PERCEIVED INDUSTRIAL DEAFNESS AND HEARING LOSS AMONG PEOPLE IN A SMALL QUEENSLAND RURAL COMMUNITY

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Abstract. This paper aims to describe chronic diseases including hearing loss reported by people in a small rural community. It will present the results of audiometric screening among a group of people in this community and their self reported risk factors of hearing loss. Different risk factors experienced by men and women will be compared. Two surveys were conducted in a small Queensland rural community. The first survey gathered information relating to chronic diseases among 604 people using a telephone interview method. The second survey assessed the level of hearing among 64 people who presented themselves for audiometric screening, their history of exposure to loud noise and their previous use of hearing protective measures. A higher rate of "industrial deafness" was reported (110.75 per 1,000 population) than the 1995 National rate (95.2 per 1,000 population). Of 64 people who attended the audiometric assessment, 60 (93.8%) had some level of hearing loss using the 2000 International Standard of hearing level (ISO 7029: 2000) taking age and gender into account. However, 15 persons (23.4%) perceived that they had good hearing. When compared to ISO 7029: 2000 standard, men and women had a similar pattern of hearing loss. Compared to men, a lower percentage of women were exposed to different sources of loud noise and were less likely to use hearing protection devices.

INTRODUCTION

Hearing loss is a common and insidious public health and occupational health problem, with the prevalence in Australia amongst the general population being reported as high as 22% (Victorian Deaf Society, 1998). Approximately 182,600 people in Queensland in 1993 were estimated to have some type of hearing impairment, with a suggestion by Wilson *et al* (1992) that this is an under-estimated public health problem. In many developed countries, including Australia, New Zealand and the USA, a high prevalence rate of hearing loss has been reported amongst rural farming and agricultural communities. Eddington *et al* (1995) compared the hearing ability of farmers to an age and gender matched cohort of office workers and found that farmers had significantly more hearing loss than office workers. In a recent cross sectional hearing loss study conducted in New Zealand amongst farmers, McBride *et al* (2003) reported on significant levels of hearing loss being found amongst farmers after audiometric testing was conducted. In another study in Australia by Williams and others (2002) the ISO 7029: 2000 - Acoustics- Statistical distribution of hearing thresholds as a function of age, was used for comparison in assessing the levels of hearing loss among approximately 300 adults who attended rural field days. The participants underwent audiometric testing and the results showed that more than 70% of the participants had hearing loss, compared to the expected median level of hearing at 3k, 4k and 6kHz amongst the general Australian population. The ISO 7029: 2000 takes age and gender into account for the ex-

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pected hearing thresholds at different frequency hearing levels. However, the researchers did not provide information relating to background noise exposure and the participants' exposure to loud noise prior to the assessment. In the USA, Kerr *et al* (2003) conducted a study among 147 construction laborers and 150 farmers in the Midwestern United States. They found that the percentages of hearing loss among the construction workers who had hearing loss, defined as an inability to hear more than 25 decibels (dB), at 1, 2, 4 and 6 kHz were 12.9, 17.0, 53.1 and 63.9%, respectively. The respective percentages of hearing loss across the same frequencies among the farmers were 16.7, 28.0, 66.7 and 78.7% (Kerr *et al*, 2003). Plakke and Dare (1992), showed by age matching non-noise exposed individuals with noise exposed farmers that farmers exposed only to noise from farming had significantly poorer hearing than persons not exposed to noise. It can be concluded that farmers are at increased risks of hearing loss, probably from prolonged exposure to loud noise (Plakke and Dare, 1992, Eddington *et al*, 1995; Williams *et al*, 2002; Kerr *et al*, 2003). The need for preventive measures in agricultural communities was discussed by Schenker (1996), where the author points out that in the USA, hearing loss has increased amongst farmers whereas injuries and fatalities have fallen in other hazardous industries like mining and construction, even though agriculture has been recognized as one of the most hazardous major industries.

Hearing loss is a progressive irreversible condition. An individual may not realize that their hearing has'detiorated and is poor. The results of the studies by Williams *et al* (2002); and Kerr *et al* (2003) showed that people self evaluated their hearing level as being better than the actual hearing ability when compared to audiometric screening results.

In 1995, the Australian National Health Survey reported a standardized rate of partial or complete deafness of 95.2 per 1,000 population (Australian Bureau of Statistics, 1995a). This was from self reported data, not from audiometric testing. Some relatively dated data from the United Kingdom indicated an overall prevalence of hearing impairment (25 dB in a better ear exposed to the average pure tone of 0.5, 1, 2 and 4 kHz) as 16.1% of the total population (Davis, 1989).

Little published information was available among male and female farmers' perceived hearing level compared with the hearing assessment data from the same population group. This paper aims to describe the prevalence of self reported chronic diseases including hearing loss, reported by people in a small rural community in Queensland. It will also present the results of audiometric screening conducted amongst a group of people in this community and their self reported risk factors for hearing loss.

SUBJECTS AND METHODS

Two surveys were conducted in a small Queensland agricultural community located approximately 700 km northwest of Brisbane, the State capital city. There were 356 households listed in a commercial telephone directory which included more than 96% of the total households (Australian Bureau of Statistics, 1998). Jirojwong and Savage (2003, unpublished data) conducted the community's needs assessment of 226 households (63.5%) with 604 members and found that 29.5% of the population was aged 19 or younger, 57.1% were aged 20-64 years and 13.4% were aged 65 years or older. Of these 226 households, their main income earners were the following: 51.8% were full-time farmers or graziers, 8.1% were part-time farmers or graziers, 11.1% were retirees or students, and 3.6% were engaged in home duties. The agricultural products of this community included wheat, lucern and cattle. The majority had private health insurance (62.2%) and family cars (96.3%).

The first survey was conducted in 2002 using a telephone interview method to explore the prevalence of chronic diseases. The second survey was conducted seven months after the initial survey among 64 people who presented themselves to the audiometric screening sessions as a convenience sample. The Central Queensland University Research Ethics Committee approved the study.

Two studies (Brown *et al*, 1996; Jirojwong and Manderson, 1999) and the results of four

focus group interviews among 28 participants in rural Queensland were used as a guide to develop close-ended questions used in the first survey. A pilot study was conducted to revise the questionnaire. As the result of community feedback, one question item assessing self reported noise-induced hearing loss notated as "industrial deafness" replaced a question on a non-specific cause of hearing loss used in the draft questionnaire.

Four research assistants were trained to conduct telephone interviews. A manual was also developed to be used by the research assistants. It described the purpose of the study and the questions included in the questionnaire. The inter-rater reliability was assessed with the agreement of data among the interviewers ranged between 0.80 and 0.95 which was considered satisfactory (Nunnally, 1978).

Data collection

The First survey. A telephone directory was the source of names, mailing addresses and telephone numbers of all 356 households in the community. A letter introducing the study was mailed out to all households. Each household was later contacted by telephone and an interview was conducted. Out of the 356 households, 272 (76.4%) households that were contacted; 226 (83.1%) agreed to participate (160 females, 66 males). Of the 272 contacted, 46 (16.9%) refused. Of the remaining 84 households (23.6% of the total of 356 households), nobody was at home when called, between four and eight times. From the 226 who participated, information was documented on 604 household members. The respondent provided information relating to chronic disease experienced by all household members.

The second survey. An assessment of hearing was conducted seven months after the initial survey. An invitation letter for adults to participate in the hearing test was included in the local newsletter. Sixty-five people participated in this assessment, but one (1.5%) did not want his information to be used in any report or publication. All 65 were asked to avoid unprotected exposure to loud noise 16 hours prior to the test.

The Guidelines for the Acoustic Measurement of Audiometric Test Environments, auditory assessment (Standards Australia AS/NZS 1269.4, 1998) were followed for the assessment of the audiometric test environments used. The background noise levels were tested using a calibrated Bruel and Kjaer type 1 modular precision integrated sound level meter. Testing was conducted in the designated areas with low background noise levels across the required frequencies.

The audiometric assessment was performed by a trained technician using a calibrated Oscilla Audiometer DS 780 and Peltor H7A earphones. Participants were presented with a pure tone at 0.5, 1, 3, 4, 6, 8 kHz. Since the focus of the survey was to explore hearing loss due to noise exposure, the results of the 50 percentile or the median of the hearing ability of the better ear at 3, 4, 6 kHz were calculated and are presented in this paper. The ISO 7029: 2000 Acoustics-Statistical distribution of hearing thresholds as a function of age, was used as a comparison with the results taking into account the effects of an individual's gender and age in relation to the distribution of hearing thresholds which would be considered "normal" for the person's age group. The standard was developed for adults aged between 18 and 70 years for a range of audiometric frequencies from 125Hz to 800 Hz (ISO 7029: 2000, 2000).

Data were analysed descriptively and presented as numbers and percentages. The Pearson chi-square test and the Student's *t*-test were used to assess a relationship between two variables. SPSS statistical computer package version 12.0.1 was used to analyse the data. A standardized rate was computed using the mid 1995 Australian population estimate, categorized to three age groups (0-19 year, 20-64 year and 65 year or older age groups) as a standard population (Australian Bureau of Statistics, 1995a). This standardization is a technique used when comparing estimates for populations that have different structures (Hennekens and Buring, 1987).

RESULTS

The first survey

Chronic illnesses. Table 1 shows the number and the standardized rate per 1,000 population of

reported chronic diseases. When data was available, the standardized rate of chronic diseases based on the 1995 Australian National Health Survey is also shown in the table (Australian Bureau of Statistics, 1995a,b,c). The respondents provided information relating to chronic diseases of all household members. Arthritis, hypertension, asthma, "industrial deafness" and cancer were the first five leading chronic diseases reported by people in the community. Compared to the 1995 National Health Survey, the study community had a higher rate of "industrial deafness", asthma and cancer. The rate of self reported "industrial deafness" was 110.75 per 1,000 population which was higher than the national average (95.2 per 1,000 population). It should be noted that "complete/partial deafness" was the term used in the National Health Survey report.

As expected, the people in the study who reported "industrial deafness" were significantly older (mean = 57.3 years old, SD = 11.7 years old) than those who had normal hearing (mean = 36.5 year old, SD = 22.3 years old) ($p<0.001$). A significantly higher proportion of men reported industrial deafness (n = 60, 89.6% of 67) than the proportion of women (n = 7, 10.4% of 67) ($p<0.001$). Table 2 shows the characteristics of people in the community who reported having industrial deafness and normal hearing.

The second survey

There were 65 persons who attended the audiometric screening and the data of 64 persons were analyzed and presented in this paper (one was excluded on request). The age of all 64 participants ranged between 28 and 89 years. The majority (n = 38, 59.4%) were farmers or graziers. The age and occupation of the participants categorized by gender are shown in Table 3.

Self reported hearing ability

The participants were asked to estimate their level of hearing. Almost one quarter (n = 15, 23.4%) perceived that they had "good" hearing. The majority (n = 41, 64.0%) reported that they had "fair" hearing and seven persons (12.5%) reported that they had "poor" hearing. The average ages of the men and women were not significantly different. There was a significant

Table 1
Number and standardized rates of reported chronic diseases in the study community (604 persons), 2002, compared with the 1995 National Health Survey.

Self reported chronic illness	Study community Number (rate/1,000 population)[a]	Australian National Health Survey, rate/1,000 population[a]
Arthritis or diseases of joint	108 (176.4)	147.0[b]
Hypertension	92 (113.5)	144.0[c]
Asthma	89 (147.3)	110.9[d]
Industrial deafness	67 (110.75)	95.2[d]
Cancer	44 (71.89)	17.8[d]
Heart Disease	39 (62.3)	37.0[c]
Disease of bladder or kidney	37 (60.8)	na
Disease of digestive system	31 (52.8)	na
Disease of reproductive organs	30 (49.2)	10.3[d]
Anemia	28 (46.4)	na
Lung problems	26 (42.44)	na
Diabetes	25 (41.0)	22.4[d]
Osteoporosis	17 (27.1)	13.7[d]
Stroke	8 (12.6)	90.0[c]

[a]Standardized rate using mid 1995 Australian population estimate; [b]Australian Bureau of Statistics (1995b); [c]Australian Bureau of Statistics (1995c); [d]Australian Bureau of Statistics (1995a); na = not available.

Table 2
Characteristics of people in the community who reported having industrial deafness and people who did not have the deafness.

Characteristics	Having industrial deafness	No industrial deafness	Total (a)
Age (year)			
Mean (SD)	57.3 (11.7)	36.6 (22.3)	
≤ 24	0	186 (34.6)	186 (30.8)
25-34	2 (3.0)	45 (8.4)	47 (7.8)
35-44	7 (10.4)	78 (14.5)	85 (14.1)
45-54	19 (28.4)	107 (19.9)	126 (20.9)
55-64	18 (26.9)	61 (11.4)	79 (13.1)
65-74	18 (26.9)	39 (7.3)	57 (9.4)
≥ 75	3 (4.5)	21 (3.9)	24 (4.0)
Number (%)	67 (11.1)	537 (88.9)	604 (100.0)
t= 7.7 (638) p <0.0001			
Gender			
Male	60 (89.6)	258 (48.4)	318
Female	7 (10.4)	275 (51.6)	282
Number (Percent)	67 (11.1)	533 (88.2)	600 (99.3)
χ^2= 38.8 (1), p <0.001			
Missing			4 (0.7)

[a]Total may not be equal to 604 due to missing data.

Table 3
Characteristics of the participants who had the audiometry.

Characteristics Number (Percent)	Male 38 (59.4)	Female 26 (40.6)	Total 64 (100.0)
Age (year)			
Mean (SD)	56.3 (12.34)	58.6 (15.14)	
25-34	2 (5.3)	1 (3.8)	3 (4.7)
35-44	6 (15.8)	3 (11.5)	9 (14.1)
45-54	8 (21.0)	8 (30.8)	16 (25.0)
55-64	12 (31.6)	3 (11.5)	15 (23.4)
65-74	7 (18.4)	8 (30.8)	15 (23.4)
≥75	3 (7.9)	3 (11.5)	6 (9.4)
t= -0.66 (df=62) p = 0.514			
Occupation			
Farmers or graziers	32 (82.2)	6 (23.1)	38 (59.4)
Others[a]	6 (15.8)	20 (76.9)	26 (40.6)
χ^2 = 21.45 (df= 1), p <0.001			
Self-assessed hearing level (b)			
Good	7 (18.4)	8 (30.8)	15 (23.4)
Fair	24 (63.2)	17 (65.4)	41 (64.1)
Poor[b]	7 (18.4)	1 (3.8)	8 (12.5)
χ^2 = 3.64 (df = 2), p = 0.16			

[a]These included retired persons, garage proprietor, self-employed persons, home duty, officer workers and unemployed persons.
[a]This category was excluded from the chi-square test due to a small number of one cell.

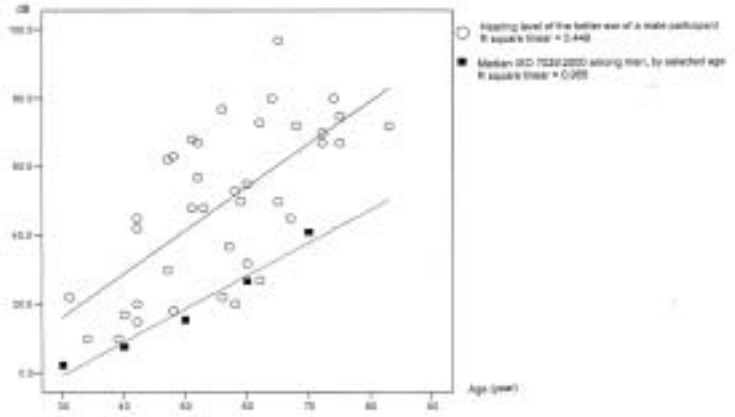

Fig 1–The average hearing level of the better ear among 38 men and their age compared with the median ISO 7029:2000 at 1, 2, 4 and 6 kHz.

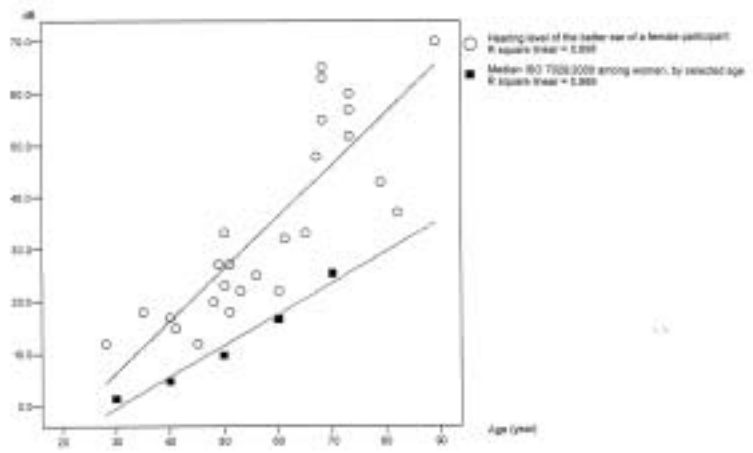

Fig 2–The average hearing level of the better ear among 26 women and their age compared with the median ISO 7029:2000 at 1, 2, 4 and 6 kHz.

relationship between occupation and gender. No relationship was found between gender and self-assessed levels of hearing ability.

Figs 1 and 2 show the levels of hearing loss among men and women compared with the standard of hearing adjusted for age. Of 64 participants, only three (4.7%) were found to have a normal hearing level compared to the median level of the age adjusted ISO7029: 2000 standard.

Details regarding the information relating to conditions and previous history which could affect the participants' hearing are shown in Table 4. The majority reported that they were exposed to noise in their workplace (n = 41, 64.1%). The majority had ear-ache (n = 37, 57.8%) sometime in the past, and almost half of the participants were exposed to noise in their past employment (n = 31, 48.4%). Compared to men, women were significantly less likely to be exposed to loud noise in past and present workplaces. Other reported risk factors for hearing loss including having tinnitus, head injuries and family history of deafness are shown in Table 4.

The percentages of participants who were exposed to noise from recreational activities were fairly high, including (n = 30, 46.9%) reporting shooting activities, and (n = 25, 39.1%) bike racing. A significantly lower percentage of women were exposed to noise from bike racing than men. The use of hearing protection measures during recreation activities was not investigated. Table 5 shows the percentages of the participants who were exposed to loud noise from recreational activities.

The majority of the participants (n = 43, 67.1%) reported that they used hearing protection devices in their past employment. However, only 15 (23.4 %) reported always using the devices while 20 (31.2%) reported using the devices sometimes. More than one third (n= 24, 37.5%) used both earplugs and earmuffs (Table 6). Women were less likely to use hearing protection than men. This difference was statistically significant.

DISCUSSION

A high prevalence rate of hearing loss from both self reporting and audiometry was found among people living in a farming community. This corroborates the results of previous studies con-

Table 4
Reported current and past exposure to noise and associated risk factors for hearing loss among 64 participants.

Reported factors Number (%)	Female 26 (40.6)	Male 38 (59.4)	Total 64 (100.0)	χ^2 (df) p
Reported current condition affecting hearing level				
Exposure to noise in present employment or workplace	9 (34.6)	32 (84.2)	41 (64.1)	16.49 (1) <0.001
Presently suffer from a disease or condition that has had an adverse affect on the participant's hearing	5 (19.2)	3 (7.9)	8 (12.5)	1.81 (1) 0.18
Previous history affecting hearing level				
Exposure to noise in the past employment	8 (30.8)	23 (60.5)	31 (48.4)	5.47 (1) 0.02
Had a history of ear-ache	18 (69.2)	19 (50.0)	37 (57.8)	2.34 (1) 0.13
Suffered from tinnitus (ringing in ears)	9 (34.6)	15 (39.5)	24 (37.5)	0.16 (1) 0.7
Had a head injury	6 (23.1)	14 (36.8)	20 (31.3)	1.36 (1) 0.24
Suffered from a disease or condition that has had an adverse affect on the participant's hearing in the past	6 (23.1)	9 (23.7)	15 (23.4)	0.003 (1) 0.96
Have a family history of deafness	5 (19.2)	7 (18.4)	12 (18.8)	0.007 (1) 0.94
Exposed to noise during military service	1 (3.8)	7 (18.4)	8 (12.5)	3.0 (1) 0.08
Had recent ear discharge	4 (15.4)	3 (7.9)	7 (10.9)	0.89 (1) 0.35
Had ear injury	2 (7.7)	3 (7.9)	5 (7.8)	0.001 (1) 0.98

Table 5
Reported exposure to sources of recreational noise by 64 participants.

Sources of recreation noise Number (%)	Female 26 (40.6)	Male 38 (59.4)	Total 64 (100.0)	χ^2 (df) p
Shooting	7 (26.9)	23 (60.5)	30 (46.9)	7.00 (1) 0.08
Bike racing	6 (23.1)	19 (50.0)	25 (39.1)	4.70 (1) 0.03
Motor car	10 (38.5)	14 (36.8)	24 (37.5)	0.003 (1) 0.96
Other sources of recreational noise	3 (11.5)	13 (34.2)	16 (25.0)	4.23 (1) 0.04

Table 6
Previous use of hearing protection devices reported by 64 participants.

Use of hearing protection devices Number (%)	Male 38 (59.4)	Female 26 (40.6)	Total 64 (100.0)	χ^2 (df) p
Used of hearing protection devices in the past	31 (81.6)	12 (46.2)	43 (67.2)	6.10 (1) 0.01
Did not use	7 (18.4)	14 (53.8)	21 (32.8)	
Frequency of the previous use of hearing protection devices				
Always	13 (34.2)	2 (7.7)	15 (23.4)	3.57 (2) 0.17
Sometimes	14 (36.8)	6 (23.1)	20 (31.2)	
Rarely	4 (10.6)	4 (15.4)	8 (12.5)	
Types of hearing protection devices				
Earplugs	5 (13.2)	6 (23.1)	11 (17.1)	5.42 (4) 0.20
Earmuffs	6 (15.8)	2 (7.7)	8 (12.5)	
Both earmuffs and earplugs	20 (52.6)	4 (15.4)	24 (37.5)	

ducted among farmers in Australia and USA (Williams *et al*, 2002; Kerr *et al*, 2003). However, hearing among the participants of this study probably was poorer than the participants included in the study by Williams *et al* (2002) as adults who attended the rural field day were younger than this study's participants.

Cautions are needed to evaluate these results, as the participants of the audiometry screening did not represent all adults in the community. A similar pattern of hearing loss in both men and women was expected since women worked in farming as well as men (Wilkinson and Blue, 2002).

Although a lower percentage of women were exposed to loud noise in their past and present workplaces than the percentage of men, they were less likely to use hearing protection. There is a need to explore women's awareness of their exposure to noise, actual noise exposure, and the use of hearing protection, so that heath education and health promotion messages can be appropriately designed for this gender group.

We did not explore the level of noise and its duration created by each type of machinery, and the use of hearing protective measures. Collaborative and on-going efforts should be made to monitor the activities used to reduce the risk of hearing loss. These include the maintenance of machines and the use of hearing protection devices while farmers are exposed to noise at work and in recreation activities.

There were weaknesses in the study. The standardized rate was based on self-reporting and this was likely lower than the actual rate. Evidence showed that subjective assessment of hearing was better than the results of the hearing test (Williams *et al*, 2002; Kerr *et al*, 2003).

We did not examine the presence of ear wax. Ear wax can influence test results. The participants were asked to recall past events, which is subject to recall bias.

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