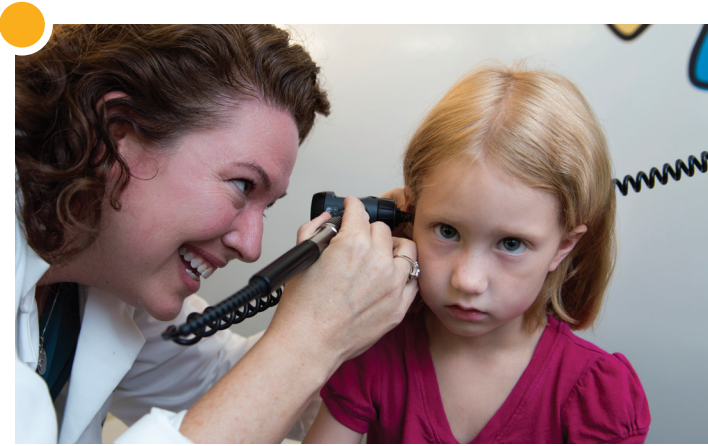


3. UNADDRESSED HEARING PROBLEMS

This section contains: a description of the types of hearing problems that affect children; the prevalence of hearing problems; unmet needs for hearing screening, diagnosis and treatment; and evidence on the learning consequences of unaddressed hearing problems.



Definitions

Normal hearing was defined in 1965 by the American Academy of Ophthalmology and Otolaryngology (AAOO) as any hearing loss up to 26 dB. This level of hearing loss is the point at which an individual begins to find it difficult to understand typical speech in a quiet environment. The AAOO guidelines around normal hearing have not changed since this cutoff was established and are supported by the American Medical Association and the American Academy of Audiology.

Hearing deficits are categorized and defined in various ways, and there is variation in defining levels of hearing loss across countries, states, and health care providers. There are no widely agreed upon definitions for all types and levels of hearing loss. The American Speech-Language-Hearing Association (ASHA) categorizes and defines hearing loss primarily by type, degree, and configuration.¹⁰³

Type of Hearing Loss (as defined by ASHA)

- **Sensorineural hearing loss (SNHL)** is the most common type of permanent hearing loss and “happens when there is damage to the inner ear (cochlea) or to the nerve pathways from the inner ear to the brain.” Audible speech may be unclear or sound muffled. This type of hearing loss can usually not be corrected with medical treatment or surgery. SNHL can be caused by:
 - Drugs that are toxic to hearing
 - Hearing loss that runs in the family (genetic or hereditary)
 - Head trauma
 - Malformation of the inner ear
 - Exposure to loud noise
- **Conductive hearing loss** “occurs when sound is not sent easily through the outer ear canal to the eardrum and the tiny bones (ossicles) of the middle ear.” Sounds will seem softer and less easy to hear. Conductive hearing loss often can be resolved medically or surgically. Conductive hearing loss can be caused by
 - Fluid in the middle ear from colds or allergies
 - Ear infection (otitis media)
 - Poor eustachian tube function
 - Hole in the eardrum
 - Tumors in the middle ear
 - Too much earwax (cerumen)
 - Swimmer’s ear (external otitis)
 - Foreign body in the ear canal
 - Malformation of the outer ear, ear canal, or middle ear
- **Mixed hearing loss** occurs when a conductive hearing loss happens in combination with an SNHL.

Degree of Hearing Loss (as defined by ASHA)

Degree of hearing loss is measured in decibels (dB).¹⁰⁴ The commonly used categories of degree of hearing loss are shown in the table below.

| Degree of Hearing Loss | Range (dB HL) |
|------------------------|---------------|
| Normal | -10 to 15 |
| Slight/Minimal | 16 to 25 |
| Mild | 26 to 40 |
| Moderate | 41 to 55 |
| Moderately Severe | 56 to 70 |
| Severe | 71 to 90 |
| Profound | 91+ |

Other important descriptors of hearing loss

- **Bilateral hearing loss** is hearing loss in both ears. **Unilateral hearing loss** is hearing loss in only one ear.
- **Progressive hearing loss** is hearing loss that worsens over time. **Sudden hearing loss** happens quickly and requires immediate medical attention to determine cause and treatment.
- **Fluctuating hearing loss** is hearing loss (usually conductive) that changes over time, sometime getting better, sometimes getting worse.
- **Symmetrical hearing loss** means the degree of hearing loss is the same in both ears. **Asymmetrical hearing loss** means the degree of hearing loss differs between ears.
- For school-age children, **hearing impairment** is defined as unilateral or bilateral sensorineural and/or conductive hearing loss greater than 20 dB HL in the frequency region most important for speech recognition (approximately 500 to 4000 Hz). **Educationally significant hearing loss** has been defined as “any hearing loss that potentially interferes with access to classroom instruction and impacts a child or youth’s ability to communicate, learn, and develop peer relationships.”¹⁰⁵

Prevalence

Prevalence of congenital hearing loss in newborns ranges between 1 and 6 per 1,000 babies born in the US each year with some degree of permanent hearing loss.¹⁰⁶ Although 95% of newborns receive hearing screening in the US, screening will still miss children who have undetected hearing loss and/or acquired hearing loss at school age.¹⁰⁷ An estimated 9 to 10 children out of every 1000 have identifiable permanent hearing loss in one or both ears by school-age.¹⁰⁸ The Third National Health and Nutrition Examination Survey data shows almost 15% of school aged children in the United States have some degree of hearing loss (more than 7 million in the 6-19 age range).¹⁰⁹ Noise-induced hearing loss is an increasing concern for children and adolescents. In 2001, Niskar et al. (2001) estimated that 12.5% of U.S. children (ages 6 to 19) have evidence of noise-induced hearing threshold change, and concerns exist for loud headphone, stereo, and TV exposure.¹¹⁰

Unmet need for services

The Joint Committee on Infant Hearing (JCIH) outlines guidelines for early hearing detection and intervention programs. Universal newborn hearing screening (UNHS) has become a standard of practice in the United States in the past two decades. JCIH first endorsed the goal of universal detection of newborn hearing loss in a 1994 position statement. In 1999, the American Academy of Pediatrics (AAP) released a statement which officially recommended universal newborn hearing screening (UNHS).¹¹¹ UNHS was also integrated into Healthy People 2010 goals.

The American Academy of Pediatrics (AAP) Bright Futures Guidelines recommend children to be screened at the newborn visit and well child visits at age 4, 5, 6, 8, and 10.¹¹² For school aged children, ASHA recommendations support completion of a hearing screening for all children in grades K, 1, 2, 3, 7, and 11.¹¹³ ASHA lists the following risk factors as warranting the need for a hearing screening in other years:

1. Parent/care provider, health care provider, teacher, or other school personnel have concerns regarding hearing, speech, language, or learning abilities;
2. Family history of late or delayed onset hereditary hearing loss;
3. Recurrent or persistent otitis media with effusion for at least 3 months;
4. Craniofacial anomalies, including those with morphological abnormalities of the pinna and ear canal;
5. Stigmata or other findings associated with a syndrome known to include sensorineural and/or conductive hearing loss;
6. Head trauma with loss of consciousness;
7. Reported exposure to potentially damaging noise levels or ototoxic drugs.

Additionally, ASHA supports hearing screening upon entrance into special education, when a child repeats a grade, or when a child enters a new school system without record of having passed a previous screening.¹¹⁴

Current state of hearing screening

Most children with hearing loss present at birth are identifiable by newborn and infant hearing screening.¹¹⁵ Screening newborns for hearing loss is now standard and occurs for more than 95% of infants born in the US.¹¹⁶ However, despite a 95% screening rate for newborns, many children still reach school age with untreated or undiagnosed hearing deficits. Hearing loss can remain unaddressed in children for the following reasons¹¹⁷:

- Hearing screenings use equipment targeting hearing loss of 30-40 dB or more. ASHA guidelines support a minimal screening level of 20 dB HL for school aged children because literature supports a possible risk for academic and communicative difficulties even from minimal hearing loss (16-25 dB HL).¹¹⁸
- All infants failing a screen do not receive diagnostic services. Nearly half of newborn infants who fail the initial screening do not have the follow up that is needed to confirm hearing loss, and start early intervention as required.¹¹⁹
- Universal newborn hearing screening doesn't identify children with late onset, acquired, or many cases of progressive hearing loss. Hearing loss also can be acquired during infancy or childhood for various reasons. Infectious diseases, especially meningitis and cytomegalovirus, are a leading cause of acquired hearing loss. Trauma to the nervous system, damaging noise levels, and ototoxic drugs can all place a child at risk as well. Otitis media is a common cause of hearing loss, though in this case, often temporary or reversible.¹²⁰

Regulation for child hearing screening, diagnosis, and treatment varies greatly among states. A 2012-2013 review of state Medicaid laws and policies showed most states mandate providers to follow the Bright Futures/AAP schedule for screening, however some states use an outdated version of the guidelines and others use a completely separate schedule. Only half of states have any regulations that guide providers in content of age-appropriate screening and over half of states provide no regulated guidelines at all for how providers should refer children based on results of a screening.¹²¹ Likewise, state governments vary in regulation of hearing screenings in the school setting.¹²²

In addition, monitoring of hearing screening is mostly unregulated and inconsistent across states. In 1999, Centers for Medicaid Services (CMS) eliminated a requirement for states to report on the number of children receiving hearing screening, diagnosis of hearing problems, and treatment services. As a result, there is no longer a good source of data regarding provision of hearing screening services for children.

Impact on learning

The American Academy of Audiology (AAA) released the *Childhood Hearing Screening Guidelines* report in September 2011. A Subcommittee on Childhood Hearing was formed to produce the report outlining recommendations based on current evidence for hearing screening of children age 6 months through high school. The AAA guidelines include the current state of literature linking hearing deficits to educational outcomes. This report is a primary source for information presented here as the content from the AAA related to education outcomes is thorough and accurately based in the current literature.¹²³

A growing body of literature finds that deaf or hard of hearing infants who are identified and receive intervention by no later than 6 months of age perform significantly better on school-related measures than those who don't receive intervention before 6 months of age. School-related measures include vocabulary, articulation, intelligibility, social adjustment, and behavior.¹²⁴ This supports the benefit of early identification and intervention through universal newborn hearing screening as a mitigator of poor academic outcomes later in life for children with hearing loss.

For school aged children, the setting of the classroom is an environment requiring students and teachers to be able to accurately transmit and receive speech in order for effective learning to occur.¹²⁵ Research supports that in a typical classroom, often noisy with poor acoustics, even fluctuating hearing loss interferes with reception of speech.¹²⁶ The effects of hearing loss on students vary depending on type and severity of hearing deficit.

A child with severe hearing loss will most likely be identified by a parent or doctor before the age of school entry. Therefore, the focus of literature for school aged children tends towards hearing loss that is milder, unilateral, late onset (i.e. high frequency hearing loss), or fluctuating (i.e. hearing loss caused by ear infections). The *Childhood Hearing Screening Guidelines* released by the AAA highlights the literature showing educational impact of hearing loss for these categories: (1) Minimal sensorineural hearing loss (2) Unilateral hearing loss (3) Hearing loss due to otitis media with effusion.¹²⁷ Summary of content is presented here.

Minimal sensorineural hearing loss and impact on academics

Milder levels of hearing loss have been a focus of research for several decades. Minimal sensorineural hearing loss (MSHL) can be bilateral, unilateral, or high frequency. A study by Bess, Dodd-Murphy and Parker in 1998 explored outcomes for a group of 1200 3rd, 6th, and 9th grade children with minimal sensorineural hearing loss¹²⁸. The study found that 3rd grade children with MSHL performed lower on education tests. For 6th and 9th graders with MSHL, greater dysfunction in behavior, energy, stress, social support, and self-esteem was found compared to children with normal hearing. Also, the study found 37%

of children with MSHL failed at least one grade.¹²⁹ Another study found children with MSHL were 4.3 times more likely to have speech-language deficits, and higher rates of social emotional difficulties including lower self-esteem and less energy.¹³⁰

Unilateral hearing loss and impact on academics

Historically, it was commonly accepted that unilateral hearing loss (UHL) did not have an impact on a child's language and speech development because it was assumed these would not be influenced if a child had one normal functioning ear. However, research from the 80s and 90s as well as more recent literature, supports the potential for UHL to impact learning.

A study by Bess et. al (1982) explored the link between unilateral hearing loss (UHL) and a child's ability to function well in the classroom setting. Children with hearing loss of 20 dB and greater in one ear were included. Results showed children with UHL had a slightly higher incidence of behavior problems and 37% of children with unilateral hearing loss had repeated a grade. No difference was found in language skills and intelligence between children with UHL and children with normal hearing.¹³¹

In 2004, Lieu and colleagues conducted a literature review of research from 1966 through 2003 that explored UHL and educational outcomes. The review reflected an increased likelihood of children with UHL repeating a grade (rates ranged from 22%-37% in studies). Research also supported some increased need for more educational assistance for children with UHL (rates ranged from 12%-41%). Literature was mixed around language and speech delays, with some studies showing delays for children with UHL.¹³²

In 2010, Lieu et al. conducted a study pairing 74 children aged 6-12 years with UHL with a normal hearing sibling to explore differences in educational outcomes. Siblings with UHL performed worse on language tests than normal hearing siblings. Family income and mother's level of education were found to be independent factors for lower language scores. This study suggests children in poverty with UHL are at an even higher risk of negative impacts on language.¹³³

Hearing loss related to ear infection and impact on academics

Hearing deficits due to ear infections are potentially of special interest for children in poverty. Otitis media with effusion (OME), fluid in the middle ear that does not present signs of an acute ear infection, makes up more than 90% of all middle ear pathology in children.¹³⁴ OME can cause conductive hearing loss. Around 25% of school aged children, primarily in early grades, experience OME sometime throughout the school year.¹³⁵ Literature exploring the link between hearing deficits due to recurrent ear infections (otitis media) and academic outcomes is highly mixed with no clear consensus. There is a breadth of literature from the 1990s that links otitis media to educational outcomes like speech and language delays, reading problems, and attention problems. However, this literature has received much criticism. A 2004 literature review by Roberts et al. concluded that the link between hearing loss caused by OME and outcomes including development of speech and language, auditory processing, academics, attention, and behavior was not clear. However, for children from underserved populations who might receive fewer well child care visits than recommended and therefore potentially experience longer lasting or recurrent episodes of OME, the risk of poor academic outcomes may be higher. Further research is needed in this population to explore the link more closely.

Conclusions

Key points:

- Despite early screening and intervention recommendations, hearing loss is still prevalent in school aged populations. Late onset hearing loss due to exposure to loud sounds in older children (i.e. use of headphones) is also becoming a concern.
- Hearing problems and their consequences are best addressed before school age. However, universal newborn screening and routine hearing screens during well child checks still fail to capture all children with hearing loss. In addition, children who are identified as having hearing loss at an early age frequently do not receive services as early or robustly as needed to minimize the impact of hearing loss on development, particularly lower income populations who have barriers such as lack of access to insurance or transportation.
- Hearing loss can affect a child's ability to speak and learn. Even minimal hearing loss or loss of hearing in one ear can affect school performance. Research is mixed, but also shows a possible link between recurrent ear infections and ability to learn.