ABSTRACT

THE EFFECTIVENESS OF A HEARING CONSERVATION PROGRAM FOR FOURTH GRADE STUDENTS

By Anne M. Byrnes

Hearing conservation programs (HCP) used in industrial work settings reduce noise induced hearing loss (NIHL) in adults. There is a growing movement to adapt HCPs for use with children as a means to prevent hearing loss in later life. The purpose of this study is to measure the effectiveness of a HCP appropriate for use in fourth grade classrooms. It was hypothesized that this program could significantly improve knowledge of ear anatomy and how hearing loss occurs, as well as increase willingness to practice hearing protection strategies. Two 4th grade classrooms received the HCP. Outcome measures were compared with a control group. The results indicated a significant increase in overall knowledge from pre to post test results compared to the control group. The intervention also increased willingness to practice hearing conservation strategies.
The Effectiveness of a Hearing Conservation Program

for Fourth Grade Students

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EFFECTIVENESS OF A HEARING CONSERVATION PROGRAM
FOR FOURTH GRADE STUDENTS

Introduction

Noise induced hearing loss (NIHL) occurs when the hair cells of the inner ear are exposed to hazardous noise. It can occur with one episode of noise exposure. However, it is more common for NIHL to occur gradually with repeated noise exposure; high frequencies are usually the first to be damaged (Berger et al., 2000). It affects nearly 10 million Americans (Folmer, Griest & Martin, 2002). Researchers have also confirmed the incidence of NIHL is increasing among children (Folmer et al., 2002; Niskar, Kieszak, Holmes, Esteban, Rubin & Brody, 1998). The National Institute of Occupational Safety and Health (NIOSH, 1998) states that NIHL is preventable, but not curable. One way to prevent NIHL is through education. Unfortunately, there are no national guidelines or regulations requiring hearing conservation programs (HCP) to be presented to school-age children (Folmer et al., 2002).

While studies providing varying estimates of the prevalence of high frequency hearing loss in children, even the lowest numbers are significant. In 1996, it was determined that NIHL affected 1% of school-age children (Berg, Blair, & Benson). In 1998, high-frequency sensorineural hearing loss (HFSNHL) was estimated to affect 1.4% of school-age children in grades three, six and nine (Bess, Dodd-Murphy & Parker). Another study discovered 12.7% of the students tested had high frequency hearing loss of at least 16 dB HL (Niskar et al., 1998). This percentage could translate to a possible 5.2-million school-age children. The above studies yielded different estimations of hearing loss because they differed in the pass/fail criteria and the frequencies tested. Berg et al. (1996) defined hearing
loss with hearing sensitivity levels poorer than 20 dB HL. Bess defined hearing loss beyond 25 dB HL, and Niskar used 15 dB HL as the cutoff. Regardless of what studies are used to estimate, the point is that the potential prevalence is high.

For the past 30 years, experts have recommended that hearing conservation education should be available to schoolchildren (Cozad et al., 1974; Roeser, Coleman & Adams, 1983; Lass et al., 1987; Select Committee, 1992; Chermak & Peters-McCarthy, 1991; Niskar et al., 1998; & Folmer et al., 2002). There are hearing conservation programs for adults; the same consideration should be given to schoolchildren. One of the many duties of the National Institute of Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) is to promote hearing conservation for adults. Both organizations promote assessment, preventive education, monitoring worker’s hearing levels and monitoring sound levels of equipment. Research studies and pilot programs have proven that hearing conservation programs (HCP) for children can also significantly improve their awareness of how hearing loss occurs and how to prevent it (Chermak & Peters-McCarthy, 1991; Chermak, Curtis & Siekel, 1996; Knobloch & Broste, 1998).

Numerous studies have indicated that children are exposed to dangerous levels of noise on a daily basis (Select Committee, 1991; Chermak & Peters-McCarthy, 1991; Folmer, 2002). A survey of 1500 Ohio high school students reported that up to 92% of respondents were exposed to damaging levels of noise (Select Committee, 1992). At least 80% of middle class elementary students in one survey reported long-term use of personal stereos, which have a potential to produce noise levels up to 126 dB SPL (Select Committee, 1992). NIOSH recommends that noise exposure over 85 dBA as an 8-hour time weighted average could produce permanent damage to hearing (NIOSH, 1998).
As mentioned earlier, NIHL is almost always preventable, but it is not curable (NIOSH, 1998). NIHL progressively worsens with repeated noise exposure, first affecting the frequencies of the noise exposure (NIOSH, 1998). Frequencies beyond 4000 Hz are most commonly damaged first, due to the tonotopic placement of the outer hair cells in the cochlea. Unfortunately, ASHA’s guidelines only require hearing screenings at 1000, 2000 and 4000 Hz with a pass/fail criteria of 20 dB HL (Northern & Downs, 2002). Yet some professionals suggest 15 dB HL should be considered the cutoff of normal hearing for children (Niskar et al, 1998; Northern & Downs, 2002).

One way to prevent noise induced hearing loss is through education. Several hearing conservation programs targeting school age children have produced favorable results. A four-year longitudinal HCP study by Knobloch and Broste (1998) focused on 753 7th, 8th and 9th graders in 34 Wisconsin schools who work in agriculture. The final fourth year survey indicated that 87.5% of the students who were educated about hearing conservation stated they wore hearing protection, compared to 45% of the control group. Another HCP study reported that 97% of the children stated they would wear hearing protection after the program compared to 6% prior to the program (Chermak & Peters-McCarthy, 1991).

It is important that HCPs begin in the formative years so children can learn to protect hearing across their lifetime (Frager, 1986). The panel of High Risk Youth makes several statements regarding the prevention intervention education (Greenburg, Domitrivich, & Bumbarger, 2001). It was stated that multiyear preventive intervention programs produce longer-term benefits than one-time intervention programs. Secondly, the school environment should be the central focus of the preventive intervention. Most importantly, it was stated
that the education of the preventive behavior is more effective for school-age children than intervention that only focuses on the child (Greenburg et al. 2001).

Summary

NIHL in children has the potential to reduce academic and behavioral performance, as well as other side effects such as tinnitus and reduced speech discrimination abilities. Hearing conservation education reduces NIHL for adults and can also be effective in preserving the future hearing abilities of our nation’s children. Hearing screenings with cutoffs of 15 dB HL and up to 8000 Hz will be better able to target children who are showing early signs of NIHL. There are many hearing conservation programs available to teachers, but there are no regulations requiring the dissemination of such programs.

Purpose of the Study

The purpose of this study is to measure the effectiveness of a hearing conservation program for fourth grade students. The goals of this program were to improve the knowledge of ear anatomy and how hearing losses occurs, as well as to increase the willingness to take steps to protect hearing. If this HCP is successful, it could serve as a basis for future programs to be adopted on a larger scale.

The program, titled “Listening for Life”, was developed by the researcher and derived from a combination of HCPs from the American Tinnitus Association (Tabachnick-Sanders, 1991), the Military Audiology Association (MAA, 2003), Chermak & Peters-McCarthy (1991), Berger (2001), classroom acoustic research, and studies supporting effective teaching and behavior modification strategies. “Listening for Life” was designed to be used by classroom teachers as well as speech and hearing professionals. Two 45-minute lessons were designed to fit into a normal class period, possibly math, science or health classes. The
inexpensive materials chosen for this program were chosen because schools have most of these supplies on hand.

Hypothesis

Null Hypothesis (Ho): There will not be a significant difference between the results of the groups receiving the intervention and the control groups.

Alternate Hypothesis (H1): There will be a significant difference between the results of the intervention groups and the control groups.
CHAPTER 2

Literature Review

The Affects of Noise Exposure

Noise Exposure Defined

Noise exposure can create permanent threshold shifts (PTS), temporary threshold shifts (TTS), permanent or temporary tinnitus and other physical side effects such as high blood pressure (Select Committee, 1992; NIOSH, 1998). Together, these types of hearing damage are often referred to as noise induced hearing loss (NIHL). The higher frequencies are more commonly the first to be damaged by the hazardous noise. The hair cells of the inner ear, located at the first bend of the cochlea, are largely responsible for stimulating the high frequency perception of sound. The first bend of the cochlea is especially susceptible to damage if the incoming soundwave is at a hazardous level.

Hazardous noise is generally any noise that is above 85 dBA (NIOSH, 1998; Berger et al., 2000). The duration of exposure at various intensities in the work place is regulated by the Occupational Safety and Health Administration (OSHA) and has been researched the National Institute of Safety and Health (NIOSH). Both groups have specific guidelines for the duration of noise exposure (Appendix A).

A permanent threshold shift (PTS) can occur with one episode of high intensity noise exposure such as the sound of a gunshot. Most often, the hearing loss occurs with repeated noise exposure over long periods of time. For example, the average 60 year-old with thirty years of work-related noise exposure can expect to have a severe hearing loss. However, the average 60 year-old without noise exposure can expect to have normal hearing (Berger et al., 2000). Young ears have no more resiliency than older ears in guarding against hearing
damage. Noise induced threshold shifts (NITS) have been documented in children as young as age 6 (Niskar, Kieszak, Holmes, Esteban, Rubin & Brody, 2001).

The frequencies beyond 4000 Hz are usually the first to be affected by hazardous noise. A typical audiogram depicting early stages of NIHL or NITS shows normal hearing through 2000 - 3000 Hz, a slight decrease at 4000 to 6000 Hz, then improvement at 8000 Hz (Stach, 1998). The damage to hearing at these frequencies could still be above the normal hearing cutoff (25 dB HL for adults and 20 dB HL for children) and go unnoticed for many years.

The range for normal hearing is slightly different for adults and children. Hearing levels better than 25 dB hearing level (HL) are considered in the normal range for an adult. There is some controversy regarding the normal range of hearing for children. Northern and Downs (2002) suggest that the normal hearing range for children should be 0-15 dB HL. Children are in the process of acquiring language and learning the subtle acoustic differences in speech. Dobie and Berlin (as cited in Northern & Downs, 2002), found that children with thresholds of 20 dB HL had decreased morphological markers, intonation was inconsistent and shorter words such as “are” and “to” lost intensity in expressive language. The American Speech Language and Hearing Association (ASHA) only requires school-age hearing screenings to test 1000, 2000 and 4000 Hz with a pass/fail cutoff of 20 dB HL (Northern & Downs, 2000).

Noise induced hearing loss in children would be caught earlier if the criteria for pass/fail were screened at 15 dB HL at 1000, 2000, 4000 and 8000 Hz. Research has shown that noise induced hearing loss initially is exhibited at 4000 Hz and beyond, but ASHA’s guidelines for school-aged hearing screenings only test up to 4000 Hz. Typical school
hearing screenings fail to detect the typical pattern of early noise induced hearing loss. A study of 6,166 children ages 6 - 19 revealed 12 ½% of the subjects had minimum hearing levels of 16.75 dB HL at 6000 Hz (Niskar, Kieszak, Holmes, Esteban, Rubin & Brody, 2001). Niskar’s results detected the early signs of early hearing loss that would have gone undetected under the ASHA guidelines. These results verify that many more cases NIHL could be caught earlier if hearing screenings assessed beyond the speech range of 4000 Hz.

Prevalence of NIHL for Adults

In 1971, 6.9% of the population in the United States reported they had hearing loss (Montgomery & Fujikawa 1992). There were no NIHL statistics at that time. A 1990 survey from the National Institute of Health concluded that over 8% (28 million) of the U.S. population had hearing loss, of which one third were considered due to noise exposure (Select Committee, 1992). This figure translates into approximately 10 million cases of preventable NIHL.

Prevalence of Hearing Loss for Children

Reports of the incidence of hearing loss overall is somewhat variable. In 1991, the National Institute of Health further divided its hearing loss statistics for children. One million cases (or 1.6%) of hearing loss under age 18. A 1998 study reported as many as 7 million children as having hearing loss (Northern & Downs, 2002). The etiologies of the cases were not disclosed in either report. Roughly 50% of hearing loss is from unknown causes (Northern & Downs, 2002).

Prevalence of NIHL for Children

Reports of NIHL for children are minimal, but the evidence suggesting the possibility of NIHL is compelling. A cross-sectional, ten-year study from 1979 to 1989 of eighth grade students revealed an increase in failed hearing screenings from 3.4% to 11.3% (Montgomery
& Fujikawa, 1992). The 664 eighth graders were screened with the pass/fail criteria of 25 dB HL at 2000, 4000 and 8000 Hz. Another study reported approximately 12 % of 6,166 children (translated to 5.2 million children nationwide) between ages 6 and 19 years have noise induced threshold shifts (which is a precursor to NIHL) in one or both ears (Niskar, Kieszak, Holmes, Esteban, Rubin & Brody, 2001). Lastly, Weber, McGovern and Zink, as cited by Roeser, Coleman and Adams (1983), reported 30% of 1,000 children who failed a hearing screening performed by the Colorado Department of Health, had losses in the 4000 Hz region. It was also noted that as age increased to 16 plus years, so did the increase of hearing loss at 4000 Hz.

**Sources of Noise Exposure for Children**

Children are exposed to potentially damaging levels of noise from everyday objects such as personal stereos, home appliances, environmental noises, and toys (Select Committee, 1992). The school environment should also be considered as a location where school children are exposed to hazardous noise, particularly during music practice, woodworking, or metal shop classes (Woodford & O’Farrell, 1983; Lankford & West, 1993; Crandell & Smaldino, 2000; Zembower, 2000; Folmer et al., 2002). As mentioned earlier, NIOSH and OSHA have determined that noise, which exceeds 85 dBA, is hazardous. Appendix B lists the duration allowable at various noise levels.

A university-based study revealed hazardous noise levels of common toys to include toy sirens (74-102 dB), squeaky toys (78-108 dB), toy robots and cars (82-100 dB) and toy pistols (excess of 150 dB) (as cited in NIH, 1991) (the type of dB measurement was not disclosed in this article). Chermak & Peters-McCarthy (1991) reported that 77% of the fourth graders surveyed use portable stereos with headsets. In a survey of 273 third graders, 97% of students were exposed to hazardous sound levels (Blair, 1999). Lastly, Bess stated
that 77% of 3rd and 6th graders and 89% of 9th graders reported exposure to loud noises (Bess et al., 1998).

Brookhouser et al., as cited in Select Committee (1992), surveyed 94 children diagnosed with NIHL. The cause of NIHL was identified to be fireworks or firearms (46%), live or amplified music (12%), power tools (8%), and recreational vehicles (4%). Noise sources of 1500 Ohio high school students surveyed were personal stereos with headphones, dances, rock concerts, tractor pulls, and firearms (Lewis, 1989). The Select Committee on Children, Youth, and Families (1991) disclosed that personal stereos could have maximum output levels ranging from 115 to 126 dB SPL.

Social noise is not the only source of noise exposure for school children. Reports confirm that hazardous noise has been present in various school settings such as orchestra, woodshop or metals classes. Einhorn (1999) found that orchestral musicians are exposed to sound levels ranging between 83-112 dB SPL. Unilateral hearing loss was found among musicians who play the violin, flute or viola (Einhorn, 1999). The tools used in two particular high school woodworking class depicted noise measurements from 86 – 110 dBA (Roeser, Coleman & Adams, 1983; Lankford & West, 1993). Noise measurements surveyed from metals shop class disclosed noise levels from 74 – 96 dBA (Roeser et al., 1983).

Side Effects of NIHL

Lifetime consequences of noise induced hearing loss include chronic tinnitus, communication difficulties, depression, insomnia, and difficulty concentrating (Folmer et al., 2002). Elementary students near a busy airport were shown to have higher blood pressure and were more likely to fail cognitive tasks than children from quieter environments (Cohen, 1980; Select Committee, 1992). Kentish, Crocker and McKenna (2000) cited emotional distress as one of several psychological factors experienced by children with tinnitus, all of
which could affect school performance. It was discovered that children with thresholds of 16 dB HL or poorer have a 37% increase of repeating a grade compared to 8% of normal hearing peers (Bess, Dodd-Murphy & Parker, 1998; Johnson, Stein, Broadway & Markwalter, 1997).

Bess, Dodd-Murphy and Parker (1998) revealed that children with high frequency sensorineural hearing loss scored lower on comprehension tests, had lower self esteem and were more likely to repeat a grade than normal hearing matched peers. Folmer, Griest and Martin (2002) reported that children with high frequency hearing loss had more behavioral and learning problems than peers with normal hearing. The potential side effects of NIHL can be extensive.

Prevalence & Etiology of Tinnitus for Adults

Tinnitus is the ringing or buzzing sound heard in one or both ears. The American Tinnitus Association (ATA) estimates that 50 million Americans have tinnitus (2002). Tinnitus has also been documented as the most prevalent side effect of NIHL (NIOSH, 1998, Kowalska & Sulkowski, 2001). A study by the National Institute of Occupational Safety and Health stated that 79% of workers with noise induced hearing loss complain of tinnitus compared to 6% of adults without noise exposure (NIOSH, 1998). The etiology of tinnitus can also be related to medical conditions such as diabetes, hypertension, Meniere’s Disease, or atherosclerosis (Kowalska et al., 2002). Such medical conditions are more common for adults than for children.

Prevalence of Tinnitus in Children

European reports have indicated 6% to 36% of normal hearing children to have tinnitus (as cited in Holgers, 2003). Holgers’ study (n=964) reported 12% of the children to have tinnitus and 2.5% to have noise induced tinnitus. In a stateside observation,
Tabachnick, (Director of Education for the ATA) reported that at least 2 children in each classroom have confided in her about their tinnitus. She has conducted weekly hearing conservation programs during each school year, totaling approximately 300 presentations (personal communication, 7/02/02). However, there are no current statistics on the prevalence of noise-induced tinnitus for children for the U.S. To estimate the prevalence of tinnitus in children, one could consider comparing the percentage of tinnitus among adults.

Side Effects of Tinnitus

Children with tinnitus have similar symptoms as adults with tinnitus. Tinnitus can contribute to insomnia, listening and attention difficulties, and emotional distress, all of which can affect school performance (Kentish, Crocker & McKenna, 2000). For most tinnitus sufferers, it occurs so gradually, that they are surprised to learn it is an abnormal function of the inner ear. Not all cases of tinnitus have an etiology related to noise exposure, however, one can speculate that if hearing conservation decreases NIHL, then noise-induced tinnitus would also decrease.

Prevention Intervention Strategies

Prevention Research

A recent trend in the field of health prevention research is the integration of developmental theory with models from public health, epidemiology, sociology and developmental psychopathology in designing, conceptualizing and implementing preventive interventions (Greenberg, Domitivich, & Bumbarger, 2001). A fundamental principle that guides prevention research is that developing children are strongly influenced by the environment or context in which they live.

Bronfenberner, as cited by Greenberg et al. (2001), described an ecological model that contains four levels of the social world that affect child development. The first level, or
microsystem, is composed of social systems with which the child directly interacts such as family, school, peer groups and neighborhood. The second level, mesosystem, includes relationships between the various microsystems, such as the family-school connection. The exosystem refers to levels of social situations outside the child’s control that affect development, such as a divorce or socioeconomic status. Finally, the macrosystem level represents the widest level of system influence, consisting of broad ideological and institutional patterns and events that define a culture.

Another approach to developing prevention interventions has been the public health model, which has based its interventions on reducing the risk factors for a population while at the same time trying to promote factors that protect one from problematic health outcomes. For example, Coie et al. (1993), identified several risk factors associated with the increased risk of childhood psychopathology such as aggression, depression or anxiety. Physical handicaps, developmental delays, emotional difficulties, family problems, interpersonal problems, school problems and environmental risks were all associated with increased mental illness in children. Conversely, Coie also identified several protective factors that mitigate against the risk of developing psychopathology. Enhancing cognitive and social skills, as well as improving family and school situations have been found to buffer or protect the developing child from the effects of risk factors.

Another theoretical approach to prevention programs was suggested by the Institute of Medicine (1994) report. The Institute of Medicine report proposed to replace the terms primary, secondary and tertiary prevention with the terms universal, selected and indicated prevention. Universal prevention programs target the general public or a population group. Examples include prenatal care, childhood immunizations and school-based competency
enhancements programs. Selective interventions target individuals or subgroups whose risk of developing a disorder is significantly higher than average. These interventions include Headstart and specialized programs for traumatized children. The indicated programs target individuals who are beginning to show signs or symptoms of a disorder but who do not yet meet diagnostic criteria. Examples include parental training programs for children who begin to show early behavioral problems.

Using these approaches has led to important advances in prevention research with children and schools. There is a growing body of research documenting the efficacy of prevention programs in reducing psychiatric and physical symptomology (Greenburg et al., 2001). The panel of High Risk Youth (as cited in Greenburg et al., 2001) developed the following conclusions and recommendations for prevention programs with children:

- Short-term preventive interventions produce time-limited benefits, whereas multiyear programs tend to produce longer-term benefits.
- Ongoing intervention starting in preschool and early elementary years may be necessary to reduce morbidity.
- Prevention programs are best targeted at risk and protective factors rather than categorical problem behaviors.
- Interventions should be aimed at individual as well as environmental factors.
- Prevention programs that focus only on the child are not as effective as those that also educate the child and instill positive behaviors in school and at home.
- Program success is enhanced by also focusing on teacher and family behavioral interactions with the child.
• For school aged children, the school environment should be the central focus of the intervention.

It is clear that some health care professions have made excellent suggestions for reducing the morbidity of various disorders by using research orientations. The public health model has been especially helpful in addressing large-scale childhood developmental disorders. Various programs have been funded for research to improve hardiness or resistance to the factors that negatively affect proper emotional development. For example, there has been emphasis on developing programs that prevent the onset of adult physical disorders such as heart disease and lung disease by teaching early healthy habits to school-aged children (Farquhar et al., 1990).

The Effectiveness of Hearing Conservation Programs

For over 30 years, experts have recommended that hearing conservation education should be available to school-aged children (Cozad, 1966; Roeser, 1980; Lass, Woodford, Lundeen, Lundeen, & Everly-Myers, 1986; Select Committee, 1992; Chermak & Peters-McCarthy, 1991; Niskar, 1996; Folmer, 2002). Folmer (2002) recommends raising public awareness, persuading teachers and school administrators about existing HCPs, and seeking a mandate through state or federal legislation.

Approximately 29 HCP programs are publicly accessible and appropriate for a variety of ages of children (Appendix A). Only a few programs have published findings regarding their effectiveness (Knobloch & Broste, 1998; Chermak, Curtis & Seikel, 1996; Chermak & Peters-McCarthy, 1996; Roeser, Coleman & Adams, 1983). For instance, a four-year longitudinal study of 753 Wisconsin agricultural youth determined that 87% of the students who received HCP training wore hearing protection compared to 45% of the control group
(Knobloch & Broste, 1998). Another study stated that 82% of 39 fourth-grade students exposed to a HCP intended to use hearing protection near noisy activities (Chermak et al., 1996).

The Chermak and Knobloch (Knobloch & Broste, 1998; Chermak, Curtis & Seikel, 1996; Chermak & Peters-McCarthy, 1996) studies both had limitations. Although Chermak’s results were encouraging, the article did not mention the use of a control group. A control group would have given added strength to the pre/post-test results. This program’s success may have been due to several factors. It is interactive components included plastic ear models, sound level meters, and videotape. The results of Knobloch’s longitudinal study were also positive. Free earplugs mailed periodically to the home of each subject may be part of the reason for success. The disadvantage to incorporating audiological equipment and mailings might decrease the average school’s willingness to support such an ongoing expense.

Summary

Hearing conservation programs for adults have been successfully documented in reducing noise induced hearing loss. The facts support the need for hearing loss prevention program for children. An ideal HCP would be inexpensive, highly interactive, simplistic, and easily delivered.

One such HCP is titled “Listening for Life”. It was developed by this researcher and derived from a combination of HCPs from the American Tinnitus Association (ATA, 2002), the Military Audiology Association (MAA, 2003), and Chermak & Peters-McCarthy (1996). “Listening for Life” will serve as the intervention for this study. The intention of this study
is not to detract from previously mentioned successful HCPs, but to discover if a more cost effective approach has statistical significance.
CHAPTER 3

Methodology

Introduction

“Listening for Life” was designed to be highly interactive, inexpensive and effective. Collaborative teaching techniques are an integral component. Each student had opportunities to be involved as objectives were presented. A worksheet was available for every student to complete during the program. Interactive opportunities were presented throughout the 90-minute program, which was presented on 2 consecutive days. The lesson plan and student worksheet (Appendix D & E) can be referenced for further detail.

Participants. Three 4th grade classrooms in southwest Ohio were targeted to be the sample population. The characteristics of the participants can be found in Table 1. Two classrooms (n = 47) were selected to receive the HCP. The remaining classroom (pretest n = 23; post test n = 22) served as the control group. One student was absent for the post-test in the control group. The demographics of the subjects include a 16% minority population, 49 boys and 31 girls (CCSEC, 2003).

Inclusion Criteria. The grade level of the subjects was selected based on the research indicating that hearing conservation education should begin prior to the 5th grade (Chermak, Curtis & Seikel, 1996; Chermak & Peters-McCarthy, 1996; Frager & Kahn, 1986). The 4th grade classrooms chosen to receive the intervention were originally to be randomly selected. After further discussion with the teachers, it was discovered that two of the four classrooms were clustered based on academic abilities. Therefore, the researcher randomly chose one of
the two clustered classrooms and one of the non-clustered classrooms to receive the intervention.

Exclusion Criteria. Some of the participants could not attend the 2-day program. A few children were pulled out to attend another class. Three hearing health questions were recorded for those students and used in the data analysis since the answers did not depend on information learned during the intervention. The remainder of the pre/post test results, which included questions on ear anatomy, hearing loss and hearing protection was disregarded for those students who could not attend the program in its entirety.

Rationale of Subject Selection. The 4th grade level was targeted to receive the intervention for several reasons. Frager and Kahn (1988) have demonstrated that hearing conservation education should begin prior to the fifth grade to be most effective. The National Research Council (1993) guidelines also suggest that effective prevention programs should begin during the early grade school years. The school in this study has a health/body awareness curriculum for the 4th grade. The principal and teachers felt that a lesson on hearing conservation complimented the program, so prior parental consent was not necessary.

A pilot study of “Listening for Life” was presented to a 3rd and 5th grade class at the same school to assess the 4th grade-appropriate content level of the pre/post test, the receptive knowledge of the program and the amount of time to be spent on each activity. The 3rd grade students were presented with a shortened version of “Listening for Life” that focused on demonstrations of hearing protection strategies and why noise can damage hearing. It was determined that a few of the demonstrations could be more time efficient. For instance, the demonstration of the making of a cochlea would be more time efficient if
the children were quickly divided in groups of three and each group given one jar of playdough and a small amount of uncooked spaghetti than affording each student to make a cochlea model. The demonstration regarding speech discrimination under earplugs or earmuffs was originally designed for one student to participate for each scenario. Noticing the apprehension of a single participant, the demonstration was redesigned to include a pair of participants. The original lesson plan also introduced how hearing aids work and included BTE and ITE samples. The students were very eager to discuss the difficulties of talking to their grandparents who had hearing difficulties or wore hearing aids. The section on hearing aids proved to be too time consuming and was dropped from the final lesson plan. The 3rd grade class exposed to the pilot HCP was looped into the 4th grade, thus making it very easy to administer a one-year post-test. The results of the one-year follow-up test (Appendix C) revealed that this classroom had an average of 55% correct responses. To put this percentage into perspective, the current study’s pre test results were on average, ten to fifteen percent lower.

The 5th grade (N=26) pre-test results were impressive, thus decreasing post-test validity (average percentage correct was 72%; post test average percent correct was 87%). This suggested that the pretest was too easy for the fifth graders. As learned in the 3rd grade pilot study, the section on hearing aids was dropped, the playdough model of the cochlea was fine-tuned and the speech discrimination demonstration was smoother with pairs of students. Through trial and error, the end result of the 3rd and 5th grade pilot studies became the basis for the current study.
Table 1

Characteristics of Subjects

<table>
<thead>
<tr>
<th>Type</th>
<th>Group</th>
<th># of Subjects</th>
<th>Grade Level</th>
<th>Boys/Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1</td>
<td>23</td>
<td>22</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Experimental</td>
<td>2</td>
<td>24</td>
<td>24</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
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<tr>
<td>Experimental</td>
<td>3</td>
<td>23</td>
<td>23</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Procedures

Description

Two 4th grade classrooms received the intervention on the same days. The program consisted of two 45-minute sessions taught by the researcher, presented on consecutive days. The pre-test and post-test were identical. The 45-minute timeframe was designed to mimic a typical class period. The consecutive days were planned in order to minimize any transfer of information from the subjects to the control groups. The program was presented early in the school year, before the unit on health was taught. The students were exposed to information on ear anatomy, how hearing loss occurs and hearing protection strategies. The design of the study is described in Table 2.

Content. The focus of the lesson was to empower the fourth graders with the knowledge of how to protect their own hearing. The content of the lesson plan kept this focus by educating the students about ear anatomy, sound waves, the effects of loud sounds, how to recognize hazardous noise levels, how hearing loss occurs, and how to use hearing protection strategies. Multiple interactive scenarios and hands-on activities reinforced each content area (Dahmer, 1992; Walker & Angelo, 1998). Refer to Appendix D and E for further details about the actual lesson. The highlights of “Listening for Life” in the order it was taught are described below.

Sound Waves. The sound wave demonstration included “feeling” the vibration of sound, how sound travels through the air and through the auditory system. The students demonstrated this by placing their fingers on their throat, hummed and closed off the nares. Next, waving their worksheet in the air slowly, then faster, thus creating sound and seeing the “wave” of the paper increase. The sound wave discussion was ultimately connected to the how the strength of the sound waves was related to damage to hair cells.
Ear Anatomy. Each student received a worksheet to reference and label during this part of the lesson. The children were given the option to use colored pencils to coincide with the anatomical structures. For example, purple was used for the pinna, black was used for the “dark tunnel of the ear canal, white was used for the “eardrum”, etc. Other students just labeled the parts. The presenter drew the parts of the ear on the chalkboard as each term was introduced. The structures defined were the pinna, ear canal, eardrum, hammer, anvil, stirrup, cochlea, hair cells and the auditory nerve. As a review, soft and loud” sound waves were drawn with colored chalk through the auditory system to discuss the function of each part of the ear. Once the anatomy was outlined, it was possible to discuss what parts are damaged by noise and how the damage occurs.

Hearing Loss. The section in hearing loss focused on some etiologies of hearing loss such as ear infections and noise. The students were divided into groups of three to make a model of the cochlea. They were given a small jar of playdough and uncooked thin spaghetti noodles to replicate a cochlea. The activity gave a tangible connection of the movement of hair cells from soundwaves. The students witnessed “hair cells” moving in a gentle fashion from soft sound, while loud noises broke the “hair cells”. The dough was rolled in a 6-inch tube and approximately 10 noodles were placed in a row. One student from each group applied soft and hard pressure movements until some of the noodles broke. This led to the discussion of permanent vs temporary damage and how the hair cells become damaged or weakened over time.

Hearing Loss Experience. The class exercise, a demonstration of the effects of hearing loss, combined speech discrimination and degrees of hearing impairments. It reinforced aural rehabilitative strategies such as distance, visual cues and background noise.
It also introduced the correct technique for inserting foam earplugs. There were four pairs of students chosen for the exercise. Each pair of students were presented with words, chosen at random from the NU-6 word list (without visual cues), at distances of 3 feet, middle, and back of the classroom (Tillman & Carhart, 1966). One last set of words was presented at the back of the class with visual cues and with intentional background noise. The remainder of the class kept a tally of who had the easiest and most difficult time in repeating the words.

The first pair of students represented normal hearing. The second pair represented a unilateral conductive loss (one earplug worn by each student). The third pair represented a bilateral conductive loss, wearing two earplugs. The fourth pair represented a greater hearing loss (bilateral earplugs and earmuffs). A final twist on this experiment was to present the words in the presence of background noise. The observers rustled papers, books and whispers. All the pairs of students could not repeat the words in the presence of background noise when presented from the middle and the back of the class. The addition of noise allowed the class to experience the importance of a quiet classroom while the teacher is speaking.

*Final Discussion.* Distance, volume and hearing protection devices were reinforced as the key points for discussion. The students learned the key phrases of “walk away”, “turn it down” and “cover your ears” (MAA, 2003). Earplugs and earmuffs were reintroduced as ways to protect hearing (Hall & Santucci, 1995). The closing message to the students was they have the power to protect their own hearing.

*Materials.* The materials chosen for the lesson focused on low expense and items commonly found in a school. A program with minimal materials could be more attractive to a school with difficulties of financing extra programs thus making “Listening for Life” more
easily adopted. The materials utilized for this lesson plan included: the pre/post test, the student worksheet, chalk, playdough, uncooked thin spaghetti, EAR soft foam earplugs, two pairs of earmuffs, and sample words from the NU-6 Word List (Tillman & Carhart, 1966).
Table 2

Design of Study

<table>
<thead>
<tr>
<th>Classroom</th>
<th>Pre-Test</th>
<th>Day 1 Lesson</th>
<th>Day 2 Lesson</th>
<th>Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
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<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
<td>X</td>
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<td>X</td>
</tr>
</tbody>
</table>
CHAPTER 4

Results

Subjects

Seventy 4th grade students from a school in southwest Ohio participated in this study. The subjects, to include the control group (n=23 pre and n=22 post) and the intervention groups (n = 47) were given a pretest and an identical post-test (Appendix C). The intervention groups were exposed to a 90-minute lesson on hearing conservation. The lesson was presented on two consecutive days. The intervention groups also completed a second post-test one-month later. The dependent variable represents the percent change of the data between the pre and post-test results and post-test to one-month post-test. The structure of pre/post test allowed for several questions to support each area of analysis. There were 3 hearing health history questions, 6 questions to measure knowledge of hearing loss, 6 questions on knowledge of ear anatomy and 9 questions on the willingness to use hearing protection strategies.

Statistical Analysis

Three hearing health history questions were analyzed individually for pre- to post-test validity and reliability of self-reported data using descriptive statistics and paired t-test calculations. The data is displayed in Tables 3-5. The remaining 21 questions were divided into three areas for analysis. This included knowledge of ear anatomy, knowledge of hearing loss, and the willingness to follow hearing protection strategies. These 3 areas were analyzed using Chi – square analysis at a .05 significance level. The control group data and the one-month posttest data of the intervention groups were also analyzed for criterion validity, extraneous variables and reliability.
Pre Test. Prior to the first session, the subjects (N=70) were given a pre-test (Appendix C). The classroom teacher administered the pre-test the day before the first session. The students were informed that someone will be teaching them about their ears the next day and want to see how much you already know. The classroom teacher also mentioned that it would not be graded. The pretest was administered to all three classrooms, then collected and sealed in an envelope by the classroom teacher. The researcher did not review the pre-test data until after the completion of the study.

Post Test. The participants (N=69) completed the post-test at the end of the second session (Appendix C). The population difference between the pre and post tests were due to one student’s absence in the control group. The researcher/presenter administered it to the two classrooms receiving the intervention. The classroom teachers administered the post-test to the control group that same day. The data was collected by the classroom teachers and placed in an envelope.

One-Month Post Test. The two classrooms that received the intervention (n = 47) also completed a second post test one month from the date of the intervention. The classroom teachers administered the one-month post test. The data was collected by the classroom teachers and placed in an envelope.

Significance of the Study

Results of the Hearing Health History Questions

The students answered survey questions about topics including difficulty hearing speech, history of equalization tubes, and acknowledgement of tinnitus. These questions were to be answered to the best of their knowledge and understanding. The questions were also addressed during the program to increase the likelihood of accurate answers from the pre test to the post-test responses. The results were combined for the two intervention groups
and the control group for each of the three survey questions (Tables 3-5). The actual questions can be referenced in Appendix C, questions 1, 2 and 3.

Summary. There are slight differences between the pre-test and post-test results for the hearing health questions. Descriptions of tinnitus and pressure equalization tubes were addressed during the intervention, which may have prompted a more accurate response to the hearing health question on tinnitus and history of PE tubes. Considering the nature of the self-report and knowledge exposure, the post-test questions should reflect a more accurate response than the pre-test results for the three hearing health questions.

Fifty-seven percent of the students (N=70) self reported that they have trouble hearing people talk in the pretest compared to 42% for the post-test (N=69). Student perceptions could be further explored to determine nature of the listening situation in which the student claims they have trouble hearing. Such information may be beneficial to the classroom teacher. For instance, a referral for testing may be warranted or room acoustics could be addressed if the students claim a fan or hallway noise is troublesome.

Twenty-five percent of the students (N=70) self reported that they have had “tubes” placed in their ear by a doctor in the pretest compared to 21% in the post test (N=69). It is the researcher’s experience that children who have had pressure equalization tubes may have been previously exposed to ear anatomy. During the intervention, several children in both intervention groups wanted a more detailed explanation of PE tubes. Therefore, the post-test results should reflect a more accurate response to the exposure to this content area.

Fifty-seven percent of the pre-test results self reported they hear ringing or buzzing noises when no other noise is present (N=70) compared to 52% for the post-test (N=69). Tinnitus was simply defined in the hearing conservation program as a noise that is heard
without any other sound present. This information could have clarified the students
understanding of tinnitus. Therefore, the post results could reflect a more accurate response.

Results of the Pre-Post Test

The remaining 21 questions were analyzed per group via chi-squared analysis using a
.05 alpha (Figure 1 and Tables 6-10). The percentage of correct response for each question
was analyzed per question and per grouped content areas. Figure 1 is a bar graph depicting
combined percentage scores of the pre test, post-test and one-month post-test per group. The
control group did not receive a one-month post-test. Tables 6 through 10 reflect the three
content areas of the pre/post test (6 questions related to hearing loss; 9 questions designed to
measure willingness to use hearing protection; 6 questions designed to measure knowledge
of ear anatomy).

The control group had no significant differences in all but one of the questions from
the pre test to the posttest. The majority of the p values were greater than .60. The sixth
question on the measure was significantly different between pre and post (p=.0027). The
results can be found in Tables 6-10. Precautions taken to minimize extraneous variables
were effective. The control group did not gain information about the program from the next
classroom within the two-day timeframe, which was apparent in the nonsignificance of pre to
post-test.

Both experimental groups (n=48) significantly improved from the pre test to the
posttest for the 21 questions analyzed (Tables 6-10). The majority of the p values were less
than .0001. A few questions were found to have no significance and should be disregarded
or reworded for future studies. These items could have been too easy or the students had
previous knowledge of the question (items 6 and 7).

Results of the Post to One Month Post Test
The experimental group (n=48) had no significant difference between the post test and the one month post test. The students demonstrated the ability to maintain information over a one month period. The foundation of hearing conservation is present and could be used as a building-block to subsequent lessons.

**Results of the Correlation Analysis**

The relationships between the three areas of analysis (related questions on hearing loss, ear anatomy and hearing protection strategies) were analyzed using the Pearson Correlation Coefficient Analysis (Table 3). The Pearson determined the r-values (.13 squared) showed a weak relationship between HL (hearing loss knowledge) and HP (willingness to use hearing protection). The r-values (.138 squared) showed a weak relationship between the EA (ear anatomy knowledge) and HP. The r-values (.46 squared) also showed a moderate relationship between the EA and HL content areas. The low correlation values suggest that one area of analysis did not influence the other area of analysis. This is understandable given the nature of the three areas in question. For example, the questions on ear anatomy were very specific and objective, whereas the questions on willingness to use hearing protection are very subjective and speculate on future behavior.
Figure Caption

Figure 1: Mean results of pre, post and one-month post-test reported on percent correct for the control group and the two intervention groups.
Pre-Post-1 Mo. Post Test Results

Control  Exper.1  Exper.2

Pre-Test  Post-Test  1 Mo. Post

Percentage

0  10  20  30  40  50  60  70  80  90

Pre-Test  Post-Test  1 Mo. Post
Table 3

Tally of Self Report on Hearing Difficulties

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>11/23</td>
<td>29/47</td>
</tr>
<tr>
<td>Post</td>
<td>8/22</td>
<td>21/47</td>
</tr>
<tr>
<td>1 Mo. Post</td>
<td>n/a</td>
<td>27/47</td>
</tr>
</tbody>
</table>

Table 4

Tally of Self Report for History of Pressure Equalization Tubes

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>6/23</td>
<td>12/47</td>
</tr>
<tr>
<td>Post</td>
<td>7/22</td>
<td>8/47</td>
</tr>
<tr>
<td>1 Mo. Post</td>
<td>n/a</td>
<td>19/47</td>
</tr>
</tbody>
</table>

Table 5

Tally of Self Report of Tinnitus Type Symptoms (ringing or buzzing sounds)

<table>
<thead>
<tr>
<th>Item</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>14/23</td>
<td>27/47</td>
</tr>
<tr>
<td>Post</td>
<td>11/22</td>
<td>25/47</td>
</tr>
<tr>
<td>1 Mo. Post</td>
<td>n/a</td>
<td>28/47</td>
</tr>
</tbody>
</table>
Table 6

Pearson Correlation Coefficients

Pre to Post Test Analysis for Experimental Groups (n=47)

<table>
<thead>
<tr>
<th>Content Areas</th>
<th>HL</th>
<th>HP</th>
<th>EA</th>
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<tbody>
<tr>
<td>Hearing Loss</td>
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<td>.13415</td>
<td>.46591</td>
</tr>
<tr>
<td>Ear Anatomy</td>
<td>.13415</td>
<td>1.000000</td>
<td>.13817</td>
</tr>
<tr>
<td>Hearing Protection</td>
<td>.46591</td>
<td>.13817</td>
<td>1.000000</td>
</tr>
</tbody>
</table>

Key:  HL = Related questions on Hearing Loss  
      EA = Related questions on Ear Anatomy  
      HP = Related questions on Willingness to use Hearing Protection
Table 7

Analysis of Correct Responses to Hearing Loss Questions

<table>
<thead>
<tr>
<th>Questionnaire Item</th>
<th>Pre Test</th>
<th>Post Test</th>
<th>1 Mo. Post</th>
<th>Pre/Post</th>
<th>Pre/1Mo.</th>
<th>Post/1 Mo.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4 – ear infections</td>
<td>14/23</td>
<td>17/22</td>
<td>n/a</td>
<td>.2348</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#5 – noise</td>
<td>17/23</td>
<td>15/22</td>
<td>n/a</td>
<td>.6716</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#8 – ringing noises</td>
<td>12/23</td>
<td>10/22</td>
<td>n/a</td>
<td>.6522</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#9 – hearing aids</td>
<td>10/23</td>
<td>9/22</td>
<td>n/a</td>
<td>.8615</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#12 – hearing damage</td>
<td>0/23</td>
<td>0/22</td>
<td>n/a</td>
<td>no value</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#13 – speaker distance</td>
<td>11/23</td>
<td>11/22</td>
<td>n/a</td>
<td>.8841</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Experimental Groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>#4 – ear infections</td>
<td>28/47</td>
<td>41/47</td>
<td>40/47</td>
<td>.0045*</td>
<td>.0162*</td>
<td>.5510</td>
</tr>
<tr>
<td>#5 – noise</td>
<td>39/47</td>
<td>44/47</td>
<td>46/47</td>
<td>.4386</td>
<td>.0182*</td>
<td>.0736</td>
</tr>
<tr>
<td>#8 – ringing noises</td>
<td>21/47</td>
<td>25/47</td>
<td>28/47</td>
<td>.5582</td>
<td>.0833</td>
<td>.2466</td>
</tr>
<tr>
<td>#9 – hearing aids</td>
<td>28/47</td>
<td>43/47</td>
<td>42/47</td>
<td>.0455*</td>
<td>.0162*</td>
<td>.6366</td>
</tr>
<tr>
<td>#12 – hearing damage</td>
<td>1/47</td>
<td>27/47</td>
<td>12/47</td>
<td>.0096*</td>
<td>.0409*</td>
<td>.5254</td>
</tr>
<tr>
<td>#13 – speaker distance</td>
<td>24/47</td>
<td>41/47</td>
<td>40/47</td>
<td>&lt;.0001*</td>
<td>&lt;.0001*</td>
<td>1.0</td>
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</tbody>
</table>

* p < .05  significantly different
### Table 8

**Analysis of Correct Responses to Ear Anatomy Questions**

<table>
<thead>
<tr>
<th>Questionnaire Item</th>
<th>Pre Test</th>
<th>Post Test</th>
<th>1 Mo. Post</th>
<th>Pre/Post</th>
<th>Pre/1 Mo.</th>
<th>Post/1 Mo.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#11 – define tinnitus</td>
<td>0/23</td>
<td>0/22</td>
<td>n/a</td>
<td>no value</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#15 – name 5 ear parts</td>
<td>19/23</td>
<td>18/22</td>
<td>n/a</td>
<td>.9447</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>b.</td>
<td>2/23</td>
<td>5/22</td>
<td>n/a</td>
<td>.1942</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>c.</td>
<td>0/23</td>
<td>3/22</td>
<td>n/a</td>
<td>.0668</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>d.</td>
<td>0/23</td>
<td>1/22</td>
<td>n/a</td>
<td>.3011</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>e.</td>
<td>0/23</td>
<td>0/22</td>
<td>n/a</td>
<td>no value</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

| **Experimental Groups** |          |           |            |          |           |            |
| #11 – define tinnitus | 0/47     | 13/47     | 12/47      | <.0001*  | .0004*    | .5623      |
| #15 – name 5 ear parts | 22/47    | 45/47     | 43/47      | <.0001*  | <.0001*   | .3122      |
| b.                    | 4/47     | 45/47     | 42/47      | <.0001*  | <.0001*   | .3122      |
| c.                    | 1/47     | 45/47     | 37/47      | <.0001*  | <.0001*   | .1563      |
| d.                    | 1/47     | 41/47     | 28/47      | <.0001*  | <.0001*   | .0455*     |
| e.                    | 1/47     | 39/47     | 21/47      | <.0001*  | .0045*    | .0012*     |

* p < .05 significantly different
Table 9

Analysis of Correct Responses to Willingness to Use Hearing Protection

<table>
<thead>
<tr>
<th>Questionnaire Item</th>
<th>Pre Test</th>
<th>Post Test</th>
<th>1 Mo. Post</th>
<th>Pre/Post</th>
<th>Pre/1 Mo.</th>
<th>Post/1 Mo.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6 – protect hearing</td>
<td>10/23</td>
<td>19/22</td>
<td>n/a</td>
<td>.0027*</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#7 – loud music</td>
<td>22/23</td>
<td>22/22</td>
<td>n/a</td>
<td>.3226</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#10 – walk away</td>
<td>13/23</td>
<td>12/22</td>
<td>n/a</td>
<td>.8939</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#14 – 3 ways</td>
<td>18/23</td>
<td>16/22</td>
<td>n/a</td>
<td>.6659</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>b.</td>
<td>18/23</td>
<td>17/22</td>
<td>n/a</td>
<td>.9365</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>c.</td>
<td>9/23</td>
<td>6/22</td>
<td>n/a</td>
<td>.3990</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#16 – earplugs/concert</td>
<td>11/23</td>
<td>9/22</td>
<td>n/a</td>
<td>.6407</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#17 – earplugs/tools</td>
<td>16/23</td>
<td>15/22</td>
<td>n/a</td>
<td>.9202</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>#18 – earplugs/mowing</td>
<td>14/23</td>
<td>13/22</td>
<td>n/a</td>
<td>.9031</td>
<td>n/a</td>
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</tbody>
</table>

* p < .05 significantly different
Table 10

Analysis of Correct Responses to Willingness to Use Hearing Protection

<table>
<thead>
<tr>
<th>Questionnaire Item</th>
<th>Pre Test</th>
<th>Post-Test</th>
<th>1 Mo. Post</th>
<th>Pre/Post</th>
<th>Pre/1 Mo.</th>
<th>Post/1 Mo.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#6 – protect hearing</td>
<td>40/47</td>
<td>46/47</td>
<td>45/47</td>
<td>.1213</td>
<td>.0409*</td>
<td>1.0</td>
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<tr>
<td>#7– loud music</td>
<td>46/47</td>
<td>47/47</td>
<td>46/47</td>
<td>.3122</td>
<td>.3122</td>
<td>.5510</td>
</tr>
<tr>
<td>#10-walk away</td>
<td>29/47</td>
<td>35/47</td>
<td>36/47</td>
<td>.1195</td>
<td>.2207</td>
<td>.7313</td>
</tr>
<tr>
<td>#14- 3 ways</td>
<td>29/47</td>
<td>47/47</td>
<td>45/47</td>
<td>&lt;.0001*</td>
<td>&lt;.0001*</td>
<td>.3122</td>
</tr>
<tr>
<td>b.</td>
<td>22/47</td>
<td>46/47</td>
<td>45/47</td>
<td>&lt;.0001*</td>
<td>&lt;.0001*</td>
<td>.3122</td>
</tr>
<tr>
<td>c.</td>
<td>11/47</td>
<td>44/47</td>
<td>33/47</td>
<td>&lt;.0001*</td>
<td>&lt;.0001*</td>
<td>.1213</td>
</tr>
<tr>
<td>#16-earplugs/concert</td>
<td>10/47</td>
<td>36/47</td>
<td>27/47</td>
<td>&lt;.0001*</td>
<td>.0009*</td>
<td>.2207</td>
</tr>
<tr>
<td>#17-earplugs/tools</td>
<td>23/47</td>
<td>43/47</td>
<td>39/47</td>
<td>.0006*</td>
<td>.0006*</td>
<td>1.0</td>
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<tr>
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<td>37/47</td>
<td>&lt;.0001*</td>
<td>&lt;.0001*</td>
<td>.6366</td>
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* p < .05 significantly different
CHAPTER 5

Discussion

A nation-wide hearing conservation program for America’s youth is long overdue. Currently, no information could be located on any federal or state mandated HC programs for school-age students (Folmer, Griest & Martin, 2002). As mentioned previously, from the 1960’s to the present, many hearing related organizations have all reported the need for appropriate hearing conservation education for school age children (American Speech-Language-Hearing Association; the American Tinnitus Association; the National Institute of Health; National Center for Environmental Health; The Epidemic Intelligence Service; School Nurse Association; the National Institute of Deafness and Communication Disorders, Health and Nutrition Committee).

The results of this study demonstrated an overall significant increase in the knowledge of ear anatomy, how hearing loss occurs and the willingness to use hearing protection strategies. Establishing this type of knowledge base lays the groundwork for informed decisions to take place. As mentioned earlier, research has proven that children are exposed to social noise on a regular basis. The ultimate goal of this study was to empower the children to make decisions to protect their own hearing through three simple strategies (turn down the volume, walk away from the noise, and cover your ears with earplugs or earmuffs).

The statistical findings of this study compliment results of similar research. This study yielded a post-test average of 84% compared to 40% for the pre test for the experimental groups and no significant difference for the control group (pre 44.7%; post 47.2%). Knobloch and Broste (1998) reported that the percentage of students who would use hearing protection devices at least some of the time was 87.5% compared to 45% from the
Another study stated that 82% of 39 fourth-grade students exposed to a HCP intended to use hearing protection near noisy activities (Chermak et al., 1996). The differences in these studies lie mainly in the costs. The materials for “Listening for Life” could be found in a typical school or easily obtained by a teacher (playdough, earplugs, earmuffs, etc.). The materials for the other programs consisted of sound meters, videos, a model of the ear, and earplugs (which were mailed to the home), to name a few. Significant results were still achieved with less expensive materials.

The test-retest results support the strength in the design of this study. The nonsignificant findings for the control group supported the minimal extraneous variables and validity of the study. The significant findings for the experimental group supported the validity and reliability of the content of the program. Each content area was supported by several measures to increase statistical strength (ear anatomy, hearing loss and hearing loss prevention strategies). However, several questions were not significant in the pre to post test for the experimental group (questions 5, 6, 7, 8, and 10). The results of these questions could be interpreted as strengths and weaknesses (Tables 7, 8, and 10).

**Question 5: Can loud noise damage your hearing?** Most students answered this correctly at pretest and post-test. It acknowledges the foundation for understanding hearing loss prevention. This is good news. The p-value of .43 was not significant from pre to post test for the experimental groups (Table 7) due to the high correct response. The pre-test data revealed 39 students answered correctly at pre-test compared to 44 answering correctly for the post test. Most students in the control group also answered it correctly (17 out of 23 pre-test compared to 15/22 for post test). Such an understanding can be built upon by expanding how the damage takes place and how it can be prevented.
Question 6: The best way to protect your hearing is to: Answer: wear earplugs. The p-values for the control group and the intervention group were not favorable. The experimental group scores were 40 out of 47 correct responses at pre-test compared to 46 at post test. The control group scores were 10 out of 23 at pre-test compared to 19 out of 22 at post-test for correct responses. The answer to this question could have been too obvious to the student. The control group seemed to have a difficult decision making process choosing the best answer as derived from the great difference in number of correct responses from pre to post (10 vs 19). This question would need rewording and/or further instruction in order to determine its effectiveness. The instructional material should elaborate on the best way to preserve hearing and elaborate on the differences between wearing earplugs versus covering your ears. Both of these scenarios should be evaluated in subsequent studies.

Question 7: You are listening to music with a few friends. The only way you can hear each other is to shout. What will you do to the volume? Answer: turn it down. An impressive 68 out of 70 students at pre-test compared to 69 out of 69 students post test answered correctly. The structure of this question was to make a cognitive decision based on a typical noisy situation. At pre-test, the answer of “turning down the volume” was the better action. However, at post-test, it is hoped that they understood why the volume needs to be turned down. Reviewing the results of the content area on hearing loss (Table 7), one can deduce that the understanding has increased for this question. The wording of this question should not be changed since it offers baseline information.

Question 8: Which of the following can cause ringing in your ears? Answer: noise. The experimental group scores were 21 out of 47 correct responses at pre-test compared to 25 at post test. The control group scores were 12 out of 23 at pre-test compared to 10 out of 22 at post-test for correct responses. Two factors could be the reason for this result. The
wording of the question could be adjusted based on the similar results of the control and intervention groups. Or, the wording of question 8 could remain the same and expand the instructional material on tinnitus. Both of these scenarios should be evaluated in subsequent studies.

**Question 10:** A warning sign that music is too loud is: Answer: you must shout to your friend who is next to you. The experimental group scores were 35 out of 47 answered correctly at pre-test compared to 36 at post test. The control group scores were 13 out of 23 at pre-test compared to 12 out of 22 at post-test for correct responses. No significant difference between results for either experimental or control groups. One could deduce that the content of this question should be addressed in a few more examples or information within the lesson.

**Question 15:** Name five parts of the ear. The number of correct responses also decreased between the pre to post test results. While significant differences were noted for pre/post test results, the one-month follow-up demonstrated only partial recall of the parts of the ear (Table 8). The structure of this question relies on rote memory. Fill-in the blank questions are also more cognitively difficult. In the future, adding a diagram of the ear to this question may aid in recall.

**Question 3:** Do you hear ringing or buzzing sounds in your head when there is no other noise around? The findings of this self-report question regarding tinnitus should be noted. Fifty-three percent of the experimental groups answered yes to tinnitus-like symptoms at post-test. The post-test figures of the experimental group offer the most accurate measure since this question was addressed during the intervention. No other research could be identified at this time that has educated and surveyed grade school students about this tinnitus. As previously described (Chapter 2), side effects of tinnitus, such as
insomnia and communication difficulties, could impact school performance. The common etiologies of tinnitus are mainly adult related such as high blood pressure, diabetes, Meniere’s disease, and noise exposure. Of these etiologies, noise exposure is one of the most common causes of tinnitus (Kowalska & Sulkowski, 2001). Kowalska et al. (2001), also reported that 95.8% of workers with tinnitus also had hearing loss. Although there is a wide range of etiologies for tinnitus, the prevalence findings in this study of 53% out of 47 children self-reporting tinnitus should warrant further research. This is but one more piece of evidence that hearing conservation for children may prove valuable.

*Cost Saving Benefits of HCPs*

It was estimated by NIOSH (1998) that 6.9 billion dollars could be spent each year if hearing aids were provided to every American who needed them. It is easy to understand why most insurance companies do not reimburse for amplification. It was previously noted that one-third of the 28 million Americans have noise induced hearing loss. One could deduce that a potential 2.3 billion dollars could be saved each year, just from reducing new cases of NIHL. Also consider the fact the estimated 5.2 million children show the early signs of noise induced hearing loss. Next, include the fact that 37% of children with high frequency hearing loss have repeated a grade (Johnson, Stein, Broadway & Markwalter, 1997). It would be beneficial to the individual and society if just one child per school avoids repeating a grade based on a hearing conservation intervention.

*Limitations of Solving the Problem*

The availability of hearing conservation programs to school-aged children is the main limitation of getting the information to the students. Another difficulty lies in the delivery and costs of such a program. Who is responsible and qualified to educate students about
hearing conservation? Who will finance the cost of delivering such a program? The answers to these questions are the key to program implementation.

Nurses, speech pathologists and educational audiologists are all feeling the burden of providing care for more than one school. The school nurse shortage results in only 11.5% of school districts meeting the 1:750 ratio (Brener et al., 2001). Hearing conservation prevention programs were not included in the list of duties of a school nurse (Health Policy Program, 2001; Brener et al., 2001).

Hearing conservation knowledge of the classroom teacher and schoolbooks from which it is taught has proven to be inadequate (Frager & Kahn, 1988; Frager, 1986; Folmer, Griest, & Martin, 2002). The speech-language pathologists and special education teachers are more qualified, but have time constraints that only permit a focus on their clients. There are only a handful of educational audiologists in each state. For instance, the state of Ohio employs only 42 full time and part time educational audiologists to serve all of Ohio’s school-age children (EAA, 2003). Private practice audiologists are not reimbursed if they present these workshops to schools.

Future Considerations

Hearing conservation education should be available to every student. Programs such as “Listening for Life” have proved its significance at the fourth grade level. Other research should be completed on other grades as well. Research of future HCP programs should consider diverse populations such as inner city schools and special needs students.

A targeted population of volunteers and professionals could be trained to disseminate such HCPs. There are currently over 285 colleges and universities with certified speech pathology degrees across the country with approximately 13,000 members of the National
Students of Speech Language & Hearing Association (NSSLHA) (ASHA, 2002). In addition to the NSSLHA members, undergraduate and graduate students in deaf education, special education, elementary and secondary education could also join in becoming hearing conservation presenters. These students could be trained as instructors of HCP as part of a coordinated effort within a university setting and gain useful experience in the grade school system.

The usefulness of this program should be measured over time to determine if it has an effect on decreasing NIHL and tinnitus as children grow older. Baseline audiogram criteria should be established with a 15 dB HL cutoff and measured from 500 Hz to 8000 Hz. Every kindergartner, fifth grade, eighth grade and high school student should have an updated hearing evaluation and compared it to the baseline. Next, HCPs should be age-appropriate and administered at kindergarten through fourth grades to establish behavior modification, then continued into fifth, eighth and twelfth grades. Hearing protection strategies should be reinforced at each hearing screening and evaluation.

This study is only a small part of a larger plan to disseminate HCP’s in the grade-school setting. A large group of motivated and trained hearing conservation specialists will be needed to present HCPs on this broader scale. Funding, time and personnel are key issues to be solved.

Conclusion

While many other health care professions have developed and validated models of wellness prevention in children, hearing loss prevention education has lagged behind. There is a strong need to use the concepts of prevention science and apply them to the prevention of noise induced hearing loss at the early grade school level. Based on the Institute of Medicine
recommendations, such interventions should be targeted through the schools, should begin during the early grade school years and should be long-term interventions rather than a one-time educational presentation. It is time for audiology to lead the way in advocating the need for more funding for prevention program research. The tools to prevent hearing loss are at our fingertips; it is time to disseminate these programs to our nation’s children.
References


*ASHA Leader*, 22-23.


challenge for school audiologist. *Language, Speech, and Hearing Services in the Schools*, 16(1), 75-79.


### Appendix A

**OSHA & NIOSH Duration of Sound Exposure**

<table>
<thead>
<tr>
<th>A-weighted Exposure Level</th>
<th>OSHA Maximum Allowable Duration*</th>
<th>NIOSH Maximum Allowable Duration**</th>
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</thead>
<tbody>
<tr>
<td>85</td>
<td>16 hours</td>
<td>8 hours</td>
</tr>
<tr>
<td>90</td>
<td>8 hours</td>
<td>2 hrs., 10 min.</td>
</tr>
<tr>
<td>95</td>
<td>4 hours</td>
<td>47.5 min.</td>
</tr>
<tr>
<td>100</td>
<td>2 hours</td>
<td>15 min.</td>
</tr>
<tr>
<td>105</td>
<td>1 hour</td>
<td>4.75 min.</td>
</tr>
<tr>
<td>110</td>
<td>30 min.</td>
<td>1.5 min.</td>
</tr>
<tr>
<td>115</td>
<td>15 min.</td>
<td>28 seconds</td>
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</tbody>
</table>

*OSHA duration calculations use a 5 dB exchange rate  
(Berger, Royster, Royster, Driscoll & Lane, 2000)

**NIOSH duration calculations use a 3 dB exchange rate.  
(U.S. Dept of Health and Human Services, 1998)
Appendix B

Hearing Conservation Education Programs Designed for Children

Crank It Down!
National Hearing Conservation Association (NHCA)
9101 E. Kenyon Ave., Denver, CO 80237
303/224-9022/www.hearingconservation.org

Dangerous Decibels
Oregon Hearing Research Center
Mail Code NRC04
3181 SW Sam Jackson Park Road
Portland, OR 97201/503/494-0670
www.dangerousdecibels.org

Hear For A Lifetime/American Tinnitus Association
P.O. Box 5, Portland, OR 97207-0005
503/248-9985/www.ata.org

Hearing Education and Awareness for Rockers
H.E.A.R.
P.O. Box 460847, San Francisco, CA 94146
415/431-3277/www.hearnet.com

Hear US (National Campaign for Hearing Health)
Deafness Research Foundation
1225 I Street NW, Suite 500
Washington, DC 20005/202-289-5850
www.hearinghealth.net/pages/toxicnoise/index.html

HIP Talk; Hearing is Priceless (HIP)
House Ear Institute
2100 West 3rd St., Los Angeles, CA 90057

Know Noise/Sight & Hearing Association
674 Transfer Road, St. Paul, MN 55114-1402
651/645-2546/www.sightandhearing.org

Operation BANG (Be Aware of Noise Generation)
Military Audiology Association

Operation SHHH
Self Help for Hard of Hearing People
7910 Woodmont Ave., Suite 1200
Bethesda, MD 20814/301/657-2248
www.shhh.org

Quiet Please/Sertoma International
1912 East Meyer Blvd., Kansas City, MO 64132
816/333-8300/www.sertoma.org

Stop That Noise!
League For the Hard of Hearing
71 West 23rd St., New York, NY 10010-4162
888/NOISE-88/www.lhh.org/noise/stn.htm

Wise Ears
National Institute on Deafness and Other Communication Disorders (NIDCD)
NIDCD Information Clearinghouse
1 Communication Ave., Bethesda, MD 20892-3456
800/241-1044
www.nidcd.nih.gov/health/kids/index.htm

Aearo/Ear Hearing Protection Products
5457 West 79th St., Indianapolis, IN 46268
317/692-6666
www.peltor.com/html/industrial/films%5F01.htm

American Academy of Audiology
8300 Greensboro Drive, Suite 750, McLean, VA 22102
800/AAA-2336/www.audiology.org

American Academy of Otolaryngology - Head and Neck Surgery
One Prince Street, Alexandria, VA 22314-3357
703/836-4444/www.entnet.org/noise-hearing.html

American Speech Language Hearing Association (pamphlet only)
Pacific Hearing Conservation, 518 6th Ave., NW
Seattle, WA 98107 /800/498-2071/www.asha.org/sidivisions/sid_8.htm

Better Hearing Institute
515 King St., #420, Alexandria, VA 22314-3137
703/684-3391/www.betterhearing.org/conserve.htm#A

Caldwell Publishing Company
P.O. Box 3231, Redmond, WA 98073
800/284-7043/www.caldwellpublishing.com

Dept. of Community Health Sciences, University of Edinburgh
Teviot Place, Edinburgh, Scotland EH8 9AG
0131 650 3219/www.link.med.ed.ac.uk/hew//hearing/hearing_loss.htm

The EAR Foundation
1817 Patterson St., Nashville, TN 37203
800/545-HEAR/www.earfoundtion.org

Howard Leight Industries
7828 Waterville Road, San Diego, CA 92154
800/327-1110/ www.howardleight.com

It’s About Time, Inc.
84 Business Park Drive, Amonk, NY 10504
888/698-8463/ www.Its-About-Time.com

N.A.S.A. - GRC Environmental Programs Manual
Chapter 11, Hearing Conservation Program
www.osat.grc.nasa.gov
N.A.S.A. - Central Opeation of Resources for Educators
Appendix C

Pre/Post Test

Initials _______     Date ________________

Circle Yes or No

1. Do you believe you have normal hearing?  YES      NO

2. Has a doctor ever put “tubes” in your ears? YES      NO

3. Do you hear ringing or buzzing sounds in your head when there is no other noise around? YES      NO

4. Can an ear infection make your hearing worse? YES      NO

5. Can loud noise damage your hearing? YES      NO

6. The best way to protect your hearing is to:
   a. Cover your ears
   b. Wear earplugs
   c. Wear a hat
   d. Put cotton in your ears

7. You are listening to music with a few friends. The only way you can hear each other is to shout. What will you do to the volume?
   a. turn it down.
   b. leave it where it is

8. Which of the following can cause ringing in your ears?
   a. Wearing earplugs
   b. Noise
   c. Cleaning your ears with a Q-tip
   d. Talking loudly on the phone

9. Hearing aids:
   a. make sounds softer
   b. make sounds louder
   c. make sounds quieter
   d. are only for older people
10. A warning sign that music is too loud is:
   a. You can speak to your friend in a normal voice.
   b. You must shout to your friend who is next to you.
   c. You have trouble hearing the music.

11. The word “tinnitus” means: ____________________________________________

12. Which part of the ear becomes damaged by noise? _______________________

13. Where should students with hearing problems sit in the classroom?
    __________________________________________

14. Name three ways to protect your hearing.
    ________________________________
    ________________________________
    ________________________________

15. List five parts of the ear.
    ________________________________
    ________________________________
    ________________________________
    ________________________________
    ________________________________

16. Will you wear earplugs the next time you are at a music concert?   YES  NO
17. Will you wear earplugs if you are near an adult with noisy tools?   YES  NO
18. Will you wear earplugs if you are mowing the lawn?   YES  NO
LISTENING FOR LIFE

A lesson on ear anatomy, hearing loss and hearing protection.

AUDIENCE
Fourth Grade Students

OBJECTIVE
To collect data on how students interpret the lesson, “Listening for Life” to determine if this education will improve knowledge about ear anatomy, hearing loss and a willingness to wear hearing protection.

VOCABULARY
Deaf, hearing impaired, hearing aids, pinna, ear canal, eardrum, hammer, anvil, stirrup, cochlea, vibrations, sound waves, hearing protection. Some of these words are defined on the student worksheet for a visual reference.

TERMS
Two 45-minute workshops will be presented on consecutive days to two out of four classrooms. All four classrooms will receive a pre and post-test. Two of the classrooms will be reserved as the control group and receive the presentation in the near future.

MATERIALS
Chalk, chalkboard, student worksheet, colored pencils, playdough, uncooked spaghetti, overhead projector, overhead marker, hearing aid sample, stethoscope, hearing aid battery, NU-6 word list, soft foam earplugs, earmuffs.

DAY ONE

PART 1 INTRODUCTION - 5 minutes

How many people in this room have two ears? Wow.
How many people in this room like their ears? Wonderful.

Mrs/ Mr._______ has allowed me to teach you about your ears, how they work and how to protect your hearing. I will be back tomorrow at this same time to teach more about your ears.

What are some of your favorite sounds?
Sometimes if a person is having trouble hearing sounds, they visit a doctor and an audiologist. An audiologist is a person who studies sound. An audiologist also tests how well a person hears, even a 1 day old baby. They help people who wear hearing aids. Audiologists also teach people how to take care of their ears so they don’t get hearing loss.

Sometimes if a person is really having trouble hearing sounds, they wear hearing aids. If you know someone who wears hearing aids, raise your hand. People who wear hearing aids could be deaf or hearing impaired.

A person who is deaf usually cannot hear anything without a hearing aid. These persons may wear hearing aids to hear important sounds like a fire alarm or a car horn.

A person who is hearing impaired can hear without hearing aids. They may be able to hear some or all sounds with their hearing aids.

**PART 2**

**HOW SOUND TRAVELS THROUGH THE AIR - 5 minutes**

Can you see sound? (They will hopefully say NO) Can you feel sound? (Maybe some of them will say YES)

Sound is Energy. Let me show you how a sound vibration feels like.

Demonstrate humming, placing fingers below larynx. I felt a little movement in my throat. That movement is the power of sound waves.

Now it’s your turn.

Sound also needs air to vibrate. This time I want you to hum for a few seconds then plug your nose. What happens to the sound? (Let the children answer)

Here is another way that sound is created. I want everyone to hold your worksheet out in front of you. First hold it still. Is it making any sound? (Let the children answer).

Next, demonstrate waving the paper, which makes a sound, but also looks wavy, like a sound wave.

Now it’s your turn. Notice the wave movements of the paper. Notice how loud the noise gets when everyone moves his or her paper. Lots of little sounds add up to bigger sounds.
Draw a sound wave on the board, leaving room for the ear drawing, below. Instruct students to draw the wave on the worksheet, #5.

**PART 3  EAR ANATOMY - 15 minutes**

This section will introduce the name, location and function of the following ear parts: pinna, ear canal, eardrum, hammer, anvil, stirrup, cochlea, and auditory nerve. An ear model will be drawn on the board and a picture on the student worksheet will be referenced throughout the lesson.

The students will have a diagram to label as the ear parts are introduced. They can use colored pencils to draw or label their worksheet (such as purple for the pinna, brown for the canal, white for the eardrum, black for the hammer, etc).

**Pinna** – *This is the outside part of the ear. Its job is to funnel or gather the sound to enter the head. Please write the word, pinna on your worksheet where it belongs.*

**Ear Canal** – *This is the tunnel where the sound enters your head. Ear wax is made in here. Ear wax is sticky because it keeps dust and insects from going deeper into your ear. Write the word, “ear canal” on your worksheet and color it a dark color to be like a tunnel. You should never stick anything into your ear canal, not even a Q-tip. This will push the wax deeper and you might need to have a doctor remove it.*

**Ear Drum** – *The sound wave vibrates the ear drum. It’s job is to push the hammer bone for each sound wave. It also acts like a window to keep the middle of the ear dry. Label your worksheet and leave it white like the color of a drum.*

**Hammer, Anvil and Stirrup** – *These three bones live in the middle ear space behind the eardrum. Their jobs are to continue the sound vibration further into the head. These bones like to stay nice and dry in a little air pocket. Sometimes when you get a cold, fluid can enter in here from a tube that leads to the back of your throat. This is the place where ear infections occur. Sometimes a doctor will put a tiny tube in the eardrum to drain the fluid.*

**Cochlea** – *This is a small bone, shaped like a seashell, filled with water. The opening of the cochlea has a skin covering. The stirrup bone pushes the cover so the water in the cochlea moves like ocean waves.*
waves. Inside the cochlea are tiny hairs that move in the water. Each hair represents a different sound, like piano keys. The job of the tiny hairs is to tell the brain if they move. You can color in the cochlea on your worksheet and label it.

**Auditory Nerve or Hearing Nerve** – A nerve is like a telephone wire that sends a message to the brain. When the brain receives the message, it decides what kind of sound was heard. Shade in the hearing nerve on your worksheet and label it.

**REVIEW**

**REVIEW EAR ANATOMY – 3 minutes**

Erase labels of the ear on the board and re-label them with a review of the lesson. Pick students to label the drawing on the board after asking each question.

*Name the part that makes earwax.*
*Name the part that gathers sound.*
*Name the part that pushes the hammer bone.*
*Name the nerve that sends a message to the brain.*
*Name the three bones of the middle ear.*
*Name the part shaped like a seashell.*

**PART 4**

**HOW SOUND TRAVELLS THROUGH THE EAR – 5 minutes**

Demonstrate how the sound travels through the ear by referencing the drawing on the board. Draw a waveform for a soft sound (wider peaks) and a loud sound (narrow peaks). Continue the waveform as it enters the canal, vibrates the drum, moves the bones, pushes the fluid in the cochlea, moves the hair cells which “turn on” the auditory nerve then sending the message to the brain. Lastly, the “play dough cochlea” is used to demonstrate moving **hair cells** for soft and loud sounds.

Each table is given a pre-rolled form of playdough and uncooked spaghetti noodles. The playdough is rolled into a flat spiral to represent the shape of the cochlea. Instruct one person to unroll the spiral. All students can place a few spaghetti strands into the playdough.

Demonstrate how the spaghetti moves during a soft sound wave. (Run your hand over the top of the noodles very slowly)

**PART 5**

**NOISE AND TINNITUS – 5 minutes**

Next, I want to talk about Noise. What is NOISE?
Noise is any sound that we don’t want to hear. It can be a quiet sound. For example, if you’re in a library trying to concentrate on something and a book drops – that’s noise.

But more often, we think of noise as a very loud sound. Some sounds hurt the tiny hairs inside your cochlea. If you have to shout to be heard three feet away from your friend, then the noise around you is TOO LOUD.

What things are noisy? (Let them name, then help) airplanes, fireworks, shouting, stereos, etc.

Too much Loud Noise can also cause Tinnitus. (Write “Tinnitus” on the blackboard).

I want you to see this word because I never want you to hear it. Tinnitus is a ringing or other noise that’s heard in the ears when there is no outside sound being made.

It is a disturbing noise and some people can hear it all the time.

PART 6 HOW CAN NOISE DAMAGE THE EAR? – 5 minutes

Loud sounds have faster sound waves.
Draw a fast sound wave with high peaks close to each other on the board leading into the ear. Students are to draw it on their worksheet. (#6).

Continue with the “play dough” cochlea” to demonstrate how loud sounds break the spaghetti. Have the students apply some pressure to the tops of the noodles as they wave their hands over it.

(Allow time for discussion) Let them know that the hair does not grow back once it is broken.

LOUD NOISE is one way that people lose their hearing and get tinnitus.

There are three things that you can do to protect your hearing. I want you to remember for tomorrow.

The first is: TURN DOWN THE VOLUME
The second is: WALK AWAY
The third is: COVER YOUR EARS
Thank you for behaving so well. Please put your worksheet in your desk so you can use it tomorrow. Please put the tray in the zip lock bag.

I’ll see you tomorrow!
LISTENING FOR LIFE
LESSON PLAN
DAY TWO

REVIEW

EAR ANATOMY – 5 minutes

Draw the ear on the board and label it for a review of the ear. Pick students to label the drawing on the board after asking each question. The rest of the students should their own worksheet.

Students: Take out their worksheet and turn it over. On the back, you will see a similar drawing to label for this exercise.

Name the part that makes the earwax.
Name the part that gathers sound.
Name the part that pushes the hammer bone.
Name the nerve that sends a message to the brain.
Name the three bones of the middle ear.
Name the part shaped like a seashell.

REVIEW

HOW TO PROTECT YOUR HEARING – 5 minutes

There are three things that you can do to protect your hearing. I asked you to remember them from yesterday. Take a minute to write your answers down on the worksheet, #10.

Allow time for writing. Review the answers. Allow time for changing their worksheet if necessary.

The first is: TURN DOWN THE VOLUME
The second is: WALK AWAY
The third is: COVER YOUR EARS

I want to show you ways you can cover your ears.
You can use earmuffs, earplugs or the palms of your hands.

Demonstrate how to insert a foam earplug on a student.
Roll one plug between your thumb and index finger until the plug is thin enough to insert. Push it into the ear, hold it in place until it begins to expand. Take your finger away from your ear.
Ask student to describe what it feels like and what you hear.

**PART 7**

**DEMONSTRATING HEARING LOSS – 20 minutes**

The goal of this demonstration is for students to experience different levels of hearing loss through the use of soft foam earplugs and earmuffs. The participant will be asked to repeat some words or answer some questions 3–12 feet away from the speaker. During the demonstration, the students are to think about which group repeated words the easiest or who had the most difficult time repeating words and write their answers down on the worksheet supplied to them. (Questions #7 and #8)

**Group 1**

Normal hearing is presented.

*Words presented by teacher with no visual cues.*

“pass” (3 ft) “wash” (5 ft) “hush” (12 ft)

*Discussion:* Did they get the words right? Which word was repeated quickly or was more difficult to repeat?

**Group 2**

Unilateral mild to moderate hearing loss is presented. They wear one earplug.

*Words presented by teacher with no visual cues.*

“goose” (3 ft) “home” (5 ft) “rush” (12 ft)

*Discussion:* Did they get the words right? Which word was repeated quickly or was more difficult to repeat?

**Group 3**

Bilateral mild-to moderate hearing loss is presented. They wear earplugs in each ear.

*Words presented by teacher with no visual cues.*

“third” (3 ft) “white” (5 ft) “juice” (12 ft)

*Discussion:* Did they get the words right? Which word was repeated quickly or was more difficult to repeat?

**Group 4**

Bilateral moderate to severe hearing loss is presented. They wear two earplugs and earmuffs.

*Words presented by teacher with no visual cues.*
Discussion: Did they get the words right? Which word was repeated quickly or was more difficult to repeat? Was it easier to repeat the words when watching the speaker?

If you had a hearing loss like group 2 or 3, what would be some of the places in the school that would be the most difficult for you to hear? (Let them name, then help) Cafeteria, strings class, music class, gym class, recess, etc.

Give them time to answer questions #7 and #8 on the worksheet. Discuss any other interesting developments.

PART 8 HOW HEARING AIDS WORK – 5 minutes

Do you know someone who wears a hearing aid? (Let students answer).

Refer to Item #12, the “Speech Banana” on the worksheet and refer to the overhead transparency.

_doctors and audiologists use this graph to see how much hearing loss a person might have. Let us graph the hearing of the Groups in our hearing loss experiment._

Group 1 had normal hearing. This means they can hear the sounds from all the pictures and letters on this graph.

Group 2 had normal hearing in one ear and a mild hearing loss in the other ear. (Draw a line across the graph at 35 dB). This means they can hear the sounds below this line.

Group 3 had mild to moderate hearing loss in both ears. This means they can hear the sounds below this line. (Draw a line across the graph, beginning at 35 and ending at 55 dB). Some of these people wear hearing aids.

Group 4 had a moderate to severe hearing loss in both ears. This means they can hear only the sounds below this line. (Draw a line across the graph, beginning at 55 and ending at 70). Most of these people should wear hearing aids.
Now, if I were a person in Group 3, how would I hear the phrase, “Good Morning”? At the bottom of the transparency, write “Good Morning”, cross off the letters that are outside of the hearing range.

If this person wore a hearing aid, then they should be able to hear at this level (draw a new line at 20 dB above Group 3’s line).

Hearing aids make sounds louder. Sometimes the hearing impaired person does not want all sounds to be louder.

Think of some of our noisy places we talked about. Where would a hearing impaired person have the hardest time listening? (Let them guess, then guide) gym class, cafeteria, noisy classroom, music class, etc.

Demonstrate a BTE hearing aid and show some pictures of people wearing hearing aids.

**PART 10**

**Post Test – 5 minutes.**
1. An **AUDIOLOGIST** is a person who studies sound and helps people with hearing loss.

2. A person who is **DEAF** can’t hear anything without hearing aids.

3. A person who is **HEARING IMPAIRED** can hear some sounds and can hear more with the help of hearing aids.

4. Label the parts of the ear. Choose from these words. Pinna, ear canal, eardrum, hammer, anvil, stirrup, cochlea, auditory nerve.

5. Draw a sound wave from a soft sound.

6. Draw a sound wave from a loud sound.

7. What are some things that are noisy?
   1. ______________________________
   2. ______________________________
   3. ______________________________

8. Who repeated the words the best? (Circle your answer.)
   a. The group with nothing on their ears.
b. The group with an earplug in one ear.
c. The group with an earplug in each ear.
d. The group with earplugs and earmuffs on their ears.

9. Which group had the most difficult time repeating words?
   a. The group with nothing on their ears.
   b. The group with an earplug in one ear.
   c. The group with an earplug in each ear.
   d. The group with earplugs and earmuffs on their ears.

10. What three things can you do to protect your hearing?
    1. _________________________
    2. _________________________
    3. _________________________

11. Label the parts of the ear as we review them in class.

12. This graph is known as the “Speech Banana”.