3.2 dB(A) in the weaving section and 89.0±2.5 dB(A) in the spinning section .

Audiometric tests revealed a 34% overall prevalence of NIHL, with a higher rate (71.7%) among weavers. NIHL was significantly associated only with level of noise, duration of exposure, and work section. Those who worked for 20 years or more had a nearly ten-fold increased risk of NIHL (OR=9.60, CI=3.40-23.30). Those chronically exposed to noise level of 90 dB(A) or more had a 14-fold increased risk of NIHL (OR=14.40, CI=8.20-25.12). Preventive interventions were generally absent, with no employees reporting use of personal protective devices (PPDs). It is recommended that a hearing conservation program be promptly implemented.

Introduction

No nation can achieve sustainable economic development neglecting the social well-being of its people. Neither, however, can social development be achieved without economic well-being. The essential link between these social and economic spheres is the working person. A healthy and productive worker is critical to sustainable social and economic development (1). Yet, occupational diseases are among the most common causes of sickness, disability and death in both the industrialized and developing world (1). Efforts to address occupational health problems remain outside the mainstream in health care systems and are rarely integrated into training curricula for health professionals. The clinical discipline of occupational medicine has historically been poorly developed and its research is generally underfunded. Despite the recent upsurge in both practice and research, reliable surveillance for occupational disease began only in the last decade in the USA (2). Particularly within the developing world, the need for occupational health services is expanding with increasing industrialization. Modernization of industry and agriculture often creates occupational hazards, such as through increased mechanization and broader use of industrial toxins such as radioactive isotopes and pesticides. Yet because they

are economically disadvantaged, workers in developing countries have rarely demanded the necessary increased investment in safety precautions in the workplace.

Even from the time of Hippocrates, who wrote extensively on the interaction of man and his environment, the effect of the workplace on health has received little attention. This neglect of occupational health, in ancient Greece just as today, may reflect a view of work as an activity reserved for slaves or the underclasses. It was five hundred years later that Pliny recognized the importance of occupational health hazards and even described use of a bladder-derived mask to protect labourers from inhaling lead dust and fumes. In 1556, Georgious Agricula described the disease now known as silicosis and recommended the introduction of ventilation in mines and the use of protective masks for miners (3). The first general treatise on occupational hazards was *De Morbis Artificum*, published in 1713 by the Italian doctor Bernando Ramazzini. His book described several occupational lung diseases, including those that are manifested in farmers, bakers, millers, grain measurers and hemp workers (4).

Noise is a major occupational health threat in occupations where levels exceed the normal value. The damaging effects of noise include hearing impairment and adverse influences on other bodily functions. Textile

factories are one of many occupational settings which pose the risk of NIHL (1,2).

There are no reported studies documenting the prevalence of and risk factors for NIHL among textile mill workers in Ethiopia. such investigations are overdue in support of efforts to protect workers' health in this country.

Literature review

NIHL was not widely recognized as an occupational hazard until the eighteenth century, when coppersmiths's deafness was reported. In the nineteenth century, blacksmiths and boilermakers were noted to be more subject to deafness. Since that time, other workers have been recognized to be at increased risk of NIHL, including artillery men, drop-forge workers, lathe-workers, stone-chippers, riveter, stampers, platers, weavers, welders, pneumatic drill operators, jet engineers, helicopter pilots, and pop musicians (5). These hearing impairments were often taken for granted among long-term employees, and even considered a sign of good work (6). However it was not until the middle of this century that the association between noise and occupational hearing loss was scientifically documented. The relationship was suspected in 1947, when a large number of claims alleged loss of hearing due to exposure to industrial noise in New York (6). In the 1950s, hundreds of similar claims were filled in the state of Wisconsin. It was during this decade that epidemiologic investigations established the relationship between hearing loss and noise exposure (6-8).

Noise is the most ubiquitous of all industrial pollutants (7). However, it is unique among health hazards in that it would be undesirable to eliminate

noise altogether, since humans rely on sound to function effectively in the environment. Sound may be perceived as "noise" when it causes discomfort or adverse health effects. Clinical and legal definitions of harmful levels of noise are therefore based on thresholds below which such undesirable effects will not be produced in the majority of the population (9). The physiologic effects of noise exposure are of two types, non-auditory and auditory. The non-auditory effects are thought to be mediated by the autonomic nervous system and may include disturbances of neuro-hormonal function (such as elevation of blood pressure) and of behaviour (such as interference with communication by speech). These non-auditory adverse effects of noise are usually seen only at noise levels above 80 dB(A)(time weighted average in decibels) (10,11). The auditory effects of noise include temporary and permanent NIHL and acoustic trauma (6). Noise can also be a risk factor for non-auditory injury through masking warning signals intended to protect workers from other hazards (12). The normal human ear can hear sound with frequencies from 20 to 2000 Hertz (Hz) (13,14). It is most sensitive in the range of 1000 to 5000 Hz and progressively less sensitive at higher and lower frequencies. Human speech frequencies are generally in the range of 500-4000 Hz(7).

There is no single classification that fully

characterizes hearing loss, including its type (sensori-neural, conductive or mixed), frequency (high or low), intensity (high or low), onset (acute or slowly progressive), laterality (unilateral or bilateral), and duration (temporary, intermittent, or irreversible). Hearing loss is generally documented clinically through use of pure tone audiometry, as the difference, in decibel (dB), between normal hearing and the subject's hearing at varying frequencies (15).

The characteristics of the audiogram vary distinctly by type of hearing loss. Audiogram may be used even to document the laterality of hearing loss. Generally, however, hearing deficits are documented at the frequencies of human speech where deficits are most important. However, it has been emphasized that actual disability should also be characterized by documenting the degree of loss of ability to hear the spoken voice in a normal environment and the spoken voice of the otologist in the clinic setting, in addition to the loss of ability to hear the signals of the pure tone and speech audiometer (5). Since deafness, or hearing loss which results in the inability to hear and understand the spoken voice, is a paramount disability (5).

* Helen Keller, who had been blind and deaf since her childhood, once wrote that "deafness...means the loss of the most vital stimulus - the sound of the voice that brings language, set thought astir, and keeps us in the intellectual company of men" (16).

The "normal" deterioration of hearing with advancing age is referred to as "presbycusis". Many people over the age of 65 have some degree of impairment of hearing in both ears, usually for higher frequencies (13,17). If the onset of impairment is early, before the age of 40, hereditary factor may be suspected (17). Distinction between NIHL and presbycusis may be difficult beyond the age of retirement. However, the hearing loss associated with age is negligible at 40 years of age, less than 15 dB at 50 years, and approximately 20 dB by age 65. At age 65, hearing loss is generally well below 25 dB, at which level impairment of hearing of human speech begins (3). NIHL may also be distinguished from presbycusis and middle ear disease in that deficits due to NIHL are confined to the frequency around 4000 Hz, while other speech frequencies (500 to 2000 Hz) are affected by other causes of hearing loss, i.e. less vulnerable to NIHL. Presbycusis affects the higher while conductive hearing loss affected the lower frequencies (6,12).

Risk factors which predispose to NIHL include the intensity and frequency of noise, the duration of exposure (years of employment, period and frequency of exposure per day), individual susceptibility, age, coexisting ear disease, and the character of the surroundings in which the noise is produced (including the distance from the sound source and the position of each ear relative to the sound waves) (3,4,6,18). Some studies have documented a protective effect of a pre-existing conductive lesion, which acts just as do protective devices to reduce the intensity of sound reaching the inner ear (6,12).

Every individual exposed to a level of 70 dB(A) or more will show temporary change in the audiogram. An experimental study of temporary deafness in human subjects in 1950 documented temporary high-tone hearing losses in ten volunteers exposed to pure tone stimuli at intensity of 110 to 130 dB for a period of 1 to 64 minutes (4).

Progressive and permanent hearing losses will be sustained by most who are exposed to noise levels of greater than 100 dB(A) for 3-4 weeks (11,13,19,20). According to Burn (21), exposure to continuous noise with an intensity of 85 dB(A) at a frequency of 4000 Hz over 20 years results in an average hearing loss of less than

5 dB. A number of people, however, will experience losses of 30 to 40 dB due to these exposures.

Such individual variation in susceptibility must be taken into account in establishing guidelines for acceptable occupational exposures. Regulations regarding acceptable levels of noise in the workplace differ from country to country. In establishing such standards, policy makers must determine the proportion of those with normal hearing who will sustain less than a certain specified (acceptable) hearing loss when exposed to noise levels above a certain value. "Acceptable" hearing loss is generally defined as the level at which the individual begins to experience difficulty in understanding every day speech in a quiet environment, usually defined as 25 dB at speech frequencies (18). The guidelines in most industrial countries are based on a maximum acceptable noise level of 85 or 90 dB(A) for 8 hours exposure, 5 days per week. In Europe, the 85 dB(A) level is more common, while in the United States (12) and Zimbabwe (22) the threshold of acceptability is 90 dB(A).

NIHL is most commonly caused by chronic exposure to occupational noise at approximately 85 dB(A) (23,24). The American Academy for Otology and Ophthalmology (AAOO) had recommended regular hearing tests are advisable if individuals are chronically exposed to noise at levels of 90 dB or more (12), though the Occupational Safety and

Health Administration (OSHA) subsequently revised this threshold to 85 dB(A) (4,12). The standard in most other countries, including Europe, is the International standard organization (ISO 1999), which calculates the probability of a hearing loss of 25 dB, as a function of exposure to noise of different intensities for variable lengths of time. These ISO 1999 guidelines are based on data which indicate that as much as 10% of a population with initial normal hearing will acquire a hearing loss of 25 dB or more after 40 years of exposure to noise at a level of 85 dB(A); for 90 dB(A) the figure is 20%. These values are based on studies of workers in the weaving industry (12).

OSHA regulations state that an occupational safety program must be designed to identify and monitor people who are exposed to noise levels of 85 dB(A) for 8 hours or more; if levels exceed 90 dB(A), measures must be taken to reduce the noise and workers must participate in a hearing conservation program, including use of personal protective devices (PPD) (120.

Textile industry workers are particularly at risk of NIHL (6,7,24), especially those engaged in weaving and spinning operations (25). Old technology and poor machinery maintenance place Ethiopian textile workers at even greater risk than their counterparts in the industrialized countries (19). Although previous studies

have documented dangerous noise levels in Ethiopian work places (14,26), including a textile mill in Asmara (19), there are no reported studies from Ethiopia which document the prevalence of NIHL and its relationship to occupational exposure.

A large textile factory was identified in Dire Dawa, 525 km east of Addis Ababa, where no occupational safety had been established to prevent NIHL. The factory, founded in 1931 by the Italian invaders, employs 5900 workers, 61.6 % of whom work in the high-risk weaving and spinning operations. According to the reports from the factory clinic (27), the leading causes of morbidity are accidents, intestinal parasites, upper respiratory tract infections, skin diseases and dyspepsia. Seasonally, malaria is another major cause of morbidity and mortality. No complaints of NIHL have been documented.

Objectives

General:

To determine the magnitude of and risk factors for NIHL among workers in the Dire Dawa textile factory.

Specific:

- To determine noise level by location in the work environment.
- To determine the prevalence of NIHL relative to the ambient noise level in each workplace location.
- To identify other risk factors for NIHL.

Methods

A cross-sectional study with internal comparison of workers by level of noise exposure was conducted in the textile mill in Dire Dawa between October 1 and December 30, 1994.

STUDY POPULATION

The source population for the study included all 5900 factory workers who reported for work during the study period. A sample size of 504 was calculated to be required to permit determination of a single proportion with 90% power, 95% confidence level, and a margin of error of ±4, assuming that a 30% prevalence of hearing loss would be detected. Anticipating that up to 30% of the selected population might be subject to exclusion or refusal to participate, 655 workers were systematically selected, after a random start, by taking every ninth employee from rosters for each department in the factory. For each worker who was selected, the study, including the voluntary nature of participation, was explained and informed consent obtained.

Those selected using this method were subsequently excluded if they had: 1) previously worked in another noisy occupation; 2) shifted jobs within the textile factory; 3) reported a history of ruptured tympanic membrane or other auditory deficit; or 4) otoscopic evidence of current tympanic membrane rupture. These

exclusion criteria are similar to those used in other studies (28) .

To replace selected workers who did not report for work during the study period, the next worker on the roster was selected and invited to participate.

Measurements

Dependent variable:

- Hearing level in decibel.

Independent variables:

- Socio-demographic characteristics:-

  Age, Sex, Marital status, Education, Alcohol and Chat consumption, and Cigarette smoking.

- Sign and symptom of ear disease (past and present).
- Characteristics of the surrounding
  - ♦ Environmental Noise level
  - ♦ Machinery and Building Survey

Operational definition:

Noise is sound that is discordant and non-periodic so that unwanted or unpleasant in contrast to the music or speech.

Hertz (Hz) Unit measurement of sound frequency in terms of the number of vibration or cycle per second.

Decibel (dB) unit measurement of sound pressure level or intensity.

Noise-induced hearing loss (Occupational hearing loss) is hearing impairment of one or both ears, partioal or complete, arising in or during the cource of and or a resultof ones emplyment; that develops over months or years of exposure to hazardious noise level.

Data collection

A data collection team was formed to carry out each of the four data collection tasks, including the interview, physical examination, audiometry, and environmental noise survey.

The interviews were conducted by locally recruited 12th grade graduates who were trained for one week in the use of the data collection instrument. A standard questionnaire used for measuring occupational hearing capacity (11) was modified for use in the interview. The questionnaire was designed to obtain a complete history relevant to hearing, including demographic data, duration of occupational exposure, history of auditory problems, drug use behaviours, and patterns of PPD use.

All otologic examinations were performed by the principal investigator. Each subject underwent otoscopic examination to detect any evidence of current tympanic membrane rupture. Cases of ruptured membrane were

industrialized countries, including UK (15).

For the environmental noise survey, noise levels were measured in work-stations corresponding to each position title using a precision sound level meter (B & K type 2232), with a range from 35 to 110 dB(A). In each department, approximately 20 locations were selected based on the proximity of the work-station to the noise source. For each of these work-stations, three measurements were taken on three separate days to obtain an average noise level.

A personal dose meter, (B & K type 4428) was used to establish a total noise dose over eight hours of exposure for individual workers randomly selected from all sections, proportional to their size, of the day shift.

Data management

Data were coded and cleaned by the principal investigator at the time of entry. Data entry and basic analysis was performed using Epi Info software, version 5(29). SAS (30) software was used for multivariate analyses.

Ethical consideration

Prior to study implementation, the purpose and procedures of the research were discussed with the

ministry of Health Environmental and Hygiene Unit, the Safety and Health Research and Education Section of the Ministry of Labour and Social Affairs, the regional Ministry of Health Bureau, the Factory Management, and the Safety and Health Unit of the factory.

Informed consent was obtained from every potential participant prior to data collection. Appropriate treatment was provided for those participants in whom ear problem were detected and those who needed further medical care were referred.

Necessary arrangements have been made with the factory management to provide counselling for those affected with NIHL.

Results

Interview and physical examination

After exclusion of 25 workers, 630 who satisfied the study requirements became participants in the study. Excluded were four employees who had previously worked in another noisy occupation, 12 who had shifted jobs within the textile factory, two who reported a history of ruptured tympanic membrane or other auditory deficit, and seven who had otoscopic evidence of current tympanic membrane rupture. More than half of these were from the weaving section. There was no refusal to participate.

The mean age of participants was 34.3 years, with a range from 20 to 59 years. There was no significant difference in the distribution by age and sex for workers in the four sections (weaving, spinning, preparation, and administration) and between the sample and source populations. Over 85% of workers reported they were able to read a newspaper. The mean level of educational attainment was grade 8±3. The mean monthly income of the study population was found to be 240±95 Ethiopian birr (US$ 37.50±14.84) with a wide range of 100 to 996 birr. Most (73.8%) of the participants reported they were married and living in union. The mean duration of employment within the same job was 15.7 years, with a range of one to 39 years. There was no significant difference in the duration of employment by the section

of the factory in which the employee worked.

Only 12.2% (77) of the participants were smokers, 11.7% (74) reported any consumption of alcohol, and less than a third (32.7%) admitted consumption of chat. All of these drug use behaviours were more common among males, including smoking (OR = 6.97, CI = 3.37-14.8), alcohol use (OR = 3.02, CI = 1.67-5.52), and chat consumption (OR = 4.99, CI = 3.34-7.49). Cigarette smoking was the only drug use behaviour which was associated with NIHL (OR = 1.85, CI = 1.11-3.09).

Only 51 (8%) of participants reported any history of hearing loss, while 57 (9%) reported a history of ear disease. 186 (29.2) complained of current problems with their hearing and 216 (34.3%) complained of ear pain.

None of the participants reported use of a PPD, citing reasons including lack of availability (71.6%), lack of knowledge of PPDs (18.6%), and belief that PPDs are ineffective (9.8%).

On physical examination, 154 (24.4%) were found to have a detectable ear problem, of whom 66 (42.2%) had otitis media or externa, while the remainder had cerumenous occlusion of the auditory canal. There was no significant difference by gender in the prevalence of detectable ear problems. Only 21 participants had both a history of "ear disease" and a detectable ear problems on physical examination. Table 1.

Table 1. Hearing loss by socio-demographic variables, In Dire Dawa Textile mill workers, Dire Dawa, 1994.

VARIABLES (95% CI)	NIHL		ODDs RATIO Yes No
Smoking			
yes(77)	36	41	
No (74)	178	375	1.85(1.11-3.09)
Alcohol			
Yes (74)	24	50	
No (206)	190	366	0.92(0.53-1.60)
Chat			
Yes (206)	70	136	
No (426)	144	280	1.00(0.69-1.45)
Hx hearing loss			
Yes (51)	17	34	
No (579)	197	382	0.97(0.50-1.86)
Hx ear disease			
Yes (51)	20	37	
No (57)	194	379	1.06(0.57-1.94)
Current ear problem			
Yes (216)	71	145	
No (414)	143	271	0.93(0.64-1.34)
Current hearing problem			
Yes (186)	64	122	
No (444)	150	294	1.03(0.70-1.50)
Ear difference			
Yes (186)	73	113	
No (444)	141	303	1.39(0.95-2.02)
Ringing			
Yes (171)	64	107	
No (459)	150	309	1.23(0.84-1.81)
Reading newspaper			
Yes (551)	177	374	
No (79)	37	42	0.54(0.32-0.89)
Married			
Yes (486)	177	309	
No (144)	37	107	0.60(0.39-0.94)
Sex			
- M (338)	103	235	
- F (292)	101	191	1.05 (0.76-1.47)

Audiometric examination

The overall prevalence of NIHL in either ear was 34% when measured at a frequency of 4000 Hz. Calculation of crude and adjusted odds ratios revealed no significant difference in the prevalence of NIHL by gender. Though the crude odds ratio showed a slight insignificant excess among females (OR=1.06, 95% CI=0.76-1.47), the adjusted figures revealed that females were at some what lower risk than their male co-workers (OR=0.65, 95% CI=0.42-1.01).

The prevalence of NIHL was significantly higher among weavers and spinners than among preparation and office workers, as summarized in table 2 and figure 1.

The prevalence of hearing loss showed a significant linear trend by age (Chi square for linear trend = 19.24, p= 0.00001), as summarized in table 3. However, multivariate analysis revealed that the association between NIHL and age was not significant after controlling for other variables.

Table 2. Hearing loss by section, In Dire Dawa Textile mill workers, Dire Dawa, 1994.

Section (N)	Cases of Hearing Loss (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Administration (167)	13 (7.8)	1.00	1.00
Preparation (72)	13 (18.0)	2.61(1.06-6.42)	1.79(0.67-4.76)
Spinning (253)	89 (35.2)	6.43(3.34-12.36)	2.52(1.16-5.46)
Weaving (138)	99 (71.7)	30.3(14.6-62.9)	10.3(4.19-25.3)
Total (630)	214(34.0)	--	--

Table 3: Hearing loss by age, In Dire Dawa Textile mill workers, Dire Dawa, 1994.

Age in years (N)	Cases of Hearing Loss (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
< 30 (195)	50 (25.6)	1.00	1.00
30-39 (274)	87 (31.8)	1.37 (0.90 - 2.06)	0.87(0.50-1.52)
40-49 (133)	63(47.4)	2.63 (1.65 - 1.20)	0.95(0.42-2.14)
≥ 50 (28)	14 (50.0)	2.92 (1.30 - 6.55)	1.55(0.47-5.16)
Total (630)	214(34.0)	--	--

The relative difference in the prevalence of NIHL among different age groups was further studied and compared between the two sexes, it was found that sex has no significant impact on the difference.

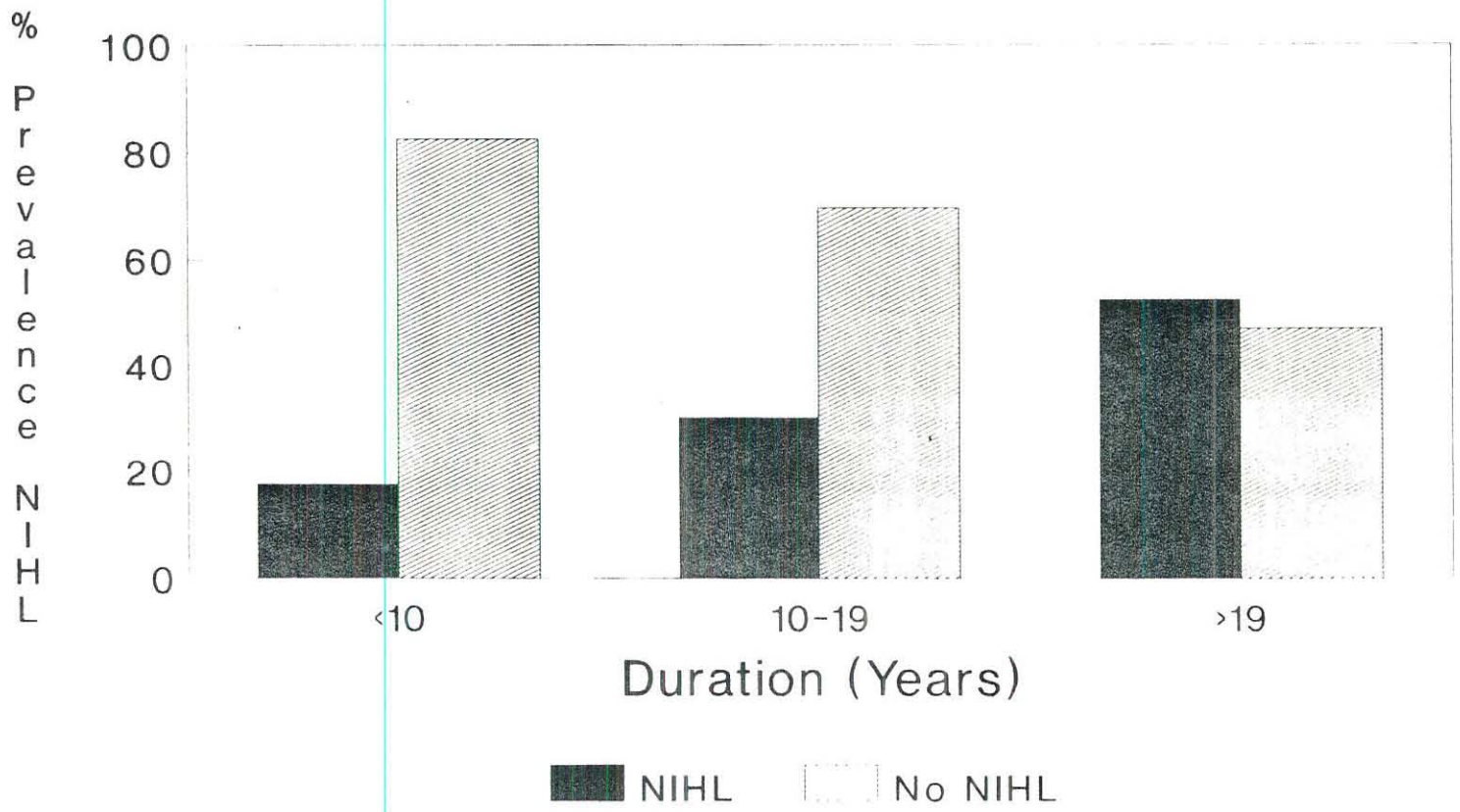
Of those with NIHL, only 63 (29.4%) were found to have either otitis or cerumenous occlusion of the external auditory canal. The crude odds ratio suggested that the prevalence of NIHL was significantly higher among those with such findings on physical examination than among those without (OR = 1.49, CI = 1.02 - 2.17), though the adjusted ratio (OR = 1.17, CI = 0.72 - 1.90) showed no such significant association. There is no significant association between the prevalence of NIHL and history of ear disease or hearing problem. The prevalence of NIHL was not significantly different between those with otitis and those with cerumenous occlusion.

The prevalence of NIHL increased with increasing years of exposure in the workplace (Chi square for linear trend = 45.9, $p < 10^{-7}$), as summarized in table 4 and figure 2.

Table 4: Hearing loss by years of exposure, In Dire Dawa Textile mill workers, Dire Dawa, 1994.

Exposure in years (N)	Cases of Hearing Loss (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
< 10 (138)	24 (17.4)	1.00	1.00
10-19 (308)	93 (30.2)	2.05 (1.24 - 3.40)	3.06(1.55- 6.05)
≥ 20 (184)	97 (52.7)	5.30 (3.13 - 8.97)	9.60(3.95-23.31)
Total (630)	214(34.0)	--	--

The Prevalence of Noise-Induced hearing loss among workrs of Dire Dawa textile mill by Duretion of exposure, 1994.



Environmental noise survey

None of the 10 buildings within the textile factory complex had any acoustical materials applied to interior surfaces. Neither the buildings nor the machinery used in the factory had any evidence of having been designed and constructed to reduce noise levels in work-stations. The walls are painted brick, and floors are of concrete block. Roofing materials are corrugated iron in some buildings, while others are reinforced concrete. The ceiling height of all the halls ranges from 5-6 meters. Workers are exposed continuously to these noise levels, except during a single half-hour meal break, for an entire eight hour shift. The factory is in use for 24 hours, five days per week.

The average noise levels in the 10 buildings, by the work function performed, measured by both area sampling using SLM and personal sampling using personal dose meters, are presented in table 5.

The values obtained by personal sampling was consistently higher than that obtained by area sampling, though the difference are not statistically significant.

The prevalence of NIHL also increased with increasing levels of noise exposure (Chi square for linear trend = 177.4, $p < 10^{-7}$), table 6 and figure 3.

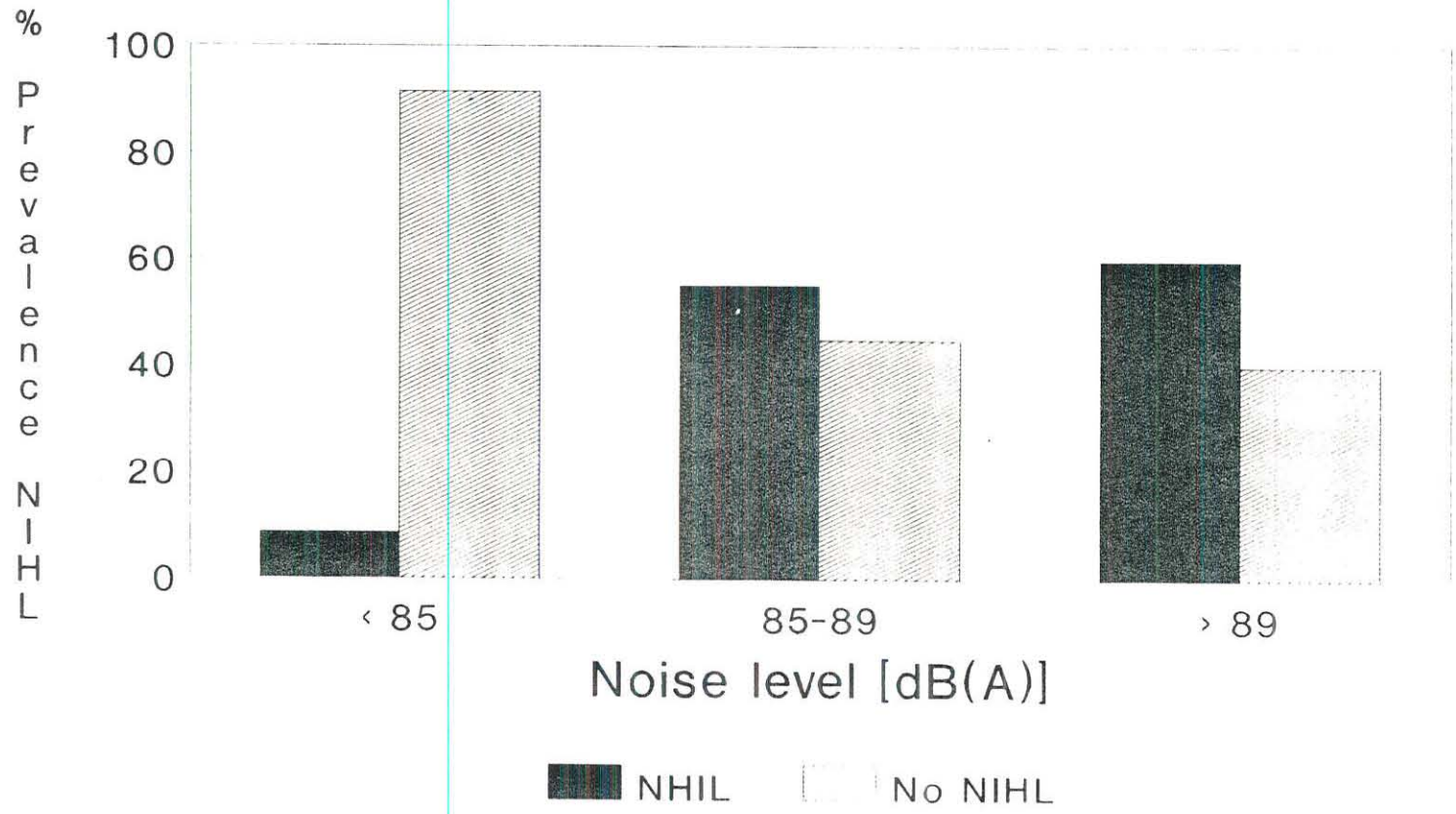
Table 5: Noise levels by work place, In Dire Dawa Textile mill workers, Dire Dawa, 1994.

Section (N)	Area Samples		Personal Samples	
	Number of Samples	Average Level [dB(A)]	Number of Samples	Average Level [dB](A)
Administration (1)	16	65.0 ±3.7	10	68.0 ±3.9
Preparation (2)	47	83.5 ±2.6	19	85.5 ±2.7
Spinning (5)	107	89.0 ±2.5	48	90.8 ±2.7
Weaving (2)	49	99.5 ±3.2	29	100.5±3.7
Total	219	84.2 ±3.0	106	86.2±3.25

Table 6: Hearing loss by level of noise exposure, In Dire Dawa Textile mill workers, Dire Dawa, 1994.

Exposure level (N)	Cases of Hearing Loss (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
<85 dB(A) (315)	27 (8.6)	1.00	1.00
85-89dB(A) (40)	22 (55.0)	13.04(6.24 -27.25)	12.50(5.6-27.95)
≥ 90 dB(A) (275)	165 (60.0)	16.00(10.08-25.41)	14.36(8.2-25.12)
Total (630)	214 (34.0)	--	--

The Prevalence of Noise-Induced hearing loss among workrs of dire Dawa Textile mill by Noise level, 1994.



Discussion

This study documents that noise is a serious occupational health hazard in this textile mill. The over all prevalence rate of 34% of noise induced hearing loss is comparable with similar settings else where in the world. This value was found to be lower than found in Egypt (34). The major risk factors for NIHL were the duration and level of noise exposure. This relationship is similar to that observed in previous studies in Thailand (33), Egypt (25), and the United Kingdom. Higher noise levels in the weaving and spinning sections, reflected in higher prevalence of NIHL among workers in those sections, have also been documented by previous studies in other countries (25,31,33). Weavers, spinners and workers in the preparation section of the mill were exposed to levels of noise of well above 85 dB(A), the threshold limit value set by many industrial countries in Europe and United States (31), as well as in some African countries, including Zimbabwe (12) and Kenya (32). These exposure levels which approached 100 dB(A), are comparable to the 99.5 dB(A) level measured in weaving sections of textile mills in Asmara (29), 102.5 dB(A) in Hong Kong (31), 101.3 dB(A) in Thailand (33), 100 dB(A) in Egypt (34,25), and 99-102 dB(A) in a jute weaving mill in the UK (Tayler 1985).

In the Dire Dawa mill, these high noise levels are likely due, in part, to poor safety engineering of outdated machinery. Additional noise-enhancing factors noted during the environmental survey included poor design and construction and crowding of work-space. In addition to increasing the risk of NIHL, such working conditions place workers at increased risk of other occupational injury due to their hampered ability to perceive warning signals.

The noise levels measured by personal sampling using personal dosemeters were consistently higher than those obtained by area sampling using the precision sound level meter (SLM). This statistically insignificant difference may be due to the greater proximity of the personal dosemeter to the machines and to the ability of the dosemeter to record sound fluctuation or impulses over time. This result also demonstrated that to determine the noise level in a work place, either method would detect the ambient noise level equally and using either of one measurement would be sufficient.

Due to the lack of availability of the sound-proof audiometry room recommended for use in such studies (35), there may have been some reduction in specificity in detection of NIHL. However, the clear association between the NIHL detected and the level and duration of occupational noise exposure suggests that any loss of

specificity did not interfere greatly with the accurate diagnosis of NIHL. The slight (non-significant) increased crude odds of NIHL among females appears to have been due to difference in the distribution of women by section. The slight (non-significant) increased adjusted odds of NIHL found among males in the study reflects the findings by other investigators (34), including the Hong Kong study (31). Although it has been pointed out that females may be resistant to NIHL (31), only small differences of 1-1.5 dB after long term noise exposure have been documented (31).

The study also detected an increasing auditory deficit with increasing age, reflecting the well-accepted phenomena of presbycusis and sociocusis (28,31). The adequacy of discrimination between NIHL and presbyacusis in this study is suggested by the lack of significant trend of NIHL with age in the multivariate analysis. Although no other studies have documented an association between NIHL and cigarette smoking, this study suggests that NIHL may be more common among smokers. However, in view of the lack of documentation of this association in the literature, it remains probable that this association is spurious.

Strengths and weakness of the study:

A standardized training of data collectors and supervisors, administration of a pretested standard questionnaires, the anonymous and coded nature of data collection, the daily supervision with random checking approach, timely corrections of identified problems are believed to have helped to minimize the effects of bias in this study.

The relatively small non-response rate, 0.02% minimizes the role of information bias. Utilization of the appropriate statistical programs for calculations and the control of confounders would contribute for ensuring the validity.

The problem of generalizability, however, still be questioned since the study was performed in a single textile mill which may have some unique properties for some other environmental factors which may not be shared with other industrial settings in the country.

Conclusions

The results of this study indicate that noise is a serious health hazard in the Dire Dawa textile mill. Additional specific conclusions include:

- Noise levels varied by section, with highest levels documented in the weaving (99.5 ±3.2 dB(A)) and spinning (89.0 ±2.5 dB(A)) sections. Lower levels were found in the preparation (83.5 ±2.6 dB(A)) and administration (65.0 ±3.7 dB(A)) sections.
- The prevalence of NIHL varied by ambient noise level, with those exposed to levels of <85 dB(A) having a 8.6% prevalence, those at 85-89 dB(A) having a 55.0% prevalence, and those exposed to ≥90 dB(A) having a 60% prevalence of NIHL.
- The other major risk factor for NIHL was the duration of exposure. Increased risk of NIHL was documented in those exposed for 10 to 19 years (adjusted OR=3.06, 95% CI=1.55-6.05) and those exposed for over 20 years (adjusted OR=9.60, 95% CI=3.95-23.31) when compared to those who had worked in the factory for less than 10 years.

Recommendations

In accordance with these findings, it is recommended that a hearing conservation program be implemented without delay in the Dire Dawa textile mill. In view of the documented risk in this Ethiopian factory and the clear danger of noise levels above 85 dB(A), ILO/Ethiopia should proceed with development and enforcement of regulations to require identification and monitoring of persons at occupational risk of NIHL. Regulations should also stipulate measures to be taken for noise reduction, including through use of PPDs. Regulatory and tax incentives should be instituted to promote investment by factory owners in worker safety. Legislation should also be implemented to restrict importation of equipment which emits dangerous levels of noise.

Engineering modifications of buildings and machinery should be required to control or reduce noise, such as through increasing open space in work areas, installation of sound adsorbents, vibration mounts and sound barriers.

Industrial audiometry or hearing testing in these settings should include a pre-employment or initial audiogram and periodic evaluation audiogram for all employees with routine exposure exceeding 85 dB(A).

The factory management and employers should promote the development of action-oriented safety and health committees within noise-prone work-places through unions or other workers' organizations. Efforts should include promotion of awareness of the risks of NIHL among both employees and employers. Such organizations may be instrumental in promoting worker awareness of the importance of frequent monitoring of auditory acuity and self-protective measures such as PPDs.

Disability compensation and auditory rehabilitation services should be provided for NIHL-affected workers to either restore hearing or improve their ability to cope with the deficit.

Currently available scientific data are already adequate to support the development of preventive programs. Future research activities should be focused on operational issues, including documentation of the cost and effectiveness of interventions targeted to prevent NIHL.

References

1. **Michail R.Reich and Toshiteru okubo**, Protecting worker's health in the developing world, National and International strategies. London, 1992; 1-5, 15, 22-34, 235-238.

2. **Harold f.S.,** Pathology of the ear. Harvard university. London. 1974.

3. **Clyton C.D.** Introduction, In: The industrial environment its evaluation and control. U.S. Govt. printing office, Washington D.C., 1973; 1-5.

4. **Ramazzini B.** De morbis artificum diatribae, Modenae, 1913, Reprinted, Turn : Edizini miniva mwdia, 1933.

5. **Stuart R.M. and Harold L.,** Disease of the ear. In: A text book of otology. forth ed., 1979; 468-480.

6. **Mery s. fox.** Industrial noise exposure and hearing loss. In: Disease of the Nose, Throat and Ear. 1969; 963-987.

7. **WALDRON.H.A.,** Occ. Health practice, third ed. Butterwarths.1989; 245.

8. **Tayler W.** Disorder of auditory function. Academic press. London. New York. 1973.

9. **BARRY S.L., and DAVID N. W.,** In: Occ. health recognizing and preventing work related disease.1978.

10. **Staurt R. M.,** Disease of the ear, London. 1974,

11. **Poul L. M.,** Patty industrial hygiene and Toxicology, Third ed. 1978; 209-231.

12. **Maxcy R.,** Public health and preventive medicine.1981.

13. **Donald H.,** The disease of occupation. 1978.

14. **Joint committee of MLSA, MOH, MOI, ILO/ETH.** Fundamentalist of occupational health and safety. In: hand out of the seminar for industrial and agricultural health of workers. Addis Ababa. August 1982; 18-20.

15. **Workers compensation board of British colombia, Hearing conservation section.** Industrial audiometry training and reference manual, eighth ed, 1991.

16. **Wendy M.** How to save your hearing. 1982; 36.

17. **Simson H.I., and Bernard H.C.,** Disease of the nose, Throat, and Ear. In: A hand book for students and practitioners.1982.

18. **US dept. of health, education and welfare, Physical health service, CDC- National institute for safety and health.** The industrial environment, its evaluation and control. 1973.

19. **Kebede Y.,** Industrial working environmental problem in Ethiopia, 1991.

20. **Hayes A.N.,** Audiometry principle and practice. Stanford university, school of medicine. 1989.

21. **Burn W., Robinson D.W,: Aege R.Moler,** Hearing and noise in industry, London: HMSO, 1970.

22. **Makambaya S.,** Preventing noise hazard at zimbabwen work place. Zimbabwe. In: Africa news letter on occupational health and safety. 1992; 12: (1).

23. **THANE C.D., Eugene B.K., Bruce W. p.,** A guide to diagnosis and management. In: Disease of the ear, nose and throat. London. 1981.

24. **Hendrick D.I., and Weill H.** Acute reactions to inhaled agents. In : Recent advances in occupational health, Cherchill Livingstone, new York. 1989; 54-83, 435-445.

25. **Abdul A.,** Study of some parameters affecting noise level in textile spinning and weaving mill. Egypt. 1982.

26. **Asmerom F.**, Occupational health and safety, In: A paper presented to the seminar on industry and environment. Nov. 1991; 20-22.

27. **Health committee**. Anual report on the activities of Dire Dawa textile factory clinic, 1991.

28. **Martin R.H., Gipson E.S., Lockington B.S.** Occupational hearing loss between 85 and 90 dB(A).1989.

29. **Epi Info version 5 statistical package.** 1988.

30. **SAS/STAT User's Guide.** Release 6.03 Edition. 1988.

31. **Evans W.A.,** Industrial noise induced hearing loss in Hong Knog. In: Ann. Occup. hyg., 1982; 25, (1) 63-80.

32. **Wambugu A.W.,** Case of noise induced deafness in industry, Kenya. In: African newsletter on occupational health. 1992; 2:(1).

33. **Prance C.** Noise exposure and permanent hearing loss of textile workers in Thailand. In: industrial health. 1989; 27.

34. **Kill R.K.,** Hearing loss in female jute weavers, In: Annal occupation. 1983; 18: (10) 97-109.

35. **ISO 1999.** Acoustic determination of occupational exposure and establishment of noise induced hearing impairment. 1991.

ANNEX 1. HEARING ASSESSMENT QUESTIONNAIRE

SERIAL NO.

1. FACTORY TEXTILE [ ]1 CEMENT [ ]2

2. EMPLOYEE NUMBER_____

3. SECTION 1. MILL 1 SPINNING

2. MILL 2 WEAVING

3. MILL 2 PREPARATION

4. MILL 3 SPINNING

5. MILL 4 STAINING

6. MILL 5 WEAVING

7. MILL 5 SPINNING

8. MILL 5 PREPARATION

9. MILL 7 SPINNING

10. SUPPORTING AND ADMINISTRATION

4. JOB TITLE [ ]1 MACHINIST [ ]2 FORAMEN
[ ]3 SUPPORTIVE (cloth-folding or sizing, giggler, stainer etc.) []4 OFFICE

5. AGE ____ 6. SEX MALE [ ]1 FEMALE []2

7. # YEARS IN THIS FACTORY _____

8. # YEARS IN CURRENT JOB _____

9. SALARY _____

10. DO YOU HAVE A SECOND JOB? EXPLAIN
_____

11. HAVE YOU WORKED IN ANY JOB PRIOR TO THIS ONE WHICH HAD NOISY WORKING ENVIRONMENT? YES [ ]0 NO[ ]1

12. DID YOU HAVE ANY HISTORY OF HEARING LOSS PRIOR TO THIS JOB ? YES [ ]0 NO [ ]1

13. HAVE YOU EVER HAD EAR DISCHARGE OR TRAUMA OR INFECTION? YES [ ]0 NO [ ]1

14. HAVE YOU EVER HAD HEAD INJURY YES? [ ]$_0$ NO [ ]$_1$

15. HAVE YOU EVER HAD A BROKEN EAR DRUM ? [ ]$_0$ NO [ ]$_1$

16. DO YOU HAVE EAR PROBLEM NOW YES [ ]$_0$ NO [ ]$_1$

17. DO YOU FELL YOU HAVE HEARING PROBLEM? YES [ ]$_0$ NO[]$_1$

18. DO YOU FELL THAT THERE IS DIFFERENCE BETWEEN THE TWO EARS? YES [ ]$_0$ NO [ ]$_1$

19. DO YOU HAVE ANY RINGING? YES [ ]$_0$ NO [ ]$_1$

20. HAS ANY ONE IN YOUR FAMILY LOST HEARING BEFORE AGE 50?
YES [ ]$_0$ NO [ ]$_1$

21. ARE YOU TAKING NOW OR REGULARLY TAKING MEDICATION?
YES [ ]$_0$ NO [ ]$_1$

22. IF YES, WHAT _____

23. CAN YOU READ NEWSPAPER? YES [ ]$_0$ NO [ ]$_1$

24. WHAT WAS THE LAST GRADE OF SCHOOL YOU COMPLETED?
_____

25. WHAT IS YOUR MARITAL STATUS? NEVER MARRIED [ ]$_0$
MARRIED [ ]$_1$ DIVORCED [ ]$_2$ WIDOWED [ ]$_3$

26. DO YOU DRINK ALCOHOL? YES [ ]$_0$ NO [ ]$_1$

27. IF YES, HOW OFTEN?[ ]$_1$ RARELY (monthly)
[ ]$_2$ OCCASIONALLY(monthly-weekly)
[ ]$_3$ FREQUENTLY (weekly-daily)
[ ]$_4$ DAILY (at least daily)

28. DO YOU SMOKE CIGARETTES? YES [ ]$_0$ NO [ ]$_1$

29. IF YES, HOW MANY PER DAY? _____

30. DO YOU CHEW CHAT? YES [ ]$_0$ NO [ ]$_1$

31. IF YES, HOW OFTEN? [ ]$_1$ RARELY [ ]$_2$ OCCASIONALLY
[ ]$_3$ FREQUENTLY [ ]$_4$ DAILY

32. DO YOU USE ANY METHOD TO PROTECT YOUR EAR WHILE AT WORK

YES [ ]0 NO [ ]1

33. IF YES, IS THE PROTECTION EQUIPMENT:

[ ]1 PURCHASED BY YOU

[ ]2 PROVIDED BY THE FACTORY

34. FOR HOW MANY YEARS HAVE YOU USED? _____

35. IF NO, WHY? [ ]1 NOT AVAILABLE

[ ]2 I KNOW NOTHING ABOUT IT

[ ]3 I DON'T BELIEVE ON ITS USE

[ ]4 OTHER, SPECIFY

36. DO YOU HAVE HYPERTENSION? YES [ ]0 NO [ ]1

37. OTOLOGIC EXAMINATION NORMAL YES [ ]0 NO [ ]1

38. IF NO, SPECIFY THE FINDING [ ]1 OTITIS EXTERNA

[ ]2 OTITIS INTERNAL

[ ]3 WAXY

[ ]4 OTHER (specify)

39. BLOOD PRESSURE _____

40. AMBIENT AVERAGE NOISE LEVEL dB(A)_____

41. AUDIOMETRIC EXAMINATION FOR:

THRESHOLD - dB(A)

FREQUENCY - HERTZ	LEFT	RIGHT	COMBINED
4000	____	_____	_____
8000	____	_____	_____

ANNEX 2. DATA CODING AND ENTRY FORM

SERNO. ###

1. FACTORY #
3. SECTION ##
4. TITLE #
5. AGE ##
6. SEX #
7. FACSERV ##
8. CURSERV ##
9. SALARY ####
10. SECJOB #
11. PRIORJOB #
12. HXHEARLOSS #
13. HXEARPROB #
14. HEADINJURY #
15. BROKENDRUM #
16. CEARPROB #
17. CHEARPROB #
18. DIFFERENCE #
19. RINGING #
20. FAMILY #
21. DRUG #
22. RX _____
23. READNEWS #
24. GRADE ##
25. MARREGE #

26. ALCOHOL #

27. FRQUENCY #

28. CIGARETTE #

29. NO. ##

30. CHAT #

31. FEQUENCY #

32. PPD #

35. NOTPPD #

36. HXBP #

37. ENT #

39. BPS ###

40. BPD ###

41. AUD4R ##

42. AUD4L ##

43. AUD8R ##

44. AUD8L ##

45. NOISE ###

46. COMLS4 ##

46. DIS4R ###

47. DIS4L ###

48. COMDIS ###

Annex 3. STUDY ARCHITECTURE

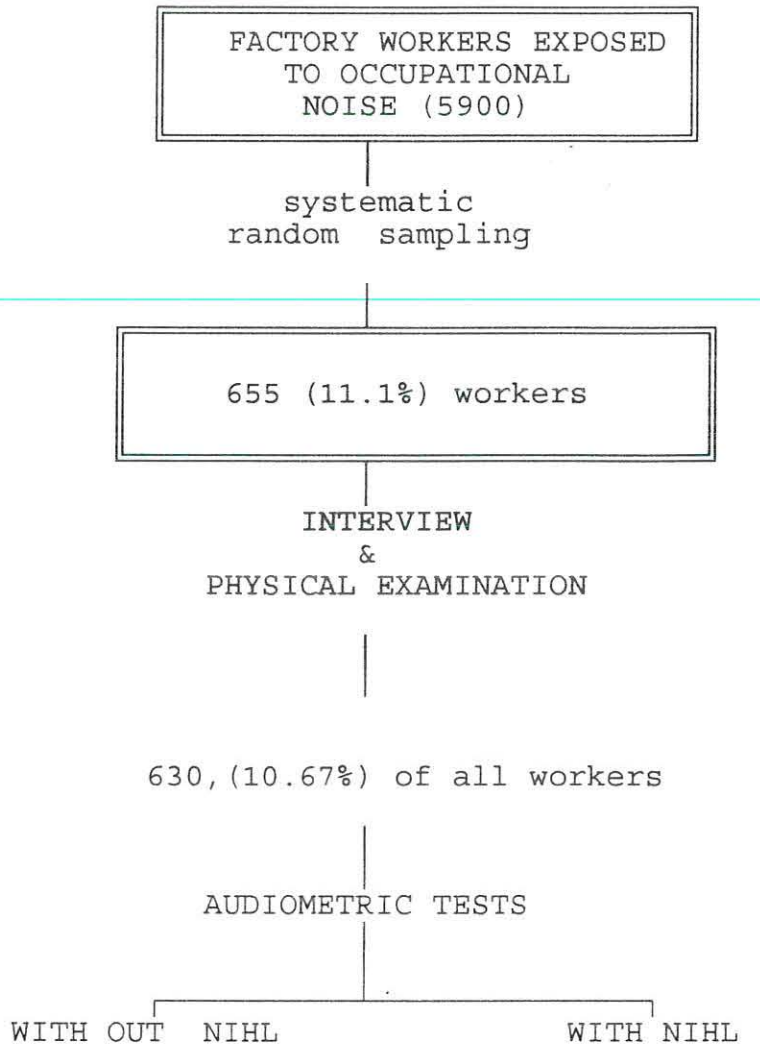


Figure 1. Study Architecture

DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in any other university and that all resources of material used for this thesis have been fully acknowledged.

Name: Dr Ayele Belachew

Signature: _____

Place: Addis Ababa, Ethiopia

Date of submission: May 1995