Hearing Loss and Hearing Conservation Practices in Rural High School Students

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Noise at levels potentially damaging to the auditory system have been associated with agricultural activities for over 50 years (Bunch, 1937). Early studies concentrated on noise generated by tractors (Bunch, 1937; Lierle and Reger , 1958). Since these reports, many articles dealing with auditory sensitivity of agricultural workers and/or sound levels associated with agricultural activities have appeared (Ouzts, 1969; Gregg, 1972; Jensen, 1966; Jones and Oser. 1968; Broste et. al.. 1989). Analysis of noise in agriculture was expanded considerably in a study by Matthews (1986). which included a wide variety of farm equipment as well as analysis of noise associated with chickens, pigs. and dairy cattle. A common conclusion of this research is that agriculture is a noisy professional pursuit.

In light of the above, it is not surprising that programs preparing young men and women for careers in agriculture often encounter noise problems (Weston and Stewart, 1980). Sound levels may sometimes be reduced by improved maintenance or replacement with newer, quieter equipment, or by isolating or containing the sound source.

A relatively high prevalence of high frequency loss of hearing has been reported in school-aged children (Hull, Mielke, Timmans, and Willeford. 1971; Lipscomb. 1972; Weber. McGovern, and Zink. 1967). Sources of noise implicated as potential contributors to hearing loss in this age group have been gunfire (Lipscomb, 1974; Woodford. 1973). loud music (Lipscomb, 1972), and noise associated with general shop classes (Roeser. 1980; Woodford, 1980; Woodford, 1981; Woodford and O'Farrell,1983; Plakke, 1985).

Objectives

The purpose of this study was to extend the studiers previously cited and to provide information to agriculture teachers and administrators regarding noise levels and their effects in high school agriculture programs. Specific objectives were to quantify sound levels of machines and operations common in agricultural mechanics laboratories, and to determine auditory sensitivity, sound exposure habits, and hearing conservation practices of 9th and 12th grade agriculture students in North Central West Virginia. The primary hypothesis was that if noise levels in agricultural mechanics laboratories are at potentially damaging levels and/or hearing conservation practices are insufficient, then we would find that the prevalence or severity of hearing loss, or both, would increase from 9th to 12th grade.

Procedures

In keeping with the multiple objectives of this study, a multi-faceted method was used. Sound levels were recorded at five locations on equipment viewed as representative of that to which high school agriculture students are exposed. Sound levels were obtained using a Quest Model 155 sound level meter with attached OB 145 octave band filter. The "slow" response mode was used for all readings, except for impulse noise where the "impulse" mode was used. All measures were obtained at the location of the equipment operator's head during normal operation.

Seven high schools in North Central West Virginia were purposefully selected on the basis of geography and school policy to participate in this study. All 9th and 12th grade students (N=127) enrolled in agriculture classes in those schools were tested to determine the status of high frequency hearing. Hearing sensitivity worse that 20 dB HL was considered to constitute hearing loss.

Auditory sensitivity by air conduction was determined by a screening threshold technique at pure tone frequencies of .5, 1. 2. 3, 4. 6 and 8 kHz. Additionally, tympanometry was performed to rule out middle ear pathology. The technique employed utilized a 20 dBHL based presentation level, with threshold obtained at every frequency at which the 20 dBHL level did not elicit a response. Testing was performed in locations determined to have ambient noise levels which did not interfere with testing at the 20 dBHL level at any test frequency.

Sound exposure habits and hearing conservation practices were determined by questionnaire administered to participants.

Results

Sound levels obtained are listed by sound source in Table 1. Potentially damaging levels of steady state noise were recorded during use of all machines except the vertical belt sander and bandsaw. Particularly high steady state sound levels (above 100 dBA) were recorded during use of the Newman Planer and the offset disc grinder. Exceptionally high impulse sound levels were also recorded when the operator was hammering cold steel (dBA = 105) and chipping welds (dBA = 1106).

The percentage of students with hearing loss was not significantly different between 9th and 12th grades. The prevalence of hearing loss was high in both grades at 33.3 percent for 9th graders (22 of 66 students) and 27.9 percent for seniors (17 or 61 students). Analysis of these data yielded a Chi-square of .35 which has an associated probability of .55, well above the .05 level of significance. None of the loses identified were severe, in fact only eight percent of those with loss were aware of it.

Factors identified by the questionnaire were assessed in terms of influence on prevalence of hearing loss. Results of this assessment are shown in Table 2. The only factor that reached the .05 level of significance was whether or not hearing protection was furnished in shop. This finding is interesting in that the significance suggests a relationship opposite of that which we would expect, i.e., the prevalence of hearing loss

Table 1. Mean Sound Levels in Agricultural Mechanics Laboratories.

Noise Source	dBA	Octave Band Center Frequencies (kHz) .125	.25	.5	1	2	3	8	16
Steady State Noise Source									
Rockwell a8"Planer	99	91	90	96	94	91	90	76	62
Vertical Belt Sander	82								
Bandsaw	82								
Rockwell Edger	88	80	88	82	81	72	65	60	52
Circular Saw	87								
Grinder	91								
Dewalt Radial Arm Saw	96								
Sander	105	66	67	89	94	93	94	95	
Newman S2S Planer	104								
Impact Wrench	96	70	84	86	88	92	94	94	
Impulse Noise Source									
Hammering Hot Steel Rod	89								
Acetylene Torch "Pop"	94 to 100								
Hammering Cold Steel	105								
Chipping Welds	106								

Table 2. Questionnaire Responses by Hearing Status

Questionnaire Item		Hearing LOSS Percent N=42	No Hearing LOSS Percent N=85	Mean	Prob.
Do you play a musical instrument?	Yes	12	24	1.7	.19
	No	88	76		
Mean hours in shop per week.		5.48	4.90		
Is hearing protection furnished in shop?	Yes	64.7	18.5	4.5	.03
	No	35.3	81.5		
Do you wear hearing protection when around machinery?	Always	5.0	6.2	.51	.77
	Sometimes	26.4	23.5		
	Never	67.6	70.3		
Do you fire shotguns, rifles, or pistols?	A lot	47.1	35.8	2.15	.34
	Seldom	31.4	30.9		
	Never	21.5	33.3		
Do you wear hearing protection when you fire a gun?	Always	3.6	13.2	2.69	.26
	Sometimes	10.7	17.0		
	Never	85.7	69.8		
Do you listen to very loud music?	Yes	58	66.6	.43	.51
	No	42	33.4		
Have you ever had a ringing or buzzing in your ears after being around loud sound?	Yes	76.3	51.7	3.07	.08
	No	23.1	42.3		
How do you think your hearing is?	Good	92	100		
	Poor				

was greater where hearing protection was furnished! **A** look at the next question listed in Table 2 affords some clarification. Right around 70 percent of students with or without loss of hearing reported that they never wear hearing protection when around machinery. It appears that although hearing protection is apparently furnished, its use is not enforced or adequately encouraged.

In addition to the students, seven agriculture instructors were questioned and given hearing tests. All seven instructors had high frequency loss of hearing greater than 25 dBHL. They had been teaching for from three months to 28 years with a mean of 15.2 years. They had an average of 66 students who spent an average of 4.57 hours in shop each week. Five of the seven had never received instruction in hearing conservation and the two who had, received only 1.5 hours. Five of the seven do not wear hearing protection in the agricultural mechanics laboratory and two of the seven reported that their schools do not furnish it. Four reported having difficulty getting students to wear safety equipment. Those not having this difficulty cited their setting an example, mandatory use, and not tolerating less than expected as reasons for lack of problems. Those having difficulty mentioned students not seeing themselves as victims, not having to wear protection at home or on part-time jobs and not teaching the importance of safety enough, as reasons for the difficulty.

Discussion

In both agricultural and recreational pursuits, rural populations of school-aged children are exposed to high levels of noise. This study sought to determine sound levels of common operations in high school agricultural mechanics laboratories and the auditory sensitivity, sound exposure habits, and hearing conservation practices of 9th and 12th grade students in North Central West Virginia. Several of the sound levels of machines and operations reported in Table 1 are potentially damaging to the auditory system. The anticipated damage from noise is dependent on the duration of exposure as well as the sound level. Occupational Safety and Health Agency (OSHA) regulations have taken this into account in establishing "permissible exposure levels" for sound at various levels. For instance, under OSHA regulations, a person could be exposed to the noise from the offset disc grinder at 105 dBA for one hour without exceeding the limits prescribed, while 2.3 hours would be "allowed" on the Rockwell 18" planer at 99 dBA.

In the context of this discussion OSHA regulations must be viewed as liberal and represent the most widely used measure rather than the most appropriate measure for a number of reasons. First these regulations do not apply directly either to agriculture as an industry, or to our schools. Secondly, the sound levels noted as maximum "permissible levels" are not meant to protect workers from incurring loss of hearing, but rather to protect an estimated 87 percent from developing a degree of loss sufficient to interfere with daily life after a working lifetime (see Kryter, 1970 for a review). Noise-induced loss of hearing appears to be cumulative, that is. any loss incurred in childhood will be added to by future noise exposure. There is evidence that any damage to the auditory system early on may increase the risk of further damage (Franks, et al., 1989; Klockhoff et al., 1986). Additionally, any loss of hearing associated with age interacts with noise-induced loss in at least an additive manner (Glorig and Nixon, 1962; MacRae, 1971). Furthermore, there is considerable evidence that there can be a great deal of damage done to the auditory sensory epithelia without readily measurable loss of hearing resulting (Eldridge, Mills,

and Bohne, 1973; Henderson, Hamemick, and Sitler, 1974). Finally, in addition to potential damage to the auditory system, establishment of a pattern of not using hearing protection in recreational or shop activities in high school increases the probability that they will not be worn later. Thus exposure to noise and the resultant mild loss of hearing incurred by young people may have a maximum effect later in life as it is added to, or potentiates loss of hearing from future exposure to noise, or from aging. Noise induced loss of hearing is an insidious disease. The fact that some 92 percent of the persons with loss of hearing in this study were unaware of the loss mitigates against our efforts to influence these students to act now in order to prevent future difficulties.

The prevalence of hearing loss identified in this study, 33 percent for 9th graders, 28 percent for seniors, and 30.8 percent overall, is unacceptably high. These results are in general agreement with Kramer and Wood (1982) who found an overall prevalence of 18 percent in rural school children. This prevalence increased to 26 percent when only those indicating frequent use of machinery or firearms were considered. When researchers have looked at general shop students, the prevalence of noise induced loss of hearing has been reported at from 15.5 percent in an urban population (Axelsson et al., 1981) to 27 percent in a rural population (Woodford and O'Farrell, 1983). Establishment of overall prevalence norms for high frequency loss of hearing in high school students is confounded by lack of uniform criterion for hearing loss, and very large differences in prevalence across geographical strata. Lipscomb (1972) in studying ninth graders and seniors in the Knoxville (TN) public schools found a prevalence of high frequency loss of hearing from 10.6 percent to 11.0 percent. Lipscomb's (1972) criterion for hearing loss was 15 dB HL (ISO, 1964), and his population in Knoxville probably represented diverse lifestyles.

The absence of any significant difference in prevalence of high frequency hearing loss between 9th and 12th grades in this study suggests that factors other than shop noise are having an effect. Recreational noise, particularly firearm use, and nonschool related exposure to noise in part-time jobs or on family farms are likely sources of high noise levels in this population. Firearm use may be the single most important source. Peppard and Peppard (1992) found that 23 of 29 children meeting their criterion for noise-induced loss of hearing had gunfire as the primary risk factor. Firearms were used by 96 percent and 88 percent of the students studied in Vermont and West Virginia schools, respectively, by Kramer and Wood (1982) and Woodford and O'Farrell (1983). By contrast, Lankford et al., (1991) found only 19.9 percent of their male students in semi-urban DeKalb, Illinois used firearms. This comparison supports the notion that young people in rural areas are more likely to be exposed to the damaging levels of noise produced by firearms than are their urban or suburban peers.

The means for prevention of noise-induced loss of hearing are incorporated in hearing conservation programs. The general format of these programs in industry is applicable to our schools, grades K through 12. This format includes education, hearing testing, and hearing protection. A primary factor in providing motivation for using hearing protection is the education component of the hearing conservation program (Maas, 1969; Mellard, Boyle and Miller, 1978). Our results suggest that this motivational mechanism is needed for students and instructors alike. Additionally, school administrators and Boards of Education need to be aware of the problem in order to intelligently fund programs to provide hearing protection, material for sound barriers. and/or procurement of newer, quieter machinery. The finding that five of seven of the teachers surveyed had no

instruction in hearing conservation is particularly disturbing. Given the importance of early establishment of work habits consistent with protection from workplace hazards, coupled with the cited importance of setting an example in establishing these habits, education of agriculture instructors seems an appropriate first step. Instruction on hearing, hearing loss, and hearing conservation could be integrated into the training program curricula as well as offered as inservice programs. Additionally, since firearm use may be a factor in the unacceptably high prevalence of hearing loss in this group, these same educational programs may be offered to hunter education instructors. All 50 states offer hunter education programs with 47 states mandating completion of a program to obtain a hunting license. Very little information on hearing conservation is provided in most of these programs at present (Woodford and Lass, 1992).

Regardless of the specific mechanism utilized, persons educating our children in areas involving high noise levels should have knowledge of the effects of noise on hearing and hearing conservation. These persons can then pass on that knowledge by lecture and by example. Rural youth appear to be losing hearing at an earlier age and to a greater extent than their urban and suburban peers. We know how to minimize noise-induced loss of hearing, what remains is to implement the programs necessary to do it. Results of this study as well as others cited indicate that initiation of hearing conservation programs for our youth is long overdue.

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