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Assessing Noise Exposures in Farm Youths

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ABSTRACT. *Objective:* This exploratory study evaluated the feasibility of field exposure assessment methods to characterize the noise sources and levels that farm youths experience during a typical workday.

Methods: Detailed exposure assessments were performed with a sample of 10 farm youths working on Vermont dairy farms to characterize potential noise hazards typical in the farm setting. Personal and area noise measurements were taken using noise dosimeters. Information concerning work- and non-work-related noise exposure histories was collected via questionnaire.

Results: The average age was 15.5 years (SD 2.5, range 10-18). Youths started working at an average age of 8.4 years (SD 2.3, range 6-12) and during the summer months worked an average of 41.3 hours per week (SD 32.3, range 2-68). Two youths exceeded the OSHA action level, having eight-hour time-weighted averages of 95 dBA and 92 dBA, or alternatively, doses of 206% and 127%. (The OSHA action level for the hearing conservation amendment is an eight-hour time-weighted average of 85 dBA or a dose of 50%.) Participants exceeding the action level reported working with tractors, skid steers (Bobcats), and all-terrain vehicles and doing general barn work. Additional sources of noise exposure included a mechanical silo elevator, chain saw, and wood splitter.

Conclusion: Two of the monitored subjects were overexposed to noise in their farm work. Youths may be exposed to noise levels that exceed adult OSHA hearing conservation amendment action level as part of their daily farm activities. doi:10.1300/J096v12n02_03

KEYWORDS. Farm, youths, noise exposure, hearing conservation, agricultural health

INTRODUCTION

Noise exposure can be a significant hazard associated with agriculture, and its deleterious effects on the developing auditory system of youths are not well understood. Noise induced hearing loss is cumulative and irreversible.[1] Youths working in farm environments today

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are at risk for noise exposure, but individual susceptibility makes it difficult to predict the degree of hearing loss from any particular noise exposure. A recent literature review found only a few studies that focused on children's unique occupational and agricultural health risks that can affect permanent hearing loss.[2]

Youths working on farms may be particularly vulnerable to ototraumatic exposures since the effect of noise could be different on the developing than on the mature ear[3] and the vulnerability of developing organ systems is of concern.[2] Risk of hearing loss depends on duration and level of noise exposure (above 75-80 dBA), age, number of years worked in farming, and number of exposure sources.[4,5] Temporary threshold shifts can occur during occupational noise exposure, and the damage may become permanent after repeated exposures.[6] The seasonal nature of farm work often requires families to work with noisy equipment for longer than eight hours a day, which may prevent full ear recovery and put farm youths' hearing at high risk of permanent damage. Excessive occupational noise exposure may also disturb sleep, produce stress, and impair one's ability to communicate.[7] Several types of farm equipment have been found to operate at potentially harmful noise levels.[4] Noisy equipment is also used indoors on farms, for example in barns and milkhouses, where noise tends to reverberate.

Noise exposures in a farm environment can exceed the current acceptable occupational standards. A study conducted in New Zealand, found that 10 measurements (17%) exceeded an 8-hour equivalent level (L_{EQ}) of 90 dBA and the maximum L_{EQ} recorded during the survey was 94.1 dBA on a mixed dairy and sheep farm. The median L_{EQ} exposures were 84.8-86.8 dBA which are similar to moderate industrial noise exposure levels.[8] Another study evaluated noise levels of 155 tractors on 36 farms in central Wisconsin, where sound pressure levels ranged from 78-103 dBA. In tractors without cabs, sound pressure levels exceeded 90 dBA in 82 out of 110 (75%) tractors compared to 18% (8 of the 45) in tractors with cabs. Playing a radio increased the average noise exposure by 3 dBA.[9]

Children may be especially vulnerable to noise exposure due their developing auditory systems.[2] The third National Health and Nutrition Examination Survey (NHANES) found that 14.9% of U.S. children (6-19 years of age) have low or high-frequency hearing loss of at least 16 dB in one or both ears.[10] A study of 68 rural school children (mean age = 15.2 years) found that 18% of all children and more than 25% of males had audiograms consistent with noise-induced hearing loss.[11] Another study found that the prevalence of hearing loss among children who lived in a rural environment was 2.5 times greater than among students who lived in an urban environment.[12] In Central Wisconsin, Broste and colleagues conducted audiometric threshold testing of teen-aged farm children who lived and/or worked on a farm and found hearing loss in at least one ear in over 70% of 872 children.[13]

Although farms are known to be inherently hazardous and farm equipment is frequently responsible for traumatic injuries, noise exposure levels have not been extensively characterized in farm environments. This exploratory study evaluated the feasibility of field noise exposure assessment methods to characterize source, frequency of exposure, and noise levels that farm youths experience during a typical workday. Feasibility questions underlying the study included: Will farm youths wear noise dosimeters during the workday? Can youths follow instructions to track their work tasks throughout the day to aid in interpreting noise measures? Outcome questions of interest included: What are the types of noise sources that youths are routinely exposed to during work? What are the sound pressure level ranges from farm equipment to which youths are exposed? What is the overall noise dose that farm youths are exposed to during a typical workday? How do noise exposures compare to occupational regulatory standards?

METHODS

Overview

Detailed exposure assessments were performed with a sample of 10 farm youths to characterize potential noise hazards typical in the farm setting. Exposure assessment methods included farm-based noise dosimetry as well as questionnaire information concerning noise

exposure history. Study results are being used to determine feasibility and efficacy for planning a larger prospective investigation of hearing performance in a cohort of farm youths as they age into adulthood. The study protocol was approved by the Harvard School of Public Health Human Subjects Committee prior to data collection.

Sampling

This study was conducted in Vermont's leading dairy county (pop. 32,000), located in the northwestern region of the state. Farm youths 10-18 years of age attending middle or high school in the county were recruited for the study. School enrollment rosters were compared with the roster of dairy farms registered in the county's primary milk cooperative to identify farm students. Farm parents were contacted, and a brief screening questionnaire was administered to determine if the household students worked on the family farm. The farm youths were eligible to participate if they worked directly on the farm for 10 or more hours per week during the school year and 20 or more hours per week during the summer months. Telephone screening continued until 10 families agreed to participate. A total of 15 families were contacted; three were not eligibile, and two declined participation for unspecified reasons. Eleven youths were originally recruited. Data from one youth was deleted since his dosimeter malfunctioned after an impact with equipment. Thus the final sample size was 10 youths.

Noise Exposure Questionnaire

Detailed noise exposure assessment was a primary aim of this study because noise exposures for youths working in the farm environment have not been previously characterized. Although the rates of hearing loss in youth have been reported, the actual noise levels present in the farm environments have not been described. The questionnaire used included questions from previous studies of hearing loss in farmers[4,14] and specific questions developed for this study concerning rural youth noise exposure. Items included demographic characteristics, farm work history, the use of personal protective equipment, as well as farm and recreational sources of noise exposure (hours per week) including farm equipment, stereo and headphone use, music concerts, gun blasts, motorcycles, and all-terrain vehicles.

Noise Dosimetry

Calibrated noise dosimeters[15] were used to measure individual exposures of the 10 youths during one workday each. These measurements were made in the summer when the exposures of working youths would be expected to be the highest because they often work full days on the farm. Youths were outfitted with a dosimeter enclosed in a waist pack and attached around the waist. The microphone was clipped on the shirt collar, as close to the ear as practical. Each participant was instructed on the correct way to attach the dosimeter and turn it on. Participants were intermittently monitored for about 10 minutes every 2-3 hours during one workday. Since researchers had to interrupt youths to inspect their dosimeters, even 10 minutes of observation appeared to be disruptive. Given the mobile nature of the youths' work, it was difficult to follow participants throughout the day. To avoid misrepresentation of exposures, youths were informed that their dosimeters would be inspected throughout the day but the exact times were not specified.

Two types of dosimeters were used: the Brüel & Kjaer Noise Dose Meter Type 4436 weighed 250 grams and measured 137 x 79 x 22 mm; the Quest MICRO-15 Noise dosimeter weighted 315 grams and measured 64 x 130 x 33 mm. These dosimeters were adjusted to one of the following settings: (1) OSHA hearing conservation amendment[16]–that is, 90 dBA criterion level, 5 dBA exchange rate, and 80 dBA threshold level. Based on these settings, OSHA's action level is a dose of 50% or an eight-hour time-weighted average (8-h TWA) of 85 dBA; (2) Study setting of 85 dBA criterion level, 3 dBA exchange rate, and no threshold level.[17] In actuality, for one participant, the threshold level was set to 80 dBA rather than no threshold. For high noise levels, however, this has essentially no effect, so this measurement was also considered to be done at the study setting. The dosimeter settings are summarized in Table 1.

Both dosimeters were used for one participant to determine which dosimeter would be

TABLE 1. Settings for dosimeters used to monitor farm youths, Vermont, 2003.

Dosimeter	BRÜEL & KJAER		QUEST	
	OSHA hearing conservation amendment [A]	Study setting (L_c=85) [B]	OSHA hearing conservation amendment [A]	Study setting (L_c=85) [B]
N (# dosimeters used)	3	1	6	
L_c (Criterion) (dBA)	90	85	90	85
E (Exchange rate) (dBA)	5	3	5	3
L_t (Threshold) (dBA)	80	80	80	none

[A] Action level is 85 dBA or a dose of 50%
[B] Study setting of L_c = 85 dBA, E = 2 dBA, and L_t = none is comparable to The American Conference of Governmental Industrial Hygieniests-Threshold limit values (ACGIH-TLV) for high exposures

more convenient to use in the field. All dosimeters were calibrated before and after the measurements. In addition, for descriptive purposes only, sound pressure levels were recorded from the common farm environment noise sources by holding the dosimeter at the operator's location.

Youths were instructed to complete time-activity logs throughout the course of their workday to include the time and type of activity as they changed jobs and locations. In addition, they were asked to record the presence of noise not related to a particular farm task (e.g., the playing of music, noise from other nearby equipment, etc.). Youths were also asked to record any issues associated with wearing the dosimeters, such as inconvenience, malfunction, impact, etc.

RESULTS

There were 10 participants in this study, each monitored over the course of one workday (mean 10.0 hours, SD 5.0, range 2-14.6). The average age was 15.5 years (SD 2.5, range 10-18). The youths started working at an average age of 8.4 years (SD 2.3, range 6-12) and, during the summer months, worked an average of 41.3 hours per week (SD 32.3, range 2-68). The majority of subjects came from farming families in which the owners had lived on a farm for on average of 24.2 years (SD 20.9, range 0-50). The farms were largely dairy production farms with 216 acres (SD 259, range 0-800) and 80.6 cows (SD 117, range 0-350) on average.

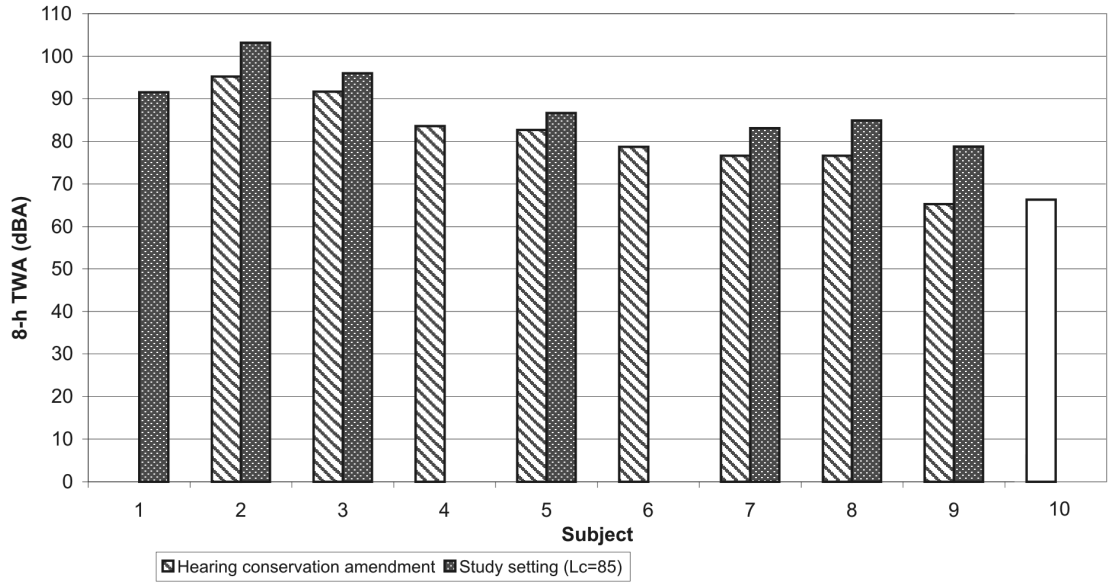
Based on youths' self-reports of usual noise exposure sources other than farm equipment, eight youths (57%) reported driving all-terrain vehicles for 1-60 hours per week (mean 10.4, SD 17.9). There were no reports of attending music concerts or riding motorcycles in the past year. Five youths (36%) reported hunting and shooting for 1-5 hours per week (mean 0.9, SD 1.6). A music player was used with headphones on average for 1.6 hours per week (SD 3.6, range 1-10), and without headphones for 15.6 hours per week (SD 17.8, range 1-50).

The 8-h TWA noise exposures for the 10 participants are presented in Figure 1. The corresponding noise doses are presented in Figure 2 for the benefit of readers more familiar with noise doses.

The hearing conservation amendment action level is an 8-h TWA of 85 dBA or a dose of 50%. Two measurements exceeded the action level, having an 8-h TWA of 95 dBA and 92 dBA (3.5-206%). Subjects 2 and 3 exceeded the action level with doses of 206% and 126.5% respectively.

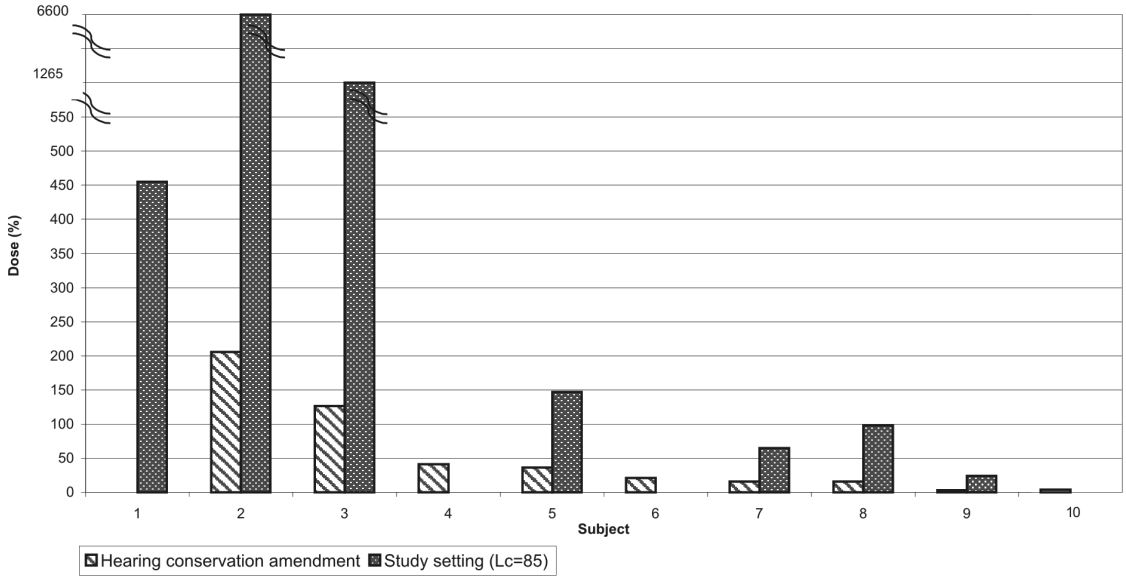
Based on the study setting, the 8-h TWA ranged from 79 dBA to 103 dBA corresponding to noise doses of 24-6612%. Our measurements showed that the 8-h TWA of subjects 1, 2, 3, and 5 were 92 dBA, 103 dBA, 96 dBA, and 87 dBA, respectively. These values corresponded to noise doses of 455%, 6612%, 1265%, and 147%. Subject 1 was riding a tractor and working with a skid steer (Bobcat). Sub-

FIGURE 1. The 8-hour Time Weighted Averages (TWA) according to the OSHA hearing conservation amendment, and the study setting in Vermont farm youths in 2003.[A]



[A] Study setting of L_c = 85 dBA, E = 3 dBA, and L_t = none is comparable to ACGIH-TLV for high exposures.
[B] Bars represent 8-hr TWA according to dosimeter settings for each subject

FIGURE 2. Dose based on the OSHA hearing conservation amendment and the study setting in Vermont farm youths in 2003.[A]



[A] Study setting of L_c = 85 dBA, E = 3 dBA, and L_t = none is comparable to ACGIH-TLV for high exposures.
[B] Bars represent percentage of allowable dose according to dosimeter settings for each subject.

ject 2 reported haying with a tractor and riding an all-terrain vehicle all day. Similarly, subjects 3 and 5 reported riding the tractor while haying (Table 2).

For descriptive purposes only, sound pressure levels were recorded from noise sources common in the farm environment by holding the dosimeter at ear level and at a distance proximate to a working distance (e.g., while sitting inside the tractor cab). These measurements showed that noise levels were relatively high, ranging from 77 to 100 dBA (Figure 3).

All participants reported that wearing the dosimeters was slightly uncomfortable and disruptive. One participant's dosimeter was damaged due to impact with equipment. Periodic checks by researchers interrupted youths' work. In addition, it was challenging to locate youths in order to check their dosimeters. Youths had difficulty recording specific work activities they performed during the day.

DISCUSSION

Children growing up on farms usually begin working very early in life. In this study, youths as young as 10 years old were found working near noisy farm equipment. On average, youths started working at 8.4 years (SD 2.3, range 6-12).

Two participants were exposed to noise levels exceeding the OSHA hearing conservation amendment action level. Four subjects were exposed to noise levels exceeding 85dBA based on the study settings. If this exposure continues, noise induced hearing loss may occur. In addition, farm youths are exposed to non-occupational noise sources such as all-terrain vehicles as well as hunting and target shooting that may also damage their hearing. OSHA standards were put in place to protect the majority of healthy adult workers. The mature auditory system of adults is different from the developing auditory system of youths and thus may be differently affected by noise. The combination of occupational and non-occupational exposures may make farm youths more susceptible to noise-induced hearing loss than youths working in other settings or adult farmers.

This study had several limitations. It was a pilot study to investigate noise exposures in farm youths, and sample size was small. A

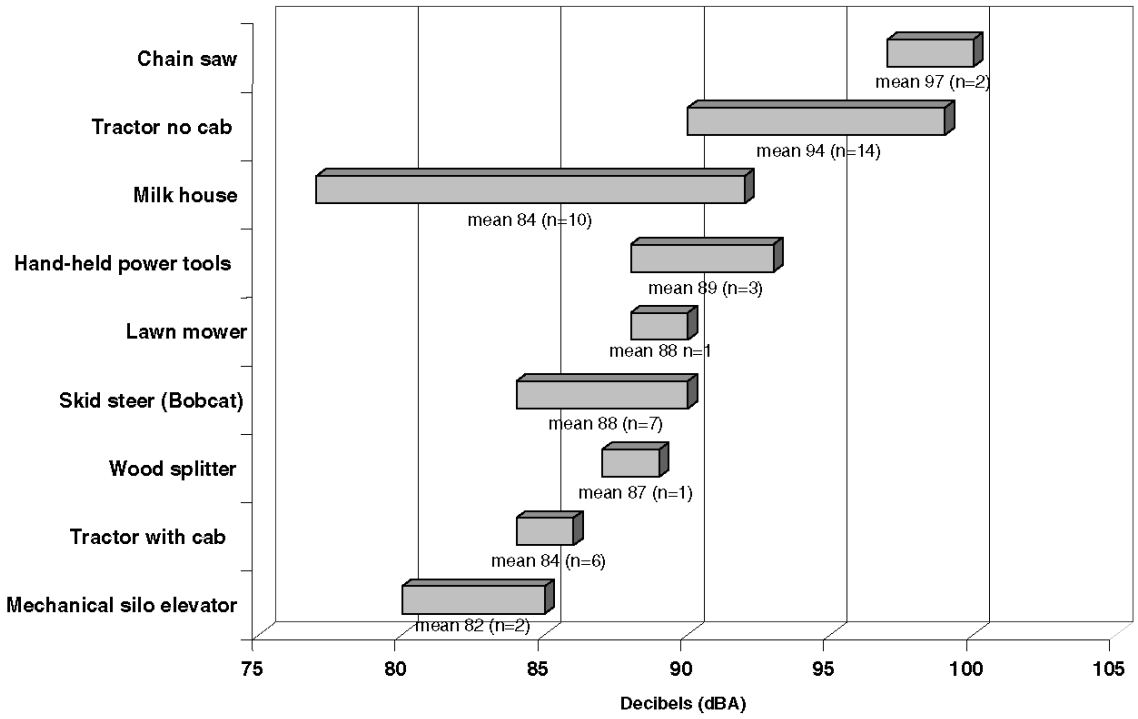
TABLE 2. Summary of dairy farm work activities and noise exposures in Vermont youth, 2003.

Subject	Age (years)	Total hours worked	OSHA Hearing conservation amendment (% DOSE)[A]	Activity/ Noise Source										
				Milk cows	General barn work	Mechanical silo elevator	Lawn mower	Tractor cab on	Tractor cab off	Skid steer (Bobcat)	All terrain vehicle / 4 Wheeler	Wood splitter	Hay wagon	Chainsaw
1	18	13.4	-[B]	X	X				X	X				
2	15	13.1	206	X					X		X			
3	10	14.6	127	X	X				X					
4	15	12.4	41	X		X			X	X	X	X		
5	19	13.4	37					X	X				X	
6	15	10.6	21	X			X							
7	17	2.6	16	X	X									
8	12	13.6	16					X	X				X	
9	17	2.0	4	X	X									
10	17	5.9	4	X	X				X	X	X			

[A] Percentage of allowable dose according to OSHA Hearing Conservation Amendment; action level is 85 dBA or a dose of 50%.

[B] Measurement for this subject was done according to the ACGIH-TLV (455%)

FIGURE 3. Ambient noise measurements at worker ear level according to ACGIH-TLV settings taken on Vermont dairy farms, 2003.



larger study is needed to make generalizable conclusions about youths' noise exposures in farm environments. Second, there were inconsistencies in dosimeter settings. Measurements were done according to the OSHA hearing conservation amendment and study setting. Additional consistent measurements are needed to provide more comprehensive comparative noise exposure assessment. Only one participant used both dosimeters, making it difficult to compare differences in convenience in the field. Finally, exposure was determined from time-activity logs filled by youths during their workdays. Therefore, only general descriptions were obtained and times spent on each task were not reported. Better recording system is needed to monitor tasks and times spent on each task.

This pilot investigation gave insight into feasibility issues in conducting exposure assessments with youths in the farm environment. Noise dosimeters often interfered with the highly mobile nature of the farm work. One observation was excluded because of malfunctioning dosimeter due to an impact with equipment. Youths were cooperative but had difficulties completing the activity logs and reporting specific rather than general work activities or their precise duration. Researchers monitored youths and dosimeters several times throughout the day, but found it difficult to check on dosimeters without interfering with the youths' fast paced work demands. Ideally, more systematic measurements of noise exposures could be accomplished by having youth wear dosimeters that log sound pressure levels vs. time and by following youths around to see exactly what they are doing during the day as a function of time. Without this information, the varieties of farm equipment common on the farms studied make identifying the main noise exposure hazards difficult.

The two youths exposed to noise levels beyond the OSHA action level reported riding all-terrain vehicles and tractors. No hearing protection was used by any of the participants during monitoring and the average weekly self-reported protection use was minimal. Although not immediately apparent, barn work may also have high noise exposures, because

music was played loudly in several barns and noise tends to reverberate indoors. A study of 139 farmers found that noise protection is used 17% of the time (SD = 13.4), and the majority of subjects (56%) do not use hearing protection at all.[18] Hearing and noise safety recommendations should be given to farm owners to protect their youth. Some short-term solutions include job rotations and the use of hearing protection. Longer term goals may include replacing dated equipment with newer equipment that has noise-reducing mechanisms in place. However, the associated costs may make equipment replacement the least feasible option.

CONCLUSIONS

This pilot investigation gave insight into feasibility issues in conducting exposure assessments with youths in the farm environment. This study showed that youths' noise exposure exceeded current occupational standards. Two participants were exposed to noise levels exceeding the OSHA action level, and four subjects were exposed to noise levels exceeding the 85 dBA criterion level for the study settings. Based on the noise exposures observed in this study, additional exposure assessment work is needed in this occupational environment and vulnerable population to determine whether guidelines and recommendations should be considered to protect the developing auditory system of farm youths.

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