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Connecting Hearing Loss: Causes, Treatments, and Prevention

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ABSTRACT

Everyone has five senses: touch, taste, smell, sight, and hearing. Each of these plays a vital role in one's life. But what happens when you don't have one of these and are forced to live with it? Hearing loss is a condition that affects one of these five senses: hearing. Those affected by this condition lose their hearing. It may be a partial loss or complete loss, but they cannot hear as one normally should. This condition is quickly growing to be common around the globe, affecting a wide variety of people. What makes these conditions so unique is that there are a multitude of causes for them. This paper focuses on some of these causes to find a connection. It was found that one connection between all of these causes is that they are a result of some sort of physical damage or injury to the ear. But this injury's location and specifications are different in each case, yet the result is also hearing loss. Furthermore, this paper offers solutions and prevention for some of the different cases of hearing loss that can be encountered; thereby preparing people to avoid this condition.

Introduction

Defined by a partial or complete loss of hearing in one or both ears, hearing loss has grown to become one of the most common conditions faced by humans around the globe. Today around 20% of the world's population from elders to young children live with this condition (Hearing Loss: Causes, Risks, Prevention). Hearing loss can be categorized into one of three types: conductive, sensorineural, and mixed. Conductive hearing loss involves the outer or middle ear while sensorineural hearing loss involves the inner ear, others suffer from a mixed hearing loss which combines conductive and sensorineural hearing loss. As a result of many causes, hearing loss can be sudden or develop over some time. However once affected by this condition it cannot be reversed and despite any treatments, one will never be able to hear the way they once did. Therefore, it is imperative to recognize these causes and identify a connection between them to better learn how to protect oneself from hearing loss. Hearing is a multistep process that starts with sound waves. Sound waves enter through the outer ear and then travel to the eardrum through the ear canal, a narrow passageway. When the sound waves reach the eardrum, they cause vibrations that are then sent to the malleus, incus, and stapes, three tiny bones that lie in the middle ear. These bones amplify the vibrations before sending them to the cochlea in the inner ear. When the vibrations reach the cochlea, they cause ripples in the fluid inside which then creates a traveling wave along the basilar membrane. The waves then pass the hair cells. Hair cells near the wide end of the cochlea can detect high-pitched sounds while hair cells near the center of the cochlea detect low-pitched sounds. When the hair cells move up and down stereocilia, hair-like projections that sit on top of the hair cells, bend after they bump into an overlying structure. The bending leads to channels that exist at the tips of the stereocilia, to open up thus creating an electrical signal when chemicals rush into the cells. This signal travels through the auditory nerve into the brain where it turns into sound. Despite all of these intricate steps, many things could go wrong causing hearing loss.

This paper will delve into detail into the different causes of hearing loss ranging from genetic causes to environmental causes through cross-examination of prior research conducted on the subject. It will also provide information on how to protect one from these different causes and the treatments available in case one is affected by

one. Overall, this paper will focus on educating society on how to protect themselves from this condition and thus enabling everyone to lead happy and healthy lives.

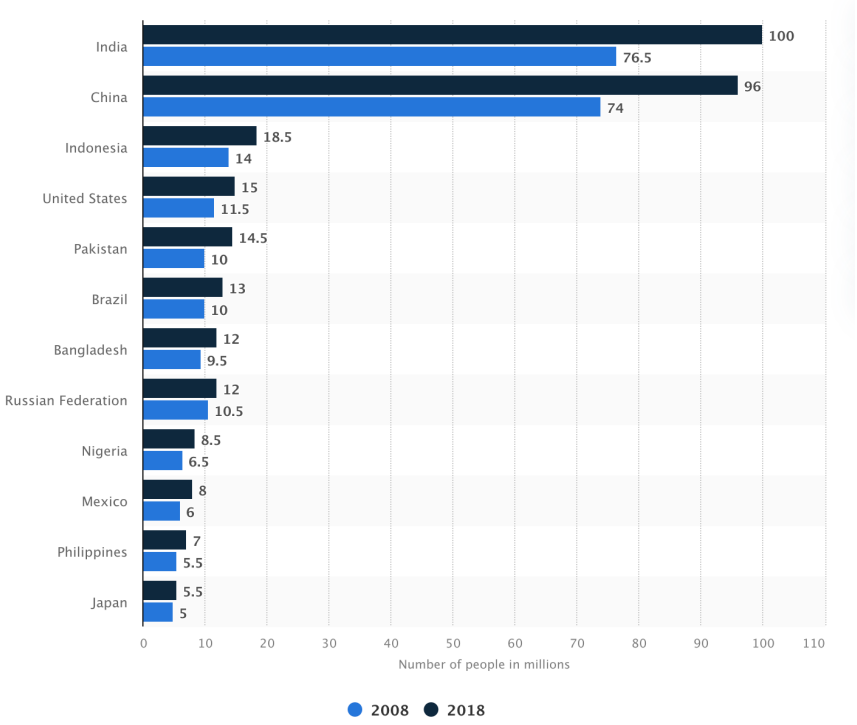

Figure 1. From 2008 to 2018 many countries around the world saw an increase in hearing loss cases. The trend will continue going upwards in recent years unless a change is made. Source: Statista, https://www.statista.com/statistics/888666/number-of-people-with-hearing-loss-worldwide-select-countries/

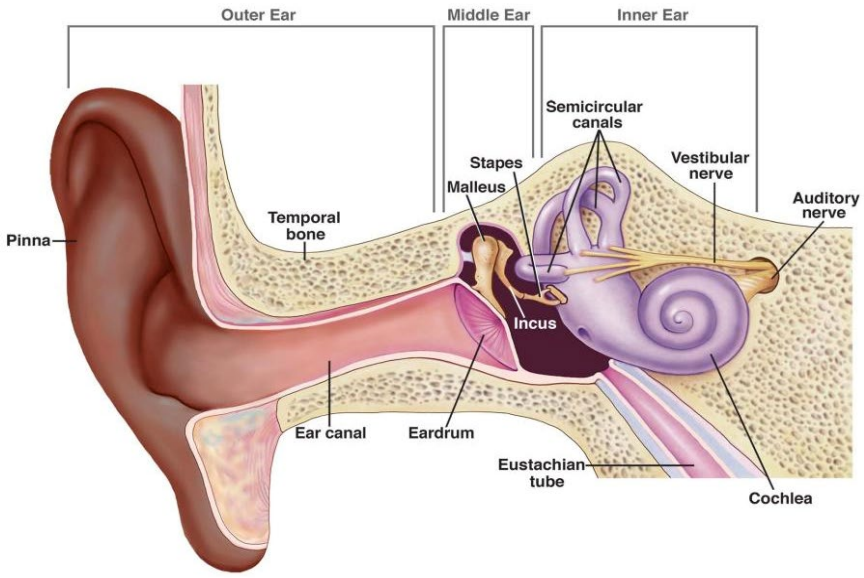

Figure 2. A labeled diagram of the ear shows the different parts of the ear involved in the hearing process. Source: National Institute on Deafness and Other Communication Disorders, https://www.nidcd.nih.gov/health/how-do-we-hear

Genetic Causes of Hearing Loss

Hereditary hearing loss can be syndromic or non-syndromic. Syndromic hearing loss aligns with malformations of the outer ear, other organs, or other organ systems while non-syndromic hearing loss has no visible symptoms but is heavily associated with issues in the middle or inner ears (Shearer et al., 2017). Over 50% of hearing loss cases are caused by genetic causes, with 70% being non-syndromic, 80% of cases being autosomal recessive while 15% being autosomal dominant, and 1-2% being mitochondrial or male chromosomal linked. (Yang et al., 2019). There are currently over 140 genes that are related to hearing loss (Yang et al., 2019).

Congenital hearing loss

Congenital hearing loss is a hearing loss that occurs at birth. This is mostly present in newborns due to one of their parents carrying this gene. Children born with congenital hearing loss may feel its effects immediately or may gradually develop the condition over time. Congenital hearing loss can also develop throughout the pregnancy through maternal infection, diabetes, or the use of drugs and alcohol during the pregnancy. (Congenital Hearing Loss) It is also often a result of birth complications including premature birth, low birth weight, or birth injuries (Congenital Hearing Loss).

This is tested immediately after the child's birth but may be difficult to identify if the condition is only mild. However, it can take up to adulthood to develop. So many may be living with it without feeling its effects (Congenital Hearing Loss)

Syndromes

Otosclerosis is a syndrome that is mostly inherited or caused by maternal infections during pregnancy. This causes abnormal bone growth of the stapes bone in the middle ear thus inhibiting normal vibrations from occurring. The sound that the inner ear will receive will be reduced thus causing hearing loss. (Otosclerosis)

Caused by defects in either chromosomes one, six, or 12 Stickler syndrome affects the collagen used to produce joint cartilage and vitreous (Stickler Syndrome). In the ear, this syndrome affects the inner ear where the bulk of the hearing process takes place (Sticker Syndrome). Thus, due to the lack of cartilage many with this syndrome also suffer from hearing loss.

Pendred syndrome is also hereditary and can be found at birth or in adulthood. It results from a defect in the production of the thyroid hormone and can be characterized by a growth in the thyroid gland near the Adam’s apple (Pendred Syndrome). This growth causes hearing loss that will minimally change over the years.

Due to a mutation in genes, the control formation of connective tissue in Ehlers-Danlos syndrome causes the joints in the middle ear connecting the three bones to become hypermobile (Ehlers-Danlos Syndrome). Thus hindering the effectiveness of the sounds being conducted from the middle ear to the inner ear.

Treacher Collins syndrome is a result of a defect in the fifth chromosome and causes physical defects near the face and head (Treacher Collins Syndrome). One of these defects can exist in the outer and middle ear which will then prevent sound conduction to nerve endings (Treacher Collins Syndrome). This can be a result of parents having the disease or could also come up spontaneously in newborns.

Affecting mostly males, Alport syndrome progressively deteriorates the kidney and reduces kidney function. It is caused by a mutation in the collagen production gene and often results in hearing loss as a symptom (Alport Syndrome). Any hearing loss that exists, as a result, is permanent.

Treatments

Most genetic hearing losses are not treatable and are often only combatible through the use of a hearing aid or a cochlear implant. These devices will help the patients be able to hear normally. Other genetic hearing loss can be fixed through surgery. An example of this is hearing loss caused by otosclerosis. This surgery involves the replacement of the abnormal bone growth with an implant, through stapedotomy, or by a prosthesis, through stapedectomy (Otosclerosis). Yet other cases of genetic hearing loss cannot be treated at all. Occasionally, their symptoms could be treated but the hearing loss itself will remain permanent.

Protection

Unfortunately, genetic hearing loss is not a preventable condition. However, expecting parents can test themselves before the pregnancy for any gene mutation that may possess to prepare themselves for the possibility of their child suffering from hearing loss. Sometimes when these genetic traits are caught in advance early intervention may be possible through genetic counseling to prevent serious cases of hearing loss (Yang et al., 2019). Furthermore, when pregnant it is important for the mother to keep herself safe from any infections and to avoid using any drugs or alcohol. Lastly, make sure to get oneself and one's child tested throughout the pregnancy and take notice of any changes occurring as they may result in a serious condition after birth. By taking these necessary cautions it would be possible to evade the development of genetic hearing loss.

Environmental Causes of Hearing Loss

Although not as common as genetic hearing loss, environmental hearing loss could affect about 50% of people (Shearer et al., 2017). This hearing loss can exist in both or only just one ear and often is a result of ear care negligence. Environmental hearing loss mostly affects adults or older people if it often develops over time to be severe, but regardless it can affect people of all ages. This type of hearing loss cannot be detected until someone is affected by it making it very important to look out for all of its different causes.

Noise

Noise exists in everyday life and is impossible to avoid but this factor plays the largest role in hearing loss. Because it exists everywhere and anywhere, noise is a constant presence in one's life. Most common noises are at the safe level of 70dBA and will most likely not cause hearing loss (Noise-Induced Hearing Loss). However when noises are too loud, and over 85 dBA, for either a brief or long time damage could occur in the inner ear damaging the hair cells, which can never grow back, leading to hearing loss (Noise-Induced Hearing Loss). Noise-induced hearing loss can be sudden or develop over a while and it can affect any age.

Presbycusis

Age-related hearing loss also known as Presbycusis can exist in one of four categories: sensory, neural, metabolic, and mechanical (Mills et al., 1982). In sensory cells, the outer and inner hair cells host the major pathology which is indicated by large losses of spiral ganglion cells in the neural (Mills et al., 1982). Metabolic shows the stria vascularis of the cochlea and the major pathology site and mechanical postulates that the elasticity of the basilar member and other structures is reduced (Mills et al., 1982). Aging often causes physical changes in the inner ear or auditory nerve thus resulting in hearing loss. A few cases of Presbycusis show it to be a genetic condition however most are not (National Institute on Aging et al., 2018).

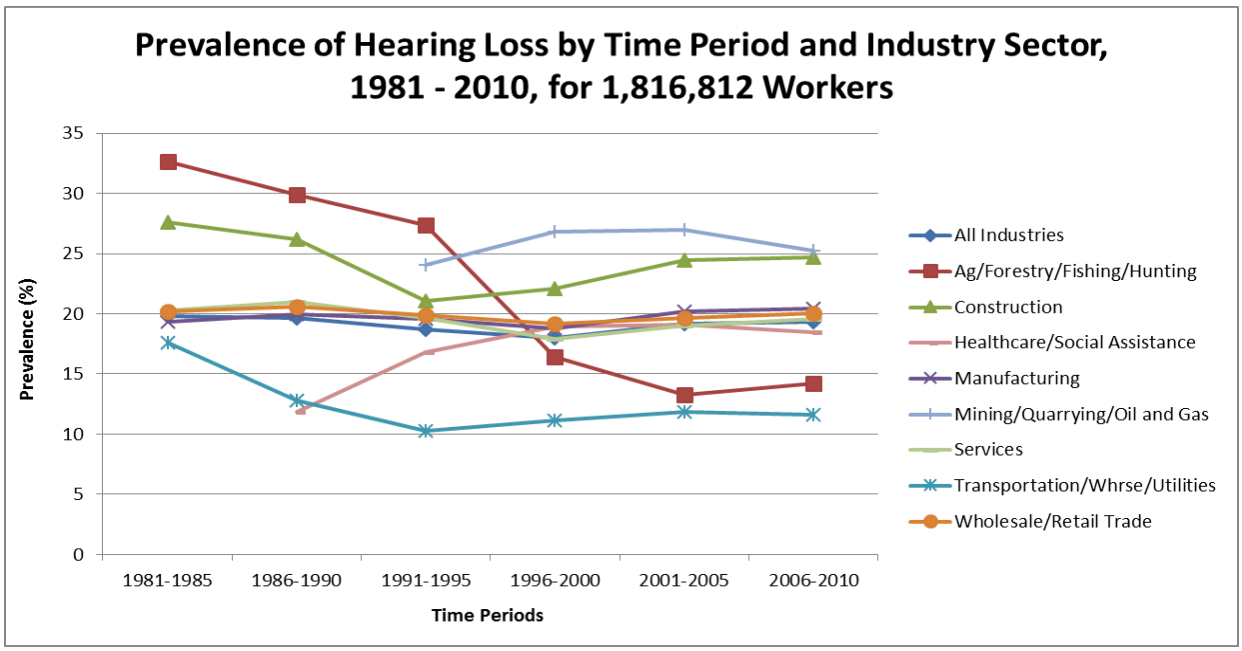

Figure 3. Shows the change over time of hearing loss due to different careers. Workers in many of the careers shown spend their days surrounded by loud noises that may affect their hearing in the future. Source: Center for Disease Control and Prevention, https://www.cdc.gov/niosh/topics/ohl/overall.html

Infections

Viral infections such as rubella and mumps cause deterioration of sensory cells, stria vascularis, tectorial membrane, and nerve supply (Mills et al., 1982). This deterioration leads to sensorineural hearing loss by affecting the inner ear (Mills et al., 1982). Other common examples are influenza, adenovirus, and herpes (Mills et al., 1982). If affected by a severe degree of any of these infections the patient can lose, progressively or suddenly, their hearing.

Bacterial infections such as ear infections or Swimmers Ear can also affect one's hearing. These infections can be caught in common places such as a swimming pool. The bacteria travel into the middle or inner ear and affect the eustachian tubes by inflaming or blocking them, thus affecting the path of the sound waves and inhibiting hearing (Ear Infection (Middle Ear)). Most ear infections are temporary but if they are not treated can grow to a severe stage. Bacterial ear infections are most common in young children.

Treatment

No treatment exists to rid of hearing loss. Most people affected by this condition live their lives using a hearing aid or a cochlear implant. For hearing loss that results from noise or aging these devices are the only way to hear again. But for hearing loss that may result from infections treating the infection could cure the hearing loss. For example, bacterial infections can be rid of with antibiotics and viral infections can be rid of with other medicine or rest.

Protection

Until genetic hearing loss environmental hearing loss can be protected against in many ways. To protect against noise-induced hearing loss those in the constant presence of loud noises every day should wear protection like earplugs or noise canceling headphones. Since noise-induced hearing loss can occur anywhere one needs to be aware of their surroundings and take the appropriate measure to protect themselves and their loved ones. Protection such as ear plugs

can also be used to protect against infections. If people make sure to not let foreign objects, such as earbuds, or foreign substances, such as unfiltered water, into their ear they will drastically reduce their chances of being affected by a viral or bacterial infection. In the case that one is infected it is important to take all measures possible to rid of the infection, through medication, before it becomes serious. Lastly, although aging cannot be prevented, those in fear of developing age-related hearing loss should make sure to continuously get checked and bring up any concerns they may have to their doctor to get help early on. If people make sure to protect themselves against these causes of hearing loss many can prevent themselves from suffering from this condition.

Conclusion

Between both genetic hearing loss and environmental hearing loss one factor stays common and that is physical damage to the ear. However, this damage varies based on the causes. The damage could be a growth or a deterioration and it could happen in the outer, middle, or inner ear. Since all cases of hearing loss vary from each other it is difficult to pinpoint an exact similarity between them. Thus, it is important to realize that hearing loss can affect a person from anywhere and that person must be able to protect themselves against it. Whether it be using physical protection, such as earplugs or noise-canceling headphones, in places of loud noise or getting genetically tested to conduct early intervention of a potential hearing loss situation. By becoming more aware of these natural solutions society can learn to decrease the extremity of cases of hearing loss in recent years. Future research on this subject can revolve around finding a universal treatment for hearing loss that doesn't involve a technological device, possibly surgery or medication. Another potential research opportunity is finding the most effective way of preventing all types of hearing loss. This could be a new technological device for those working in loud areas or a smaller device to be worn when traveling through louder areas.

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