expected to have lower use rates as the cars age and the driver demographics change, while nondetachable automatic belts, like those in the Ford Escort and Toyota Camry, may show less reduction because their disconnection would require permanent modifications of the vehicle. However, further research on older vehicles with automatic belts would be needed to verify this hypothesis.

The data from the parking lot survey indicate that detachable nonmotorized three-point belts are used as manual belts. It is not surprising that these automatic belts tend to be used only slightly more than manual belts. The slight increase (observed only in GM cars) probably occurs because the GM automatic belt is somewhat easier to use in a manual mode than the regular manual belt system due to the location of the belt and other features. All cars with automatic two-point belt systems have knee bolsters to limit forward motion in a crash; most also have manual lap belts, which are used less than are lap belts in cars in which manual three-point belts are provided. The extent to which lower use rates for lap belts limits the protection provided by the increased use of shoulder belts is not known. Now that cars with automatic belts have been on the roads for several years and have accumulated substantial crash experience, it should be possible to assess the extent to which automatic belts of various types reduce injuries and change injury patterns compared with manual belts.

References

1. U.S. Department of Transportation: Federal motor vehicle safety standard 208. Automatic occupant restraints. 49 CFR 571.208 (1990).
2. U.S. Department of Transportation. Evaluation plan; Federal motor vehicle safety standards; passenger car front seat occupant protection. Federal Register 55: 1586–1591, No. 11, January 17, 1990.
3. Williams, A. F., Wells, J. K, Lund, A. K., and Teed, N. J.: Observed use of automatic seat belts in 1987 cars. Am J Public Health 21: 427–433 (1989).
4. Lund, A. K.: Voluntary seat belt use among U.S. drivers: geographic, social, economic, and demographic variation. Accid Anal Prev 18: 43–50 (1986).
5. Wells, J. K., Williams, A. F., Teed, N. J., and Lund, A. K.: Belt use among high school students. Excerped in National Association of Secondary School Principals News Leader 38: 8 (1990).
6. Williams, A. F., Wells, J. K., and Lund, A. K.: Seat belt use in cars with air bags. Am J Public Health 80: 1514–1516 (1990).

Occupational Hearing Loss in Farmers

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Synopsis

Studies have shown that there is a great deal of high-frequency sensorineural hearing loss among farmers. The studies have failed, however, to differentiate farmers who have occupational noise exposure only from other potential hearing loss etiologies.

This study, through extensive case history information, has isolated a farm noise-exposure group and matched its members by age with persons with no significant noise exposure. Results indicate that farmers exposed only to noise from farming have significantly poorer hearing sensitivity than persons not exposed to noise.

EXPOSURE TO EXCESSIVE NOISE from tractors, grain dryers, bush hogs, chain saws, and even radios in enclosed cabs of tractors and combines increases farmers' risk of acquiring noise-induced hearing loss (*1–3*). Studies have shown farmers have greater high-frequency sensorineural hearing loss than can be accounted for by presbycusis alone (*4–6*). Thelin and colleagues compared the hearing screening failure rates at 2,000 and 4,000 Hertz (Hz) of farmers and nonfarmers (office workers) (*5*). They found farmers had significantly higher failure rates for every 10-year age group from age 25 to age 64.

Karlovich and coworkers (*7*) found in their

5-year study of Wisconsin Farm Progress Days Exposition attendees that farmers experienced hearing losses similar to those found in industrially employed persons exposed to 95 dBA Time Weighted Average (TWA) (*8a*). Of those attending the exposition, farmers were compared with nonfarmers having probable occupational exposure and nonfarmers without occupational exposures. Their results showed all groups had losses greater than what could be accounted for by presbycusis and were similar whether the subject was a farmer or not. Karlovich speculated that the nonexposed, nonfarm group may have had military or nonoccupational noise exposures accounting for these losses, but the questionnaire used in the study was not detailed enough to identify these subjects (*7*).

The previous studies have not isolated farmers who had only occupational noise exposure. The purpose of our study was to compare the hearing of farmers who had only noise exposure from farming with a control group of white collar workers the same age with no noise exposure.

'The purpose of our study was to compare the hearing of farmers who had only noise exposure from farming with a control group of white collar workers the same age with no noise exposure.'

Method

Our study compared the hearing sensitivity of farmers exposed only to agricultural noise with people not exposed to noise at their work. A detailed case history questionnaire (see accompanying box, page 190) was used to evaluate familial or otologic causes of hearing loss, previous occupational noise exposures, use of protective devices, and agricultural noise exposure histories. Farmers were carefully interviewed about their answers on the questionnaire and were excluded if they had a history of nonfarm occupational noise exposure greater than 6 months, exposure to noise in the military service beyond basic training, or recreational noise exposure that occurred more frequently than occasionally.

Pure tone thresholds were obtained, using the Hughson-Westlake modified procedure, at 500, 1,000, 2,000, 3,000, 4,000, 6,000 and 8,000 Hz. Grason-Stadler Model 1707 or Model GSI 10 audiometers, equipped with Etymotic Research ER-3 insert earphones, were used to obtain the threshold data. Calibration of the audiometers was checked prior to and after data collection and was shown to be within ANSI (*9*) specifications for audiometers and Etymotic Research specifications for the ER-3 earphones. Testing was done at various locations in quiet rooms with the Model 1707 audiometer and ER-3 insert earphones or in a sound treated room with the GSI Model 10 audiometer. When the testing was not done in a sound room, the ambient noise levels were below 45 dBA. The ER-3 insert earphones provided noise attenuation levels equivalent to a single-walled sound booth (*10*) and subsequently met the Occupational Safety and Health Administration (OSHA) background noise levels for obtaining pure tone thresholds (*8b*).

Subjects

The farmers were matched by age, within 6 months, with members of the non-noise-exposed control group. Three decade groups of 30 years, 40 years, and 50 years were matched. (The ranges were ages 25–34, 35–44, and 45–54.) There were 10 persons in each age group for a total of 60. The mean age for the 30-year decade group was 28 years, 2 months for the farmers and 28 years, 0 months for the controls. The mean age for the 40-year decade group was 40 years, 6 months for the farmers and 40 years, 5 months for the controls. The mean age for the 50-year decade group was 48 years, 9 months for the farmers and 49 years, 1 month for the controls. The farmer subjects were solicited by contacting farm cooperatives, farm insurance groups, a hospital-based farm safety program, and by referrals from other farmers. The non-noise exposed subjects were solicited by public radio announcements and poster advertisements at a medium-size midwestern university campus and through contact with an insurance company in a large midwestern city.

There was no method for randomizing the matching of farmers and non-noise exposed people. The first farmer who matched age within 6 months was paired with the first non-noise person. There were a number of farmers tested who did not match control group members and vice versa, and these were excluded. There was undoubtedly some degree of self-selection bias in this population sample, and, therefore, our sample is not truly random. We do believe it is representative of the

Case History Questionnaire for Noise Exposure Survey

PERSONAL DATA

Date: _____ ID Number _____
Name: _____ _____ _____
Last First Initial
Address: _____
Street address City State Zip
Home phone: _____ Work phone: _____
DOB: __ __ __ Employer: _____ Farmer _____
MM DD YY

HEARING RELATED MEDICAL HISTORY

Have you now or have you ever had:
Middle ear infection yes _____ no _____
Ear surgery yes _____ no _____
Ringing in the ear yes _____ no _____
Measles yes _____ no _____
Mumps yes _____ no _____
Scarlet fever yes _____ no _____
Head trauma yes _____ no _____
Hearing loss in family yes ___ no ___ Who ___

NON-OCCUPATIONAL NOISE EXPOSURE

Do you have repeated exposure to any of the following:
Hunting/trap skeet yes _____ no _____
Lawn/garden yes _____ no _____
Power tools yes _____ no _____
Chainsaws yes _____ no _____
ATV/motorcycles, snowmobiles yes _____ no _____
Loud music yes _____ no _____
Other _____

Military service: yes ___ no ___ Exposure to noise: _____
Did you have a hearing loss when discharged? ___
Noise at previous occupations: yes ___ no ___
When: _____
How long: _____ Type of Noise: Steady _____
Impulse _____
Intermittent _____ Percent of time noise on _____
Hearing Conservation Program: yes ___ no ___
PHP used: yes ___ no ___
If yes, type: plug ___ muff ___ other ___
Your hearing is: good ___ fair ___ poor ___

Do you have difficulty understanding in a group: _____
Have you ever had a hearing test: yes ___ no ___

FARM HISTORY

Size of farm—by herd size or acres:
Dairy _____ Poultry _____ Hay _____
Swine _____ Corn _____ Set aside _____
Feeder cow _____ Soybean _____ Other _____
Calf/cow _____ Pasture _____ Lamb _____
Total number of years in farming: _____
Dairy _____ swine _____ grain _____
poultry _____ other _____
How many *hours per day* do you work in confinement buildings _____
At what age did you begin to get significant noise exposure on the farm: _____
Combine/tractor use:
Number of "tractor hours" you clock: _____
daily (off season) daily _____ (planting/harvest season) # hours at a time _____
how long? days or weeks _____
Hearing protection:
Do you use hearing protection: plugs ___
muffs ___ none ___ other ___
How many years have you worn hearing protection: _____
In what work operations on the farm do you wear PHP:
_____ operating tractor/combine
_____ around grain dryer _____ feed grinding
_____ mowing/clearing _____ other
_____ castrating

FARMING/INDUSTRIAL INTERACTION

How many years have you:
Farmed part-time and worked in industry fulltime _____
Farmed full-time and worked in industry fulltime _____
Industrial full-time without farming _____
Farmed full-time without industrial _____

population of farmers in Iowa and the distribution of hearing loss in this occupational group.

Results

For the farmers and non-noise exposed workers, the pure tone thresholds at 500, 1,000, 2,000, 3,000, 4,000, 6,000, and 8,000 Hz, the averages for 500, 1,000, 2,000, 3,000 Hz, and the averages for 2,000, 3,000, and 4,000 Hz were analyzed for statistical significance using a *t* test (two-tail probability). The results are shown in figure 1 for the 30-year decade group, figure 2 for the 40-year group, and figure 3 for the 50-year group.

Figure 1 shows a difference between the thresholds and averages of 2–4 kiloHertz (kHz) and .5–3 kHz for the farmers and controls in the age 30 group. While these differences were not statistically significant, there is a trend for the farmers hearing sensitivity to be poorer than those of the non-noise exposed subjects.

In figure 2, the age 40 decade group shows similar thresholds for both groups for the low- and mid-frequencies, 500 Hz through 2 kHz, and a marked separation between the hearing sensitivity of the farmers and controls at 3 kHz through 8 kHz as well as the 2–4 kHz average hearing levels. Differences at the individual frequencies of 3,000, 4,000, 6,000, and 8,000 Hz were statistically significant at the $P < .05$ level as well as the 2-4 kHz average. The .5–3 kHz averages were not significantly different statistically. The predominantly high frequency loss for the farmers is typical for noise-induced hearing loss.

Figure 3, showing the age 50 decade group, clearly illustrates the marked high-frequency loss of the farm group members compared with the members of the control group. Each of the individual and average frequency differences was statistically significant ($P < .05$) for the farmers compared with the controls.

Discussion

The results of this study are in agreement with those of Thelin (*5*), Lankford (*6*), and Karlovich (*7*), in that a large percentage of farmers have high-frequency sensorineural hearing loss. It is of interest to note the percentage of farmers who have some degree of hearing handicap. If the criteria for hearing handicap proposed by Suter (*11*) (19 dB or greater average for the frequencies 1,000, 2,000, and 3,000 Hz) are applied to these data, the results are as follows: none of the members of the control

Figure 1. 30-year decade farmer and control pure tone thresholds and averages

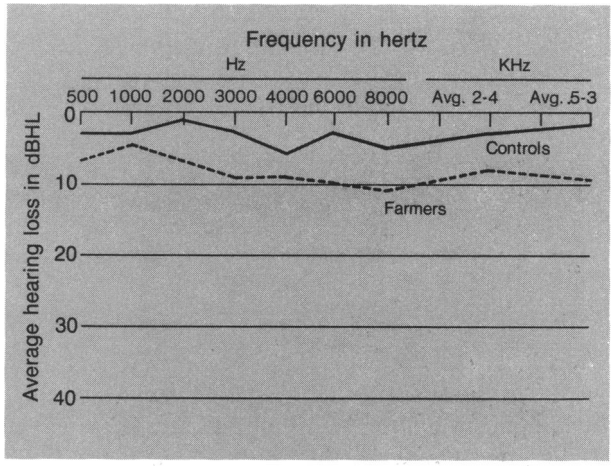
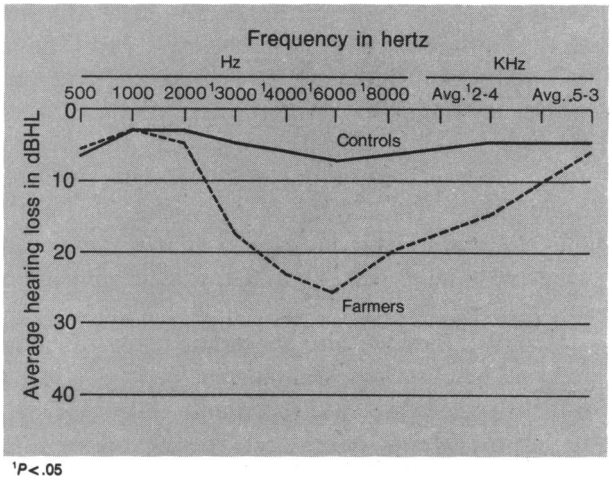


Figure 2. 40-year decade farmer and control pure tone thresholds and averages



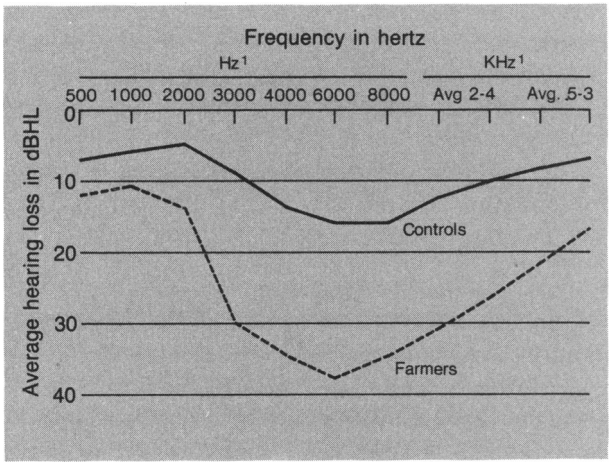
[1]$P < .05$

groups in any of the three decade groups has a clinically significant hearing loss. However, 10 percent of the age 30 farmers, 30 percent of the age 40 farmers, and 50 percent of the age 50 farmers had a hearing handicap.

The data clearly show that as the farmers get older, their hearing sensitivity is significantly poorer than that of the control group members. What is alarming is that the trend is established as early as the third decade and becomes progressively worse. These findings are significant because they establish the fact that farm noise exposure is the major cause of noise-induced hearing loss in farmers.

In many cases, farmers are also employed at some time in their careers in other occupations, in either full- or part-time capacities, where they get additional significant noise exposures. They may farm part-time and have full-time jobs in noisy

Figure 3. 50-year decade farmer and control pure tone thresholds and averages



[1]P<.05

industries. During the high-noise peaks in the farming season, spring and fall, the farmer may be getting a high dose of noise just from farming alone, not including an industrial part-time or full-time job. Although the industrial exposure alone may not over-expose the farmers based on an 8-hour day, the added noise from the farming could create a very serious noise exposure combination. This would put the farmers who were not in this study, but have both types of noise exposure, at even greater risk than the present population under investigation.

Clearly, farmers are at serious risk of noise-induced hearing loss. The current Federal effort to establish guidelines and programs through OSHA to improve farm safety and hearing conservation efforts are greatly needed. Regional centers for dissemination of information and training are needed to help educate farmers to the hazards of noise exposure. Pilot training programs need to be developed to train people who come in contact with farmers so that necessary education can be provided to help farmers protect themselves. These programs could be provided through rural hospital-based agricultural safety outreach programs, county extension offices for land grant institutions, and audiologists in rural areas.

References

1. Lierle, D. M., and Reger, S. N.: The effect of tractor noise on the auditory sensitivity of tractor operators. Ann Otol Rhinol Laryngol 67: 372–389 (1958).
2. Simpson, E. W., Jr., and Deshayes, I. L.: Tractors produce ear damaging noise. J Environ Health 31: 347–350 (1969).
3. Bridier, P.: Hearing change in drivers of agricultural tractors. MD thesis, University of Bordeaux (1978). *In* Ergon Abstr 77064, No. 3 (1979).
4. Glorig, A., and Nixon, J.: Hearing loss as a function of age. Laryngoscope 72: 1596–1610 (1962).
5. Thelin, J. W., et al.: High-frequency loss in male farmers in Missouri. Public Health Rep 98: 268–273, May–June 1983.
6. Lankford, J. E., Stukas, N., and Zurales, S.: Hearing loss among those in the farming community. Poster session, meeting of the American Speech Language Hearing Association, St. Louis, November 1989.
7. Karlovich, R. S., Wiley, T. L., Tweed, T., and Jensen, D. V.: Hearing sensitivity in farmers. Public Health Rep 103: 61–71, January–February 1988.
8. Occupational noise exposure; hearing conservation amendment; final rule. Federal Register 48: 9738–9785, Mar. 8, 1983. (*a*) Appendix A, Noise exposure computation, pp. 9779–9780; (*b*) Appendix D, Table D–1, maximum allowable octave-band sound pressure levels for audiometric test rooms, pp. 9781.
9. Specifications for audiometers. (ANSI S3.6–1989) American National Standards Institute. New York, 1989.
10. Killion, M. C., and Villchur, E.: Comments on "Earphones in audiometry" by Zwislocki et al. J Acoust Soc Am 85: 1775–1778 (1989).
11. Suter, A. H.: The ability of mildly hearing-impaired individuals to discriminate speech in noise. Hearing Report No. 550/9–78–100. U.S. Environmental Protection Agency, Washington, DC, 1978.