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# Effect of noise emitted by forestry equipment on workers' hearing capacity

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ABSTRACT

Forest logging involves the use of various noise-producing equipment, which may be harmful to the hearing capabilities of operators in the immediate area. Yet, little research has been performed to determine the long term effect of noise on forest loggers. Therefore, the purpose of this study was to determine how noise from forestry work affects operators' hearing capabilities at different frequencies, in relation to their age, years of experience as forest loggers, and whether or not they regularly wore hearing protection equipment (HPE). Twenty-six male forest loggers who were directly involved with logging equipment operations participated in this study. They were divided into different groups depending on age (20–29, 30–39, 40–49, and 50–59), years of experience (1–10, 11–20, 21–30, and 31–40), and whether they used HPEs. A Beltone audiometer was used to measure hearing thresholds at different frequencies (125, 250, 500, 750, 1000, 2000, 4000, and 8000 Hz). To determine whether the loggers experienced threshold shifts, their hearing thresholds were compared with average persons' hearing thresholds. The hearing threshold and threshold shift were found at 4000 Hz, and the lowest hearing thresholds were found at 500, 750, and 1000 Hz. According to results, as age increased, hearing threshold either increased or remained the same. This study also concluded that the years of experience or exposure to forestry equipment can adversely affect hearing. Participants that used HPE had lower hearing thresholds than participants that did not use HPE. By wearing HPE, forest workers may prevent hearing loss at 4000 Hz.

*Relevance to industry:* Forest logging has adverse effect on the hearing of workers. Specifically the loggers who do not use hearing protection equipment are more susceptible to hearing loss. Therefore, the hearing of workers needs to be monitored on a regular basis and the use of HPE should be made mandatory.



## 1. Introduction

Forest logging involves the use of various noise-producing equipment, which may be harmful to the hearing capabilities of operators in the immediate area. Two common operations found in forest logging are felling (tree cutting) and tree transportation. These operations involve using an array of different heavy machinery, including tree cutters, skidders for transporting tree trunks to loading areas, loaders for loading tree trunks onto trucks, and chainsaws for cutting limbs of trees. Most of this equipment is noise-producing and could be hazardous to operators' hearing. Yet, little research has been performed to determine the long term effect of noise from forestry work on operators' hearing.

Taoda et al. (1987) measured the level of daily noise exposure for 81 national forestry workers, who were using chainsaws, log cutters, bush cleaners, timber-collecting cable machines, and forklifts. The forestry workers were given a portable sound meter, which measured the level of noise exposure and estimated the equivalent continuous noise level (Leq) for eight hours. The estimated Leq (8 h) for 32 of 34 lumbermen surveyed was more than 85 dB, and for 5 lumbermen, the Leq (8 h) was more than 90 dB. According to OSHA (2007), noise higher than 89 dB (dB) is considered hazardous. The maximum noise level for each machine except the forklift was above 100 dB. Moreover, the maximum noise levels for most of the chainsaws were above 110 dB. At this sound level, OSHA standards (29 CFR, 1910.95) permit a maximum exposure time 30 min.

Neitzel and Yost (2001) performed a study to describe the occupational exposure of forestry workers in the US Pacific Northwest to sources of hand-arm vibration (HAV), whole-body

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vibration (WBV), and noise. They found that the NIOSH time-weighted average of noise exposure of the forestry workers was 90.3 dB and the OSHA time-weighted average was 86.1 dB. The operations with the highest NIOSH and OSHA time-weighted averages in the forestry work were felling (tree cutting) and road construction for making a path through the woods in order for equipment to move into the cutting zone.

Various studies have been performed to determine a relationship between noise and hearing loss. Being subjected to high levels of noise for extended periods of time may lead to chronic hearing loss, which applies to any industrial cohort. Tunay and Melemez (2008) performed audiometric tests on 114 forest loggers to determine whether they were experiencing hearing loss. They found that the degree of hearing loss (hearing threshold) was in the range of 40–50 dB.

Iki (1984) conducted audiometric testing of forestry workers and analyzed the results for acute hearing loss. The study found that the participants who operated the forestry tools for longer periods of time developed more hearing loss than those who operated the tools for shorter periods. Also, the workers who used the forestry tools for longer hours exhibited more advanced audiogram types of noise-induced hearing loss than workers who had operated the tools for fewer hours.

Ferrite and Santana (2005) examined the hypothesis that smoking, noise, and age jointly affect hearing acuity. This cross-sectional study was carried out in 535 male adult workers in a metal processing factory. Results indicate that age and occupational noise exposures were separately and positively associated with hearing loss. Among age group of 20–40 years, the estimated effect on hearing loss from all the factors combined was higher than the sum of the effects from each variable alone (especially for smoking and noise).

The purpose of the this study was to determine how noise from forestry work affects operators' hearing capabilities at different frequencies, in relation to their age, forest logging experience, and whether or not they regularly wore hearing protection equipment (HPE). This study differentiates from what has already been done in the literature in several aspects. The forest logging operations in this study involved the use of heavy equipment in contrast to Iki's (1984) and Tunay's and Melmez's (2008) studies. Taoda et al. (1987) determined that there are elevated levels of noise to which forest loggers are exposed to, but they did not determine whether these levels are associated with hearing loss. Although Ferrite and Santana (2005) and Tambs et al. (2006) have already found an association between high levels of noise exposure and hearing loss, their studies included participants from an industrial environment. Furthermore, no study in the literature was found to investigate the effects of HPE and/or years of experience in logging operations on hearing loss. This study is unique in that it not only determines the hearing capabilities of forestry workers at different frequencies but also considers the possible associations of HPE, age, and years of experience with hearing loss.

## 2. Method

### 2.1. Participants

Twenty-eight forest loggers volunteered to participate in this study. Two of the twenty-eight subjects could not continue participation due to a chronic illness that had resulted in permanent hearing loss. The remaining participants were all healthy male subjects and full-time forest loggers; they worked five days a week, for an average of 10 h per shift. The participants were in the age range of 20–60 years and the average age was 43 years. All participants were informed of the demands of the testing procedure, and all of them signed a consent form approved by the Institutional Review Board (IRB), Louisiana State University.

Before performing hearing tests, participants were given a questionnaire to provide age, amount of time working as a logger, hours of work per week, previous hearing problems, previous employment, noise exposure outside of their occupation, and whether or not they regularly wore HPE. The average years of experience as forest loggers was 17.4 (±12 years). Of the 26 participants, only eight reported wearing HPE regularly.

### 2.2. Forest logging equipment

Each type of equipment utilized by forest loggers generates a different noise level. Depending on the daily conditions, loggers operate different equipment on various shifts. Equipment that the participants of this study commonly used were:

- Skidders: heavy vehicles used in a logging operation for pulling cut-trees out of a forest in a process called “skidding”. The logs are transported from the cutting-site to an area where a loader places the logs on a transporting vehicle. The average noise level generated by this vehicle for an eight hour shift was measured to be 97 dB.
- Loaders: utilized to organize and pile up the logs on the transport trucks, which then take the wood to the lumber mills. The noise emitted by this type of equipment averages to be 88 dB, which is below the maximum permissible exposure level established by OSHA (90 dB) for an eight hour shift.
- Cutter: as the name depicts, is the equipment used for cutting trees. The cutting is performed by the rapid rotation of a saw blade an inch and a half thick with a diameter ranging from 24 to 48 inches. When performing the cutting, elevated levels of a high frequency impulse noise is generated. The average noise level generated by this equipment in an eight hour shift is 93 dB.
- Chainsaw: is a portable, mechanical, motorized saw, most commonly used in logging activities such as felling, limbing, and bucking. The noise level emitted by this machine can reach to 113 dB at full throttle.

### 2.3. Procedure

Hearing tests were performed primarily in a closed office space; however, due to distance issues, the hearing tests were sometimes conducted in a pickup truck. The truck was driven to a remote location to eliminate outside noise. The audiometer was powered using an A/C adapter connected to the truck power source. The tests were performed with the vehicle turned off and windows closed. During testing, no one was allowed to enter the testing area. If any outside noise was heard, the data was discarded, and the sound and frequency level being tested was repeated to ensure accuracy of the data.

During testing, participants were instructed to sit facing the experimenter. The audiometer controls were set to face the experimenter and away from the participant's vision. Before the hearing test, a set of tones from the audiometer were presented to each participant to get them familiar with the sounds from the audiometer and to ensure that they knew how and when to signal the experimenter. Each ear was tested separately. The test began with the ear that the participant said he heard better with. In the case where the participant was unsure of the more responsive ear, the right ear was tested first. The hearing test was performed at different frequencies to determine how hearing threshold was affected by frequency level. The predetermined order of the frequencies tested is listed in Table 1. At each frequency, the hearing