Chapter

Childhood Hearing Loss in Developing Countries: From Multidisciplinary Team Work to Public Health

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Abstract

This chapter will highlight the common causes of hearing loss in children and emphasize on the fact that most of the hearing loss is due to causes that are preventable. We know that hearing loss in childhood not only impacts on the child's learning and social interaction with the child's peers and society, but also has economic implications when the child grows into an adult. Public health awareness is therefore paramount in preventing a large chunk of the hearing gloss and therefore greatly contributes to making sure that the child grows into a productive citizen of the society that the child grows or lives in.

Keywords: Hearing loss, children, pediatrics

1. Introduction

Hearing loss can be mild i.e. 20–40 decibels (dB) hearing level (HL), moderate (41–60 dB HL), severe (61–80 dB HL) or profound (81 dB HL or greater) [1, 2]. The term "Minimal Hearing Loss" refers to any of the following hearing loss categories: unilateral hearing loss (at least 20 dB HL in the impaired ear), mild bilateral hearing loss (20–40 dB HL in both ears), or high-frequency hearing loss (at least 25 dB HL at two frequencies more than 2 KHz in both ears) [3, 4]. Hearing loss is disabling if it exceeds 30 dB in the better hearing ear in children before the age of 15 years [1], or more than 40 dB in older individuals [1, 5].

Hearing loss can also be classified as conductive, sensorineural or mixed. Conductive hearing loss occurs when the child hears bone-conducted sound signals better than the air-conducted signals, and can be traced to problems in the outer or middle ear while having a normal inner ear function. Sensorineural hearing loss occurs when there is a problem in the inner ear or beyond, i.e. in the cochlea along the 8th cranial nerve or in the brain. Mixed hearing loss occurs when a child has both conductive and sensorineural hearing loss in the same ear [6]. Most cases of profound hearing loss tend to be sensorineural, which was estimated in the year 1999 to have a worldwide incidence of 1 in 2,000 live births and to affect 6 per 1,000 children by the age of 18 years [7]. In South Africa, Le Roux et al. reported that in the year 2015, approximately 95% of under-5 children with profound hearing loss had sensorineural hearing loss [8].

Hearing loss has been described as the most common disabling condition worldwide [9]. In 2018, global estimates by the World Health Organization indicated that 460 million people worldwide i.e. approximately 5% of the world population, live with disabling hearing loss, and the number is expected to exceed 9% by the year 2050 [10]. Around 7% of the people with disabling hearing loss are children and it is very worrisome to note that 5 out of every 1000 infants are born with or develop disabling hearing loss in early childhood [11].

Most of the people with hearing loss are found in developing countries [5, 12], where it has been estimated that at least 2000 infants with hearing loss are born daily [13], highlighting the grave need for more attention to hearing loss in these parts of the world.

2. Causes of hearing loss

Genetic causes account for 50–60% of hearing loss in babies [14] and approximately 80% of prelingual hearing loss [15]. In both cases, a majority of the hearing loss is sensorineural [16]. Genetic hearing loss tends to be quite prevalent in regions where consanguinity is very high, especially where marriage among first cousins occurs quite often [17, 18]. However, most hearing loss in children overall is non-genetic.

In young children, mild and moderate grades of hearing loss are most commonly caused by either acute otitis media or otitis media with effusion [19]. Chronic ear infections feature highly among the leading causes of hearing loss worldwide [11, 20]. Over 30% of hearing loss in children is resultant from diseases such as measles, mumps, rubella, meningitis and ear infections [11]. Furthermore, greater than 19% of childhood hearing loss in the world is attributable to meningitis and rubella alone [21]. Estimates indicate that bacterial meningitis is attributed to causation of at least 6% of all cases of sensorineural hearing loss in children [17, 22, 23], and ranks as the most common cause of acquired sensorineural hearing loss in infants and children [17]. Congenital rubella syndrome ranks among the foremost causes of acquired hearing loss in countries that do not have a rubella vaccination programme [24, 25].

Noise from toys, cell phones and personal listening devices is a concerning and rising cause of hearing loss among school-aged children [17]. Over time, more and more children are being exposed to hazardous levels of noise, and children's hearing levels are vulnerable to these exposures [26]. It is known that repeated exposure to loud sounds for prolonged periods irreversibly damages the delicate hair cells lining the basilar membrane of the cochlea, thereby leading to sensorineural hearing loss [27, 28]. This damage is often insidious and incremental [17, 29, 30]. It was reported in 2001 that 1 out of 12 children aged 6–11 years in the United States of America already had noise-induced shifts in their hearing thresholds [26]. The World Health organization has estimated that 1.1 billion people aged between 12 and 35 years are at risk of developing hearing loss due to noise exposure in recreational settings such as concerts and sporting events and through the use of personal audio devices [11]. Obviously, noise- induced hearing loss is largely preventable through raising awareness of risks, legislation and following safe listening practices [11].

Treatment in a neonatal intensive-care unit is another risk factor for hearing loss in children, especially during the neonatal period [31, 32]. This has been estimated to increase the likelihood of neonatal hearing loss tenfold [33], more especially if the child is admitted in the neonatal intensive care for more than 5 days [8, 34, 35] believed to be due to its frequent association with comorbid conditions known to

cause hearing loss, e.g. neonatal hyperbilirubinaemia [8, 36, 37], congenital infections [38], prematurity, aminoglycoside use, and mechanical ventilation [17], as well as any other serious illness in the neonatal period [39]. It is quite reassuring to note, from the foregoing, that most causes of hearing loss in children are treatable and preventable [9]. This has been the observation in at least two-thirds of all cases of hearing loss in the African region, where more than half of the hearing loss in the preschool population could be linked to middle ear infections and cerumen impaction [40].

3. Effects of hearing loss

Hearing is closely linked to the development of language and speech in young children [41, 42]. Significant lags in language development, cognition and academic achievement have been noted to result from childhood hearing loss [5, 17, 43, 44]. Compared to children with normal hearing, children with hearing loss have significantly lower reading comprehension, literacy skills, socio-emotional development and academic achievement [45, 46]. It has been reported that children with hearing loss often have a reading ability that is at a lower level than what is expected for the class they have been enrolled in, even by the time they graduate from high school [47]. There is increasing evidence that the mathematical scores of children with hearing loss are significantly lower compared to those of normal-hearing children, from pre-school all the way to high school [48, 49].

These facts have been observed even in children with mild and moderate hearing loss [9, 50–53]. A failure rate as high as 37% for at least one grade has been reported among students with minimal hearing impairment versus 3% for normal hearing students [3]. It has also been reported that children with minimal hearing loss often display a reduced capacity to multitask [54]. Children with minimal hearing loss, quite sadly, may only be identified much later in their education [55] because the children who have higher degrees of hearing loss tend to be diagnosed earlier, and so they are more likely to receive attention sooner than those with lesser degrees of hearing loss [56, 57]. Minimal hearing loss is, therefore, "not inconsequential" [58]. It should be brought to the fore that all the challenges faced by children with minimal hearing loss, as described here, occur among these children irrespective of the type of minimal hearing loss, be it unilateral, mild bilateral or high-frequency hearing loss [4, 59, 60].

All these observations make children with hearing loss to have a reduced chance of being enrolled into tertiary and vocational institutions [61]. A hearing assessment is therefore highly recommended for every child at the time of school enrolment, and more especially for those who have a low rate of academic performance [42].

Without early intervention, the poor academic performance of children with hearing loss persists [55], and this then leads largely to significant economic impacts both in their childhood and adulthood [10]. For instance, in the year 2000, severe to profound hearing impairment was estimated to cost the taxpayer $297 000 over the lifetime of an affected individual in the United States, and this lifetime cost was projected to exceed $ 1 million in children with prelingual onset of their hearing loss [62]. In the year 2015, annual global costs of unaddressed hearing loss of at least moderate degree in children aged between 5 and 14 years were estimated to lie between US$ 750–790 billion [63, 64]. Of these, US$ 67 to 107 billion were costs to health care systems, excluding costs of hearing devices and cochlear implants, and US$ 4 billion were costs to the education sector, including special needs. It is concerning to note that 63–73% of the total costs are incurred in developing

countries, and approximately 10% of all these costs are among the people who have hearing loss in the sub-Saharan African region [63]. In the same year, the total average medical costs in South Africa for a child in the first 5 and 10 years post–cochlear implantation were estimated at $27 000 and $40 000 respectively [8]. Adults who have hearing loss have challenges at the workplace, which can be translated into productivity costs. Globally, these costs were estimated at US$ 105 billion in 2015 [63]. The reasons for the productivity costs in people with hearing loss are manifold, and lucidly highlight the relationship between hearing ability, employment and socioeconomic status. There is overwhelming evidence to suggest that most adults with hearing loss have fewer opportunities for employment compared to those with normal hearing [65–71] and go into retirement earlier than their normal- hearing counterparts [70, 72]. Furthermore hearing loss restricts both people's career opportunities and their levels of income. Most adults with hearing loss have less income [70] as they are more likely to have completed elementary education only [71] or may not even have received any schooling at all, as it so often happens in developing countries [64]. Productivity costs contribute the biggest chunk to the costs incurred due to hearing loss [62, 63]. Both a lack of intervention services for people with hearing loss and a lack of access to the few services that are available have been postulated as being significantly contributory to the proportionally higher unemployment levels among people with hearing loss in developing countries [5].

4. Delayed diagnosis of children with hearing loss in developing countries

It is therefore very important that hearing loss in children should be identified as early as possible, in order to optimize language, cognitive and social development as well as reduce the economic impact of hearing loss as described above. However, it is sad that in Africa, a good number of children with hearing loss are diagnosed late. For instance, the only study among children with hearing loss in Botswana reported in the year 2018 that the median age at which children were first referred for hearing screening to the audiology clinic of the country's main tertiary hospital was 6.7 years [73]. This finding is rather concerning, considering that children get enrolled into standard 1 of the primary school classes when they reach the age of 6 years in Botswana. Retrospective data analysis in an audiology clinic in the Free State Province of South Africa showed median ages of 3.4 years and 3.7 years at first visit and at diagnosis, respectively [74]. Le Roux et al. characterized a cohort of children from Gauteng and Free State Provinces in South Africa and reported late diagnosis of profound hearing loss with a mean age of 1.3 years at first diagnosis. The delay in both referral and diagnosis resulted in more delays in initial hearing aid fitting, early intervention services and cochlear implant placement occurring at 1.57 years, 1.62 years and 3.6 years respectively [8]. Late diagnosis of hearing loss used to be a common occurrence in first-world countries before they introduced universal screening for hearing loss there. For example, in 1998, the mean age of diagnosis of permanent hearing loss in Germany was 6.2 years for mild hearing loss, 4.4 years for moderate hearing loss, 2.5 years for severe hearing loss and 1.9 years for profound hearing loss [57]. Though not frequent, late diagnosis does occur even in those areas of the world where a universal neonatal hearing screening programme is in place. For instance, in one region of Canada in 2018, children were first assessed for possibility of hearing loss at a median age of 3.7 months, only to be confirmed as having hearing loss at a median age of 13.8 months [75].

5. The value of early diagnosis of hearing loss

Early detection and treatment of children with hearing loss lead to great improvements in health-related quality of life [76], and very effectively mitigate the negative impact of hearing loss on the child's speech, language, educational achievement, and vocational outcomes [5, 8, 10, 55, 65, 77]. Children who are identified as having hearing loss by the time they reach the age of 6 months and receive appropriate intervention have significantly better language scores than those who are identified at a later age, irrespective of sex, socioeconomic status, ethnicity, associated disabilities and severity of the hearing loss [41, 40, 78]. Furthermore, these early-identified children go on to have average language scores that fall within the normal range by the time they reach the ages of 1 to 5 years, matching the scores of their peers who have no hearing loss [5, 13, 41, 44, 56, 78–82]. This observation gets even better when the children are identified between the ages of 0 and 2 months [79].

It is now confirmed that when identification of and intervention for childhood hearing loss occur before the child reaches the age of 6 months, he/she performs as much as 20 to 40 percentile points higher on school-related measures (vocabulary, articulation, intelligibility, social adjustment, and behavior). There is, therefore, an urgent need to identify infants with hearing loss as early as possible, preferably before they reach the age of 6 months so that appropriate interventions can be instituted the soonest [41, 83, 84].

6. Caring for children with hearing loss requires a multidisciplinary approach

The care of children with hearing loss requires a multi-disciplinary approach so that they are enrolled into multiple early intervention services i.e. habilitative, rehabilitative, or educational programmes as soon as possible while they are still within the most sensitive time period for optimal language and communication development. Children need over 20,000 hours of parent-infant interactions and listening experience in the first 5 years of life to create a neural framework for both spoken language and literacy of the child [85].

These intervention services include the fitting of hearing aids and frequency-modulation devices (especially for children with bilateral sensorineural hearing loss) and cochlear implants, coupled with special auditory training, of which sign-language education plays a vital role [17, 86]. The proper management of a child with hearing loss requires the availability of specialized medical staff like pediatricians, family physicians, audiologists, otolaryngologists, educators of the deaf, speech language pathologists and medical geneticists to work in concert [45].

6.1 Provision of hearing aids

Guidelines on childhood hearing loss developed by the World Health Organization recommend that children with moderate to severe hearing loss in the better ear in the frequency range of 500 Hz to 4 kHz should be prioritized for hearing aids and services as these are the children who are expected to derive the most benefit from hearing interventions [87]. There is a dire shortage of hearing aids for people with hearing loss worldwide, and the current rate of manufacturing is only enough for 10% of people requiring the hearing aids utmost [5]. This is quite a worrisome state for developing countries, where approximately 20% of people with hearing loss qualify for hearing aids [5], and yet the available hearing aids are enough for only 3% of these people [64].

6.2 Fitting of cochlear implants

Cochlear implants are generally reserved for those children who fail to derive substantial benefit from hearing aids and sustained auditory training. It has been reported that both the quality of life, speech performance and the academic performance of such children improves impressively following cochlear implantation, with better results observed when the implantation is done at a younger age [17, 88]. For instance, it has been shown that after one year post- implantation, children who receive cochlear implants at an early age achieve significant improvements in speech perception compared to those who receive them later, regardless of the cause of or the age at onset of hearing loss [89]. Similarly, it has also been demonstrated that the performance of children with hearing loss is directly proportional to the length of cochlear implant use and inversely proportional to the age at which the implant is placed, with the children implanted between the ages of 12–36 months outperforming those implanted at 36–60 months [76, 90]. Better still is the finding that the academic performance of children with cochlear implants can fall within 1SD of that of their normal hearing peers, and more than half of these children can enroll into college in later life [91]. In addition to all these benefits, the use of cochlear implants has also been proven to be a cost-effective strategy in the management of hearing loss in children in developing countries of sub- Saharan Africa and Asia [92, 93].

6.3 Early enrolment into speech and language therapy

Teaching sign language to children with hearing loss, coupled with provision of captions and sign language interpretation on television are very beneficial to children with hearing loss [5]. Children with hearing loss who become proficient in sign language very early end up achieving better reading skills [94, 95], receptive and expressive language excellence and better academic performance overall, be it in English reading comprehension, mathematic prowess, et cetera [94]. It is therefore very important that children with severe to profound hearing loss should be enrolled into special education services as soon as they are diagnosed in order for them to be taught sign language early.

7. Public health measures for childhood hearing loss

There are great challenges in developing countries that militate against the early diagnosis and adequate provision of intervention services for children with hearing loss. For instance, most of these countries have both a dearth of the recommended services and meager utilization of those services that are available [96–98]. These countries also have a chronic shortage of specialized personnel that are needed to manage the child with hearing loss vis-à-vis their huge population burdens [96]. In view of these grotesque economic and resource limitations, it is quite prudent for developing countries to focus more on public health, since hearing loss can be avoided through proven cost- effective public health measures [5].

7.1 Making childhood hearing loss a public health priority in developing countries

Owing to its unseen nature, hearing loss in childhood does not attract the attention, in terms of public health funding and services, that is commensurate with the short- and long-term effects that it causes, and should rank among the top public health priorities in developing countries [99]. Up to two-thirds of childhood hearing

loss is preventable through public health actions, like strengthening maternal and child healthcare programmes including immunization, implementing infant and school-based hearing screening at the time of enrolment as well as for those children who consistently have low academic performance, training healthcare professionals in hearing care, making hearing devices and communication therapies accessible, regulating and monitoring the use of ototoxic medicines and environmental noise and raising awareness to promote hearing care and reduce stigma [11].

7.2 Intensification of childhood immunization programmes

Data from more developed countries suggest that the incidence of acquired sensorineural hearing loss has waned owing to better neonatal care as well as sustained robust immunization programmes [17]. In these countries, a good case in point is the marked reduction in the incidence of congenital rubella syndrome following the introduction of the rubella vaccine, with a drastic reduction in congenital rubella syndrome cases by 99% between1969 and 1999 in the United States [100], and from about 50 per year between 1971 and 1975 to just over 20 per year between 1986 and 1990 in the United Kingdom [101]. Furthermore, the incidence of childhood bacterial meningitis in the developed world has reduced significantly with the use of immunizations against *Haemophilus influenzae* type B and *Streptococcus pneumoniae* [19, 102]. The pneumococcal conjugate vaccines have been found to be immunogenic even in children as young as 2 months old [19], and not only have they been noted to have decreased the occurrence of childhood meningitis, but also that of otitis media, where S pneumoniae is the most common bacterial pathogen [103]. Thus a sustained focus on childhood immunization programmes in developing countries should go a long way in preventing both conductive and sensorineural hearing loss in children.

7.3 Introduction of hearing loss screening programmes for children

Both the American Academy of Pediatrics' Joint Committee on Infant Hearing, and the American Academy of Audiology have published guidelines that recommend early detection of and intervention for infants with hearing loss [45, 104]. They place emphasis on the goal of early detection and intervention for hearing loss, which is to maximize linguistic competence and literacy development for children who have hearing loss so that they do not fall behind their hearing unimpaired peers in communication, cognition, reading, and social–emotional development. It is henceforth strongly recommended that all infants should be screened for hearing loss by the age of 1 month. The infants who fail this screening should be referred to audiologists for a comprehensive audiological evaluation before the age of 3 months without delay. If hearing loss is confirmed, the baby should receive appropriate intervention before the age of 6 months [45]. This recommendation has led to the call for and establishment of universal hearing screening programmes in most developed countries, with the notably impressive reduction in the mean age of diagnosis of sensorineural hearing loss from 12 to 18 months to utmost 6 months, thus enabling timely enrolment into early intervention services [105–108] whose benefits have already been described above. Countries which have instituted universal newborn hearing screening have seen dramatic increases in the number of children identified early with hearing loss who achieve normal cognitive ability [41]. Therefore, developing countries need to strongly consider introducing universal newborn hearing screening programmes in their health systems in order to identify children with hearing loss early and enroll them into appropriate intervention services, as data from developed countries continues to prove that the identification

of hearing loss by 6 months of age through universal newborn hearing screening programmes, followed by appropriate intervention, is not only cost- effective in the long- term [109, 110] but is also the most effective strategy for the normal development of language in infants and toddlers with hearing loss [84, 110]. There are challenges with the implementation of universal newborn hearing screening programme in developing countries. In South Africa, for example, despite the efforts of the Professional Board for Speech, Language and Hearing Professions of the Health Professions Council of South Africa (HPCSA) to introduce universal newborn hearing screening in the country and screen 98% of all newborn infants by 2010 [111, 112], hearing screening is still not yet standardized and is being implemented in a haphazard manner, with most health institutions doing the screening at an individual level and mostly targeting those neonates with risk factors for hearing loss [113, 114]. The reasons cited for this state of affairs include the Department of Health's prioritization of life-threatening illnesses instead of hearing loss (thus affecting budgetary allocations) and shortage of health personnel like audiologists [113, 115, 116], as well as a shortage of equipment [117]. It appears that these are the main issues in other developing countries as well [77]. However, it would still be a good step for developing countries to start with targeted screening of infants with risk factors for hearing loss and then escalate to universal screening in future because targeted screening has also been proven to be cost-effective [63, 109, 118], although it may miss close to half of neonates with hearing loss, especially those who may not have obvious risk factors for hearing loss [119]. Given the above challenges regarding the introduction of hearing screening programmes in developing countries, it would be very beneficial if these countries would also focus on improving parental awareness of important speech and hearing milestones in children. No parental concern about hearing loss in a child should be ignored but should rather necessitate immediate scheduling for hearing screening by clinicians to assess for hearing loss [120], as parents often begin to suspect hearing loss in their children way before it is confirmed [3, 45], with a high positive predictive value [121].

As discussed earlier, bacterial meningitis is a leading cause of sensorineural hearing loss in children [17, 22–24]. There are indications that this kind of hearing loss occurs very early in most children with bacterial meningitis [122] and does not improve with the passage of time [123]. It is therefore incumbent on developing countries to make sure that every child who is diagnosed of bacterial meningitis is screened for hearing loss [24].

Developing countries must seriously consider making it mandatory that every child should have a hearing screen at the time of school enrolment. The South African government has taken a commendable lead among African countries by gazetting a school health policy that requires every child to be screened for hearing loss before starting the foundation phase of learning [124]. It would be great if other developing countries would follow suit. The school health policies should go further to require screening for hearing loss for every child whose academic performance is consistently below par [42], on one hand because the magnitude and multiplicity of the academic challenges that children with hearing loss encounter often tend to be much more grotesque than the severity of their hearing loss [17], and on the other because screening for hearing loss among school children has been proven to be a cost- effective strategy [63].

7.4 Introduction and intensification of educational programmes, public awareness and hearing- savvy legislation

Given the high rate of genetic causes of hearing loss in babies [14], developing countries need to focus more seriously on educational programmes in order to

create public awareness sufficient enough to transcend cultural practices and reduce the incidence of genetic sensorineural hearing loss [17]. Furthermore, the public needs to be made aware as much as possible about the deleterious effect of uncontrolled noise exposure both in the home and in the workplace [26]. Governments need to pass legislation for, develop and enforce standards for acceptable range of sound output emanated from toys and make it mandatory for toy manufacturers to issue appropriate warnings about the noise levels that their toys produce [27].

Health care providers need regular refresher courses on prevention of hearing loss in children through the rational use of ototoxic drugs like anti- malarials and aminoglycosides [11]. Primary health care providers should also be trained in primary ear care, as this has been proven to be cost-effective in the reduction of the incidence of chronic ear infections [5].

Policy makers, Health care workers and the public at large need to be made aware that minimal hearing loss is very common [125] and it has as deleterious consequences in children as do the other types of hearing loss [24, 126, 127]. Rather than focus primarily on bilateral hearing loss of higher degrees, health care professionals need to be constantly aware of the negative effects that minimal hearing loss has on the affected child, regardless of its type (i.e. unilateral, mild bilateral or high-frequency hearing loss), as described above.

8. Conclusion

In developing countries, hearing loss should be considered a public health priority for which concerted efforts must be made to prevent it by all means. Children who have hearing loss should be identified as early as possible and be enrolled into appropriate intervention services so that they can enjoy equal opportunities in life. The World Health Organization can contribute greatly in preventing and reducing hearing loss by helping to fund public health programmes and intervention services for hearing loss in developing countries, as well as lobbying developed countries to reduce the costs of hearing aids and cochlear implants.

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References

[1] World Health Organization. Grades of hearing impairment. www.who.int/pbd/deafness/hearing_impairment_grades/en/. (Accessed 11, December, 2020).

[2] Jamison, DT, Breman, JG, Measham, AR. Disease Control Priorities in Developing Countries. 2nd ed. New York, NY: Oxford University Press; 2006.

[3] Olusanyo, BO, Newton, VE. Global burden of childhood hearing impairment and disease control priorities for developing countries. Lancet. 2007; 369:1314-1317. doi:10.1016/S0140-6736(07)60602-3. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)60602-3/fulltext. (Accessed 12 December, 2020).

[4] Waleed B. Alshuaib, Jasem M. Al-Kandari and Sonia M. Hasan (December 2nd 2015). Classification of Hearing Loss, Update On Hearing Loss, Fayez Bahmad Jr., IntechOpen, doi: 10.5772/61835. https://www.intechopen.com/books/update-on-hearing-loss/classification-of-hearing-loss. (Accessed 12 December, 2020).

[5] Billings KR, Kenna MA. Causes of pediatric sensorineural hearing loss: yesterday and today. Arch Otolaryngol Head Neck Surg. 1999 May; 125(5):517-21. doi: 10.1001/archotol.125.5.517. PMID: 10326808. https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/vol/125/pg/517. (Accessed 12 December, 2020).

[6] le Roux, T, Swanepoel de, W, Louw, A, Vinck, B, Tshifularo, M. Profound childhood hearing loss in a South African cohort: risk profile, diagnosis and age of intervention. Int J Pediatr Otorhinolaryngol. 2015; 79:8-14. doi:10.1016/j.ijporl.2014.09.033. https://repository.up.ac.za/bitstream/handle/2263/44059/LeRoux_Profound_2015.pdf?sequence=1&isAllowed=y. (Accessed 12 December, 2020).

[7] World Health Organization. Millions of people in the world have a hearing loss that can be treated or prevented. www.who.int/pbd/deafness/news/Millionslivewithhearingloss.pdf. (Accessed 7 December, 2020).

[8] World Health Organization. Deafness and hearing loss. www.who.int/mediacentre/factsheets/fs300/en/. (Accessed 29 November, 2020).

[9] World Health Organization. 10 facts about deafness. www.who.int/features/factfiles/deafness/en/. (Accessed December 10, 2020).

[10] Stevens G, Flaxman S, Brunskill E, Mascarenhas M, Mathers CD, Finucane M; Global Burden of Disease Hearing Loss Expert Group. Global and regional hearing impairment prevalence: an analysis of 42 studies in 29 countries. Eur J Public Health. 2013 Feb; 23(1):146-52. doi: 10.1093/eurpub/ckr176. Epub 2011 Dec 24. PMID: 22197756. https://www.researchgate.net/publication/265010948_Global_and_Regional_Hearing_Impairment_Prevalence/link/54b913960cf28faced626b76/download. (Accessed on 12 December, 2020).

[11] Swanepoel, D, Störbeck, C, Friedland, P. Early hearing detection and intervention in South Africa. Int J Pediatr Otorhinolaryngol. 2009; 73:783-786. doi:10.1016/j.ijporl.2009.01.007. https://repository.up.ac.za/bitstream/handle/2263/9157/Swanepoel_Early(2009).pdf?sequence=1. (Accessed on 11 December, 2020).

[12] Centres for Disease Control and Prevention (CDC). Hearing loss in children. https://www.cdc.gov/ncbddd/

hearingloss/genetics.html. (Accessed on 28 November, 2020).

[13] Shearer AE, Hildebrand MS, Smith RJH. Hereditary Hearing Loss and Deafness Overview. 1999 Feb 14 [Updated 2017 Jul 27]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2020. https://www.ncbi.nlm.nih.gov/books/NBK1434/. (Accessed on December 10, 2020).

[14] Schrijver I. Hereditary non-syndromic sensorineural hearing loss: transforming silence to sound. J Mol Diagn. 2004 Nov; 6(4):275-84. doi: 10.1016/S1525-1578(10)60522-3. PMID: 15507665; PMCID: PMC1867482. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1867482/ (Accessed on 17 December, 2020).

[15] Smith, RJ, Bale, JF, White, KR. Sensorineural hearing loss in children. Lancet. 2005; 365:879-890. doi:10.1016/S0140-6736(05)71047-3. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(05)71047-3/fulltext. (Accessed on 11 December, 2020).

[16] Ben Arab S, Masmoudi S, Beltaief N, Hachicha S, Ayadi H. Consanguinity and endogamy in Northern Tunisia and its impact on non-syndromic deafness. Genet Epidemiol. 2004 Jul; 27(1):74-79. doi: 10.1002/gepi.10321. PMID: 15185405.

[17] Rovers MM, Schilder AG, Zielhuis GA, Rosenfeld RM. Otitis media. Lancet. 2004 Feb 7; 363(9407):465-73. doi: 10.1016/S0140-6736(04)15495-0. Erratum in: Lancet. 2004 Mar 27; 363(9414):1080. PMID: 14962529. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(04)15495-0/fulltext. (Accessed on 12 December, 2020).

[18] Smith, A, Hatcher, J. Preventing deafness in Africa's children. Afr Health. 1992; 15:33-35. PMID: 12285914.

[19] World Health Organization. Childhood hearing loss. Strategies for prevention and care. apps.who.int/iris/bitstream/10665/204632/1/9789241510325_eng.pdf. (Accessed November 30, 2020).

[20] Riordan A, Thomson A, Hodgson J, Hart A. Children who are seen but not referred: hearing assessment after bacterial meningitis. Br J Audiol. 1993 Dec; 27(6):375-377. doi: 10.3109/03005369309076713. PMID: 8054894.

[21] Fortnum, H, Davis, A. Hearing impairment in children after bacterial meningitis: incidence and resource implications. Br J Audiol. 1993; 27:43-52. doi:10.3109/03005369309077889.

[22] Wild NJ, Sheppard S, Smithells RW, Holzel H, Jones G. Onset and severity of hearing loss due to congenital rubella infection. Arch Dis Child. 1989; 64(9):1280-3. doi: 10.1136/adc.64.9.1280. PMID: 2817948; PMCID: PMC1792732. https://adc.bmj.com/content/archdischild/64/9/1280.full.pdf. (Accessed 12 December, 2020).

[23] Banatvala JE, Brown DW. Rubella. Lancet. 2004 Apr 3; 363(9415):1127-37. doi: 10.1016/S0140-6736(04)15897-2. PMID: 15064032.https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(04)15897-2/fulltext. (Accessed 12 December, 2020).

[24] Niskar AS, Kieszak SM, Holmes AE, Esteban E, Rubin C, Brody DJ. Estimated prevalence of noise-induced hearing threshold shifts among children 6 to 19 years of age: the Third National Health and Nutrition Examination Survey, 1988-1994, United States. Pediatrics. 2001 Jul; 108(1):40-3. doi: 10.1542/peds.108.1.40. PMID: 11433052. https://pediatrics.aappublications.org/content/108/1/40.long. (Accessed 11 December, 2020).

[25] Joubert K, Ellis M. Noise levels of toys for children between the ages of

birth and 3 years in South Africa. South African Journal of Child Health. 2012; 6(1):12-6. http://www.sajch.org.za/index.php/SAJCH/article/view/381/287. (Accessed 12 December, 2020).

[26] Rabinowitz PM. Noise-induced hearing loss. Am Fam Physician. 2000 May 1; 61(9):2749-56, 2759-60. PMID: 10821155. https://www.aafp.org/afp/2000/0501/p2749.html. (Accessed 11 December, 2020).

[27] Lees RE, Roberts JH, Wald Z. Noise induced hearing loss and leisure activities of young people: a pilot study. Can J Public Health. 1985 May-Jun; 76(3):171-173. PMID: 4016649.

[28] Mostafapour SP, Lahargoue K, Gates GA. Noise-induced hearing loss in young adults: the role of personal listening devices and other sources of leisure noise. Laryngoscope. 1998 Dec; 108(12):1832-1839. doi: 10.1097/00005537-199812000-00013. PMID: 9851500.

[29] Sutton GJ, Rowe SJ. Risk factors for childhood sensorineural hearing loss in the Oxford region. Br J Audiol. 1997 Feb; 31(1):39-54. doi: 10.3109/03005364000000007. PMID: 9056042.

[30] Joint Committee on Infant Hearing; American Academy of Audiology; American Academy of Pediatrics; American Speech-Language-Hearing Association; Directors of Speech and Hearing Programs in State Health and Welfare Agencies. Year 2000 position statement: principles and guidelines for early hearing detection and intervention programs. Joint Committee on Infant Hearing, American Academy of Audiology, American Academy of Pediatrics, American Speech-Language-Hearing Association, and Directors of Speech and Hearing Programs in State Health and Welfare Agencies. Pediatrics. 2000 Oct; 106(4):798-817. doi: 10.1542/peds.106.4.798. PMID: 11015525. https://pediatrics.aappublications.org/content/106/4/798.short. (Accessed 12 December, 2020).

[31] Davis A, Wood S. The epidemiology of childhood hearing impairment: factor relevant to planning of services. Br J Audiol. 1992 Apr; 26(2):77-90. doi: 10.3109/03005369209077875. PMID: 1628120.

[32] Swanepoel de W, Johl L, Pienaar D. Childhood hearing loss and risk profile in a South African population. Int J Pediatr Otorhinolaryngol. 2013 Mar; 77(3):394-398. doi: 10.1016/j.ijporl.2012.11.034. Epub 2012 Dec 23. PMID: 23266158.

[33] Young, NM, Reilly, BK, Burke, L. Limitations of universal newborn hearing screening in early identification of pediatric cochlear implant candidates. Arch Otolaryngol Head Neck Surg. 2011; 137:230-234. doi:10.1001/archoto.2011.4. https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/716187. (Accessed 16 December, 2020).

[34] Ching, TY, Day, J, Dillon, H. Impact of the presence of auditory neuropathy spectrum disorder (ANSD) on outcomes of children at three years of age. Int J Audiol. 2013; 52(suppl 2):S55-S64. doi:10.3109/14992027.2013.796532. https://www.researchgate.net/publication/259385465_Impact_of_the_presence_of_auditory_neuropathy_spectrum_disorder_ANSD_on_outcomes_of_children_at_three_years_of_age. (Accessed 16 December, 2020).

[35] Beutner D, Foerst A, Lang-Roth R, von Wedel H, Walger M. Risk factors for auditory neuropathy/auditory synaptopathy. ORL J Otorhinolaryngol Relat Spec. 2007; 69(4):239-244. doi: 10.1159/000101545. Epub 2007 Apr 4. PMID: 17409783.

[36] Cohen, BE, Durstenfeld, A, Roehm, PC. Viral causes of hearing loss: a review for hearing health professionals. Trends

Hear. 2014; 18:2331216514541361. doi:10.1177/2331216514541361. https://journals.sagepub.com/doi/full/10.1177/2331216514541361. (Accessed 10 December, 2020).

[37] Olusanya, BO, Wirz, SL, Luxon, LM. Community-based infant hearing screening for early detection of permanent hearing loss in Lagos, Nigeria: a cross-sectional study. Bull World Health Organ. 2008; 86:956-963. doi:10.2471/blt.07.050005. https://www.researchgate.net/publication/317452507_Community-based_infant_hearing_screening_for_early_detection_of_permanent_hearing_loss_in_Lagos_Nigeria_a_cross-sectional_study. (Accessed 12 December, 2020).

[38] Mulwafu W, Kuper H, Ensink RJ. Prevalence and causes of hearing impairment in Africa. Trop Med Int Health. 2016 Feb; 21(2):158-65. doi: 10.1111/tmi.12640. Epub 2015 Dec 14. PMID: 26584722. https://onlinelibrary.wiley.com/doi/pdf/10.1111/tmi.12640. (Accessed 9 December, 2020).

[39] Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early- and later-identified children with hearing loss. Pediatrics. 1998 Nov; 102(5):1161-71. doi: 10.1542/peds.102.5.1161. PMID: 9794949. https://pediatrics.aappublications.org/content/102/5/1161. (Accessed 11 December, 2020).

[40] Elbeltagy R. Prevalence of Mild Hearing Loss in Schoolchildren and its Association with their School Performance. Int Arch Otorhinolaryngol. 2020 Jan; 24(1):e93-e98. doi: 10.1055/s-0039-1695024. Epub 2019 Nov 4. PMID: 31892964; PMCID: PMC6828564. https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0039-1695024. (Accessed 13 December, 2020).

[41] Calderon R, Bargones J, Sidman S. Characteristics of hearing families and their young deaf and hard of hearing children. Early intervention follow-up. Am Ann Deaf. 1998 Oct; 143(4):347-362. doi: 10.1353/aad.2012.0100. PMID: 9842062.

[42] Kennedy CR, McCann DC, Campbell MJ, Law CM, Mullee M, Petrou S, Watkin P, Worsfold S, Yuen HM, Stevenson J. Language ability after early detection of permanent childhood hearing impairment. N Engl J Med. 2006 May 18; 354(20):2131-41. doi: 10.1056/NEJMoa054915. PMID: 16707750. https://www.nejm.org/doi/full/10.1056/nejmoa054915. (Accessed 16 December, 2020).

[43] American Academy of Pediatrics, Joint Committee on Infant Hearing. Year 2007 position statement: Principles and guidelines for early hearing detection and intervention programs. Pediatrics. 2007 Oct; 120(4):898-921. doi: 10.1542/peds.2007-2333. PMID: 17908777. https://pediatrics.aappublications.org/content/120/4/898.short. (Accessed 10 December, 2020).

[44] Qi S, Mitchell RE. Large-scale academic achievement testing of deaf and hard-of-hearing students: past, present, and future. J Deaf Stud Deaf Educ. 2012 Winter; 17(1):1-18. doi: 10.1093/deafed/enr028. Epub 2011 Jun 28. PMID: 21712463. https://academic.oup.com/jdsde/article/17/1/1/359085. (Accessed 12 December, 2020).

[45] Cawthon SW. Schools for the deaf and the No Child Left Behind Act. Am Ann Deaf. 2004 Fall; 149(4):314-23. doi: 10.1353/aad.2005.0002. PMID: 15646936. https://pubmed.ncbi.nlm.nih.gov/15646936/. (Accessed 12 December, 2020).

[46] Kritzer KL. Barely started and already left behind: a descriptive analysis of the mathematics ability demonstrated by young deaf children. J Deaf Stud Deaf Educ. 2009 Fall; 14(4):409-21. doi: 10.1093/deafed/

enp015. Epub 2009 Jul 13. PMID: 19596725. https://academic.oup.com/jdsde/article/14/4/409/490973. (Accessed 12 December, 2020).

[47] Marschark M, Shaver DM, Nagle KM, Newman LA. Predicting the Academic Achievement of Deaf and Hard-of-Hearing Students From Individual, Household, Communication, and Educational Factors. Except Child. 2015 Apr; 81(3):350-369. doi: 10.1177/0014402914563700. Epub 2015 Jan 20. PMID: 26549890; PMCID: PMC4634639. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4634639/. (Accessed 12 December, 2020).

[48] Brannon, JB, Murray, T. The spoken syntax of normal, hard-of-hearing, and deaf children. J Speech Lang Hear Res. 1966:9:604-610. doi:10.1044/jshr.0904.604. doi:10.1044/jshr.0904.604.

[49] Davis J. Performance of young hearing-impaired children on a test of basic concepts. J Speech Hear Res. 1974 Sep; 17(3):342-351. doi: 10.1044/jshr.1703.342. PMID: 4423160.

[50] Davis JM, Elfenbein J, Schum R, Bentler RA. Effects of mild and moderate hearing impairments on language, educational, and psychosocial behavior of children. J Speech Hear Disord. 1986 Feb; 51(1):53-62. doi: 10.1044/jshd.5101.53. PMID: 3945060. https://pubmed.ncbi.nlm.nih.gov/3945060/. (Accessed 12 December, 2020).

[51] Lieu JE. Speech-language and educational consequences of unilateral hearing loss in children. Arch Otolaryngol Head Neck Surg. 2004 May;130(5):524-30. doi: 10.1001/archotol.130.5.524. PMID: 15148171. https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/10.1001/archotol.130.5.524. (Accessed 16 December, 2020).

[52] Bess FH, Dodd-Murphy J, Parker RA. Children with minimal sensorineural hearing loss: prevalence, educational performance, and functional status. Ear Hear. 1998 Oct; 19(5):339-354. doi: 10.1097/00003446-199810000-00001. PMID: 9796643.

[53] McFadden B, Pittman A. Effect of minimal hearing loss on children's ability to multitask in quiet and in noise. Lang Speech Hear Serv Sch. 2008 Jul; 39(3):342-51. doi: 10.1044/0161-1461(2008/032). PMID: 18596291; PMCID: PMC2562266. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2562266/. (Accessed 16 December, 2020).

[54] Allen, TE. Patterns of academic achievement among hearing impaired students: 1974 and 1983. In: Schildroth, AN, Karchmer, MA eds. Deaf Children in America. Boston, MA: College-Hill Press; 1986:161-206.

[55] Durieux-Smith A, Fitzpatrick E, Whittingham J. Universal newborn hearing screening: a question of evidence. Int J Audiol. 2008 Jan; 47(1):1-10. doi: 10.1080/14992020701703547. PMID: 18196481.

[56] Finckh-Krämer U, Spormann-Lagodzinski ME, Nubel K, Hess M, Gross M. Wird die Diagnose bei persistierenden kindlichen Hörstörungen immer noch zu spät gestellt? [Is diagnosis of persistent pediatric hearing loss still made too late?]. HNO. 1998 Jun; 46(6):598-602. German. doi: 10.1007/s001060050279. PMID: 9677494.

[57] Tharpe, Anne & Sladen, Douglas & Murphy, Jeanne Dodd & Boney, Stephen. (2009). Minimal Hearing Loss in Children: Minimal But Not Inconsequential. Seminars in Hearing. 30. 080-093. 10.1055/s-0029-1215437. https://www.researchgate.net/profile/Anne_Tharpe/publication/

247475706_Minimal_Hearing_Loss_in_Children_Minimal_But_Not_Inconsequential/links/56490b9e08ae9f9c13ebc72c/Minimal-Hearing-Loss-in-Children-Minimal-But-Not-Inconsequential.pdf. (Accessed 16 December, 2020).

[58] Garberoglio CL, Cawthon SW, Bond M. Assessing English literacy as a predictor of postschool outcomes in the lives of deaf individuals. J Deaf Stud Deaf Educ. 2014 Jan; 19(1):50-67. doi: 10.1093/deafed/ent038. Epub 2013 Sep 27. PMID: 24077877. https://academic.oup.com/jdsde/article/19/1/50/393984. (Accessed 16 December, 2020).

[59] Mohr PE, Feldman JJ, Dunbar JL, McConkey-Robbins A, Niparko JK, Rittenhouse RK, Skinner MW. The societal costs of severe to profound hearing loss in the United States. Int J Technol Assess Health Care. 2000 Autumn; 16(4):1120-1135. doi: 10.1017/s0266462300103162. PMID: 11155832.

[60] World Health Organization. Global costs of unaddressed hearing loss and cost-effectiveness of interventions. https://apps.who.int/iris/bitstream/handle/10665/254659/9789241512046-eng.pdf;jsessionid=20CF4A0BAD3AEBA619EC067C4A8E5A25?sequence=1. Accessed on 29 November, 2020.

[61] World Health Organization (WHO). Deafness and hearing loss. https://www.who.int/health-topics/hearing-loss#tab=tab_2. Accessed on December 10, 2020.

[62] Holden-Pitt L, Albertorio J. Thirty years of the Annual Survey of Deaf and Hard-of-Hearing Children & Youth: a glance over the decades. Am Ann Deaf. 1998 Apr; 143(2):72-76. doi:10.1353/aad.2012.0630. PMID: 9569718.

[63] Woodcock K, Pole JD. Educational attainment, labour force status and injury: a comparison of Canadians with and without deafness and hearing loss. Int J Rehabil Res. 2008 Dec; 31(4):297-304. doi: 10.1097/MRR.0b013e3282fb7d4d. PMID: 19008678.

[64] Rydberg E, Gellerstedt LC, Danermark B. The position of the deaf in the Swedish labor market. Am Ann Deaf. 2010 Spring; 155(1):68-77. doi: 10.1353/aad.0.0130. PMID: 20503908. https://www.researchgate.net/publication/44631668_The_Position_of_the_Deaf_in_the_Swedish_Labor_Market. (Accessed 12 December, 2020).

[65] Jung D, Bhattacharyya N. Association of hearing loss with decreased employment and income among adults in the United States. Ann Otol Rhinol Laryngol. 2012 Dec; 121(12):771-5. doi: 10.1177/000348941212101201. PMID: 23342548. https://www.researchgate.net/publication/235365366_Association_of_Hearing_Loss_With_Decreased_Employment_and_Income_Among_Adults_in_the_United_States. (Accessed 12 December, 2020).

[66] Pierre PV, Fridberger A, Wikman A, Alexanderson K. Self-reported hearing difficulties, main income sources, and socio-economic status; a cross-sectional population-based study in Sweden. BMC Public Health. 2012 Oct 15; 12:874. doi: 10.1186/1471-2458-12-874. PMID: 23067045; PMCID: PMC3533986. https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-12-874. (Accessed 16 December, 2020).

[67] Stam M, Kostense PJ, Festen JM, Kramer SE. The relationship between hearing status and the participation in different categories of work: demographics. Work. 2013; 46(2):207-219. doi: 10.3233/WOR-131747. PMID: 24004810.

[68] Garramiola-Bilbao I, Rodríguez-Álvarez A. Linking hearing impairment, employment and education. Public Health. 2016 Dec; 141:130-135. doi: 10.1016/j.puhe.2016.09.013. Epub 2016 Oct 13. PMID: 27931988.

[69] Helvik AS, Krokstad S, Tambs K. Hearing loss and risk of early retirement. The HUNT study. Eur J Public Health. 2013 Aug; 23(4):617-22. doi: 10.1093/eurpub/cks118. Epub 2012 Aug 28. PMID: 22930741; PMCID: PMC3719475. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3719475/. (Accessed 16 December, 2020).

[70] Banda FM, Powis KM, Mokoka AB, Mmapetla M, Westmoreland KD, David T, Steenhoff AP. Hearing Impairment Among Children Referred to a Public Audiology Clinic in Gaborone, Botswana. Glob Pediatr Health. 2018 Apr 20; 5:2333794X18770079. doi: 10.1177/2333794X18770079. PMID: 29761140; PMCID: PMC5946350. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5946350/. (Accessed 16 December, 2020).

[71] Butler IR, Basson S, Britz E, de Wet R, Korsten GB, Joubert G. Age of diagnosis of congenital hearing loss at Universitas Hospital, Bloemfontein. S Afr Med J. 2013 Jun 5; 103(7):474-5. doi: 10.7196/samj.6395. PMID: 23802212. http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742013000700027. (Accessed 16 December, 2020).

[72] Fitzpatrick EM, Dos Santos JC, Grandpierre V, Whittingham J. Exploring reasons for late identification of children with early-onset hearing loss. Int J Pediatr Otorhinolaryngol. 2017 Sep; 100:160-167. doi: 10.1016/j.ijporl.2017.06.039. Epub 2017 Jul 1. PMID: 28802365.

[73] Burke MJ, Shenton RC, Taylor MJ. The economics of screening infants at risk of hearing impairment: an international analysis. Int J Pediatr Otorhinolaryngol. 2012 Feb; 76(2):212-8. doi: 10.1016/j.ijporl.2011.11.004. Epub 2011 Nov 29. PMID: 22129917. (Accessed 12 December, 2020).

[74] Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. Pediatrics. 2000 Sep; 106(3):E43. doi: 10.1542/peds.106.3.e43. PMID: 10969127.https://pediatrics.aappublications.org/content/106/3/e43. (Accessed 16 December, 2020).

[75] Apuzzo, ML, Yoshinaga-Itano, C. Early identification of infants with significant hearing loss and the Minnesota Child Development Inventory. Semin Hear. 1995; 16(2):124-135. doi:10.1055/s-0028-1083710.

[76] Meinzen-Derr J, Wiley S, Choo DI. Impact of early intervention on expressive and receptive language development among young children with permanent hearing loss. Am Ann Deaf. 2011 Winter; 155(5):580-91. doi: 10.1353/aad.2011.0010. PMID: 21449255. https://www.researchgate.net/publication/50934902_Impact_of_Early_Intervention_on_Expressive_and_Receptive_Language_Development_Among_Young_Children_with_Permanent_Hearing_Loss. (Accessed 17 December, 2020).

[77] Vohr B, Jodoin-Krauzyk J, Tucker R, Topol D, Johnson MJ, Ahlgren M, Pierre LS. Expressive vocabulary of children with hearing loss in the first 2 years of life: impact of early intervention. J Perinatol. 2011 Apr; 31(4):274-80. doi: 10.1038/jp.2010.110. Epub 2010 Aug 12. PMID: 20706190. https://www.nature.com/articles/jp2010110. (Accessed 17 December, 2020).

[78] Robinshaw HM. Early intervention for hearing impairment: differences in the timing of communicative and linguistic development. Br J Audiol. 1995 Dec; 29(6):315-334. doi: 10.3109/03005369509076750. PMID: 8861408.

[79] Yoshinaga-Itano C. Levels of evidence: universal newborn hearing screening (UNHS) and early hearing detection and intervention systems

(EHDI). J Commun Disord. 2004 Sep-Oct; 37(5):451-65. doi: 10.1016/j.jcomdis.2004.04.008. PMID: 15231425. http://lsl.usu.edu/files/yoshinaga-levelsofconfindence.pdf. (Accessed 17 December, 2020).

[80] Downs MP, Yoshinaga-Itano C. The efficacy of early identification and intervention for children with hearing impairment. Pediatr Clin North Am. 1999 Feb; 46(1):79-87. doi: 10.1016/s0031-3955(05)70082-1. PMID: 10079791.

[81] Blaiser K. Supporting communicative development of infants and toddlers with hearing loss. Semin Speech Lang. 2012 Nov; 33(4):273-9. doi: 10.1055/s-0032-1326911. Epub 2012 Oct 18. PMID: 23081787. https://www.researchgate.net/publication/232321097_Supporting_Communicative_Development_of_Infants_and_Toddlers_with_Hearing_Loss. (Accessed 17 December, 2020).

[82] Li Y, Bain L, Steinberg AG. Parental decision making and the choice of communication modality for the child who is deaf. Arch Pediatr Adolesc Med. 2003 Feb; 157(2):162-8. doi: 10.1001/archpedi.157.2.162. PMID: 12580686. https://jamanetwork.com/journals/jamapediatrics/fullarticle/481245. (Accessed 17 December, 2020).

[83] World Health Organization. Guidelines for hearing aids and services for developing countries. apps.who.int/iris/bitstream/10665/67889/1/PBD_PDH_01.1.pdf. Published July 2001. Accessed 17 December, 2020.

[84] Klop WM, Boermans PP, Ferrier MB, van den Hout WB, Stiggelbout AM, Frijns JH. Clinical relevance of quality of life outcome in cochlear implantation in postlingually deafened adults. Otol Neurotol. 2008 Aug; 29(5):615-621. doi: 10.1097/MAO.0b013e318172cfac. PMID: 18451751.

[85] Cheng AK, Grant GD, Niparko JK. Meta-analysis of pediatric cochlear implant literature. Ann Otol Rhinol Laryngol Suppl. 1999 Apr; 177:124-128. doi: 10.1177/00034894991080s425. PMID: 10214816.

[86] Kileny PR, Zwolan TA, Ashbaugh C. The influence of age at implantation on performance with a cochlear implant in children. Otol Neurotol. 2001 Jan; 22(1):42-46. doi: 10.1097/00129492-200101000-00008. PMID: 11314714.

[87] Spencer LJ, Gantz BJ, Knutson JF. Outcomes and achievement of students who grew up with access to cochlear implants. Laryngoscope. 2004 Sep; 114(9):1576-81. doi: 10.1097/00005537-200409000-00014. PMID: 15475785; PMCID: PMC3210741. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3210741/. (Accessed 17 December, 2020).

[88] Emmett SD, Tucci DL, Smith M, Macharia IM, Ndegwa SN, Nakku D, Mukara KB, Ibekwe TS, Mulwafu W, Gong W, Francis HW, Saunders JE. GDP Matters: Cost Effectiveness of Cochlear Implantation and Deaf Education in Sub-Saharan Africa. Otol Neurotol. 2015 Sep; 36(8):1357-65. doi: 10.1097/MAO.0000000000000823. Erratum in: Otol Neurotol. 2015 Dec; 36(10):1765. Kaitesi, Mukara B [Corrected to Mukara, Kaitesi B]. PMID: 26244622.

[89] Emmett SD, Sudoko CK, Tucci DL, Gong W, Saunders JE; Global HEAR (Hearing Loss Evaluation, Advocacy, and Research) Collaborative:, Akhtar N, Bhutta MF, Touch S, Pradhananga RB, Mukhtar N, Martinez N, Martinez FD, Ramos H, Kameswaran M, Kumar RNS, Soekin S, Prepageran N. Expanding Access: Cost-effectiveness of Cochlear Implantation and Deaf Education in Asia. Otolaryngol Head Neck Surg. 2019 Oct; 161(4):672-682. doi: 10.1177/0194599819849917. Epub 2019 Jun 18. PMID: 31210566. https://www.researchgate.net/publication/

333860245_Expanding_Access_Cost-effectiveness_of_Cochlear_Implantation_and_Deaf_Education_in_Asia. (Accessed 17 December, 2020).

[90] Hrastinski I, Wilbur RB. Academic Achievement of Deaf and Hard-of-Hearing Students in an ASL/English Bilingual Program. J Deaf Stud Deaf Educ. 2016 Apr; 21(2):156-70. doi: 10.1093/deafed/env072. Epub 2016 Feb 10. PMID: 26864688; PMCID: PMC4886322. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4886322/. (Accessed 17 December, 2020).

[91] Geers AE, Mitchell CM, Warner-Czyz A, Wang NY, Eisenberg LS; CDaCI Investigative Team. Early Sign Language Exposure and Cochlear Implantation Benefits. Pediatrics. 2017 Jul; 140(1):e20163489. doi: 10.1542/peds.2016-3489. Epub 2017 Jun 12. PMID: 28759398; PMCID: PMC5495521. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5495521/. (Accessed 17 December, 2020).

[92] Mulwafu W, Tataryn M, Polack S, Viste A, Goplen FK, Kuper H. Children with hearing impairment in Malawi, a cohort study. Bull World Health Organ. 2019 Oct 1; 97(10):654-662. doi: 10.2471/BLT.18.226241. Epub 2019 May 28. PMID: 31656330; PMCID: PMC6796677. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6796677/. (Accessed 17 December, 2020).

[93] Mulwafu W, Ensink R, Kuper H, Fagan J. Survey of ENT services in sub-Saharan Africa: little progress between 2009 and 2015. Glob Health Action. 2017; 10(1):1289736. doi: 10.1080/16549716.2017.1289736. PMID: 28485648; PMCID: PMC5496047. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5496047/. (Accessed 17 December, 2020).

[94] Bedford J, Mackey S, Parvin A, Muhit M, Murthy GV. Reasons for non-uptake of referral: children with disabilities identified through the Key Informant Method in Bangladesh. Disabil Rehabil. 2013; 35(25):2164-2170. doi: 10.3109/09638288.2013.770927. Epub 2013 Mar 13. PMID: 23480675.

[95] The Lancet. Taking childhood hearing loss seriously. Lancet. 2007 Apr 14; 369(9569):1234. doi: 10.1016/S0140-6736(07)60570-4. PMID: 17434379. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)60570-4/fulltext. (Accessed 12 December, 2020).

[96] Meissner HC, Reef SE, Cochi S. Elimination of rubella from the United States: a milestone on the road to global elimination. Pediatrics. 2006 Mar; 117(3):933-5. doi: 10.1542/peds.2005-1760. PMID: 16510677. https://pediatrics.aappublications.org/content/pediatrics/117/3/933.full.pdf?ck=nck. (Accessed 17 December, 2020).

[97] Tookey *P. rubella* in England, Scotland and Wales. Euro Surveill. 2004 Apr; 9(4):21-3. doi: 10.2807/esm.09.04.00464-en. PMID: 15192264. https://www.eurosurveillance.org/content/10.2807/esm.09.04.00464-en#html_fulltext. (Accessed 17 December, 2020).

[98] Booy R, Moxon ER. Immunisation of infants against *Haemophilus influenzae* type b in the UK. Arch Dis Child. 1991 Oct; 66(10):1251-4. doi: 10.1136/adc.66.10.1251. PMID: 1953016; PMCID: PMC1793483. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1793483/. (Accessed 17 December, 2020).

[99] Giebink GS. The prevention of pneumococcal disease in children. N Engl J Med. 2001 Oct 18; 345(16):1177-83. doi: 10.1056/NEJMra010462. PMID: 11642234. https://www.nejm.org/doi/10.1056/NEJMra010462?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed. (Accessed 17 December, 2020).

[100] American Academy of Audiology. Childhood hearing screening guidelines. https://www.cdc.gov/ncbddd/hearingloss/documents/aaa_childhood-hearing-guidelines_2011.pdf. Published September 2011. Accessed 12 December, 2020.

[101] Johnson JL, Kuntz NL, Sia CC, White KR, Johnson RL. Newborn hearing screening in Hawaii. Hawaii Med J. 1997 Dec; 56(12):352-5. PMID: 9447797. https://core.ac.uk/download/pdf/77123467.pdf. (Accessed 17 December, 2020).

[102] Dalzell L, Orlando M, MacDonald M, Berg A, Bradley M, Cacace A, Campbell D, DeCristofaro J, Gravel J, Greenberg E, Gross S, Pinheiro J, Regan J, Spivak L, Stevens F, Prieve B. The New York State universal newborn hearing screening demonstration project: ages of hearing loss identification, hearing aid fitting, and enrollment in early intervention. Ear Hear. 2000 Apr; 21(2):118-130. doi: 10.1097/00003446-200004000-00006. PMID: 10777019.

[103] Lyon M, Lyon D. Early detection of hearing loss: a follow-up study. Can J Public Health. 1986 May-Jun; 77(3):221-224. PMID: 3742408.

[104] Keren R, Helfand M, Homer C, McPhillips H, Lieu TA. Projected cost-effectiveness of statewide universal newborn hearing screening. Pediatrics. 2002 Nov; 110(5):855-64. doi: 10.1542/peds.110.5.855. PMID: 12415021. https://pediatrics.aappublications.org/content/110/5/855.long. (Accessed 17 December, 2020).

[105] Huang LH, Zhang L, Tobe RY, Qi FH, Sun L, Teng Y, Ke QL, Mai F, Zhang XF, Zhang M, Yang RL, Tu L, Li HH, Gu YQ, Xu SN, Yue XY, Li XD, Qi BE, Cheng XH, Tang W, Xu LZ, Han DM. Cost-effectiveness analysis of neonatal hearing screening program in China: should universal screening be prioritized? BMC Health Serv Res. 2012 Apr 17; 12:97. doi: 10.1186/1472-6963-12-97. PMID: 22510223; PMCID: PMC3353179. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3353179/. (Accessed 17 December, 2020).

[106] Sahli AS. Developments of children with hearing loss according to the age of diagnosis, amplification, and training in the early childhood period. Eur Arch Otorhinolaryngol. 2019 Sep; 276(9):2457-2463. doi: 10.1007/s00405-019-05501-w. Epub 2019 Jun 7. PMID: 31190221.

[107] Swanepoel DC, Delport SD, Swart JG. Universal newborn hearing screening in South Africa--a First-World dream? S Afr Med J. 2004 Aug; 94(8):634-5. PMID: 15352584. http://www.samj.org.za/index.php/samj/article/view/2661/1890. (Accessed 17 December, 2020).

[108] Professional Board for Speech, Language and Hearing Professions. Hearing Screening Position Statement Year 2002: Pretoria: Health Professions Council of South Africa, 2002: 1-8. Revised 2007 & 2018. https://www.hpcsa.co.za/Uploads/SLH/Guidelines%20for%20Early_Hearing_Detection_and_Intervention_(EHDI)_2018.pdf. (Accessed 17 December, 2020).

[109] Khoza-Shangase K, Kanji A, Petrocchi-Bartal L, Farr K. Infant hearing screening in a developing-country context: Status in two South African provinces. South African Journal of Child Health. 2017; 11(4):159-63. http://www.sajch.org.za/index.php/SAJCH/article/view/1394. (Accessed 17 December, 2020).

[110] Kanji A, Khoza-Shangase K. Feasibility of newborn hearing screening in a public hospital setting in South Africa: A pilot study. S Afr J Commun Disord. 2016; 63(1):e1-e8. doi: 10.4102/sajcd.v63i1.150. Epub 2016 Jul

21. PMID: 27443006; PMCID: PMC5843149. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5843149/. (Accessed 17 December, 2020).

[111] Petrocchi-Bartal L, Khoza-Shangase K. Infant hearing screening at primary healthcare immunisation clinics in South Africa: The current status. South African Journal of Child Health. 2016; 10(2):139-43. http://www.sajch.org.za/index.php/SAJCH/article/view/1114. (Accessed 17 December, 2020).

[112] Bezuidenhout JK, Khoza-Shangase K, De Maayer T, Strehlau R. Universal newborn hearing screening in public healthcare in South Africa: Challenges to implementation. South African Journal of Child Health. 2018; 12(4):159-63. http://www.sajch.org.za/index.php/SAJCH/article/view/1468. (Accessed 17 December, 2020).

[113] Theunissen M, Swanepoel D. Early hearing detection and intervention services in the public health sector in South Africa. Int J Audiol. 2008; 47 Suppl 1:S23–S29. doi: 10.1080/14992020802294032. PMID: 18781510.

[114] Krishnan LA, Donaldson LK. Newborn hearing screening in developing countries: understanding the challenges and complexities of implementation. Perspectives on Global Issues in Communication Sciences and Related Disorders. 2013 Oct; 3(2):54-61. https://www.researchgate.net/publication/275298672_Newborn_Hearing_Screening_in_Developing_Countries_Understanding_the_Challenges_and_Complexities_of_Implementation. (Accessed 17 December, 2020).

[115] Kemper AR, Downs SM. A cost-effectiveness analysis of newborn hearing screening strategies. Arch Pediatr Adolesc Med. 2000 May; 154(5):484-8. doi: 10.1001/archpedi.154.5.484. PMID: 10807300. https://jamanetwork.com/journals/jamapediatrics/fullarticle/vol/154/pg/484. (Accessed 17 December, 2020).

[116] Mauk GW, White KR, Mortensen LB, Behrens TR. The effectiveness of screening programs based on high-risk characteristics in early identification of hearing impairment. Ear Hear. 1991 Oct; 12(5):312-319. doi: 10.1097/00003446-199110000-00003. PMID: 1783234.

[117] Kaplan SL, Catlin FI, Weaver T, Feigin RD. Onset of hearing loss in children with bacterial meningitis. Pediatrics. 1984 May; 73(5):575-8. PMID: 6718111. https://pediatrics.aappublications.org/content/pediatrics/73/5/575.full.pdf. (Accessed 17 December, 2020).

[118] Dodge PR, Davis H, Feigin RD, Holmes SJ, Kaplan SL, Jubelirer DP, Stechenberg BW, Hirsh SK. Prospective evaluation of hearing impairment as a sequela of acute bacterial meningitis. N Engl J Med. 1984 Oct 4; 311(14):869-74. doi: 10.1056/NEJM198410043111401. PMID: 6472398. https://www.nejm.org/doi/10.1056/NEJM198410043111401. (Accessed 17 December, 2020).

[119] Republic of South Africa. Department of Basic Education and Department of Health. Integrated school health policy. https://www.health-e.org.za/wp-content/uploads/2013/10/Integrated_School_Health_Policy.pdf. Accessed 8 December, 2020.

[120] Feder KP, Michaud D, McNamee J, Fitzpatrick E, Ramage-Morin P, Beauregard Y. Prevalence of Hearing Loss Among a Representative Sample of Canadian Children and Adolescents, 3 to 19 Years of Age. Ear Hear. 2017 Jan/Feb; 38(1):7-20. doi: 10.1097/AUD.0000000000000345. PMID:

27556530; PMCID: PMC5181131. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5181131/. (Accessed 17 December, 2020).

[121] Bess FH, Dodd-Murphy J, Parker RA. Children with minimal sensorineural hearing loss: prevalence, educational performance, and functional status. Ear Hear. 1998 Oct; 19(5):339-354. doi: 10.1097/00003446-199810000-00001. PMID: 9796643.

[122] Coplan J. Deafness: ever heard of it? Delayed recognition of permanent hearing loss. Pediatrics. 1987 Feb; 79(2):206-213. PMID: 2433675.

[123] Harlor AD Jr, Bower C; Committee on Practice and Ambulatory Medicine; Section on Otolaryngology-Head and Neck Surgery. Hearing assessment in infants and children: recommendations beyond neonatal screening. Pediatrics. 2009 Oct; 124(4):1252-1263. doi: 10.1542/peds.2009-1997. Epub 2009 Sep 28. PMID: 19786460.

[124] Watkin PM, Baldwin M, Laoide S. Parental suspicion and identification of hearing impairment. Arch Dis Child. 1990 Aug; 65(8):846-50. doi: 10.1136/adc.65.8.846. PMID: 2400221; PMCID: PMC1792472.

[125] Winiger AM, Alexander JM, Diefendorf AO. Minimal Hearing Loss: From a Failure-Based Approach to Evidence-Based Practice. Am J Audiol. 2016 Sep 1; 25(3):232-245. doi: 10.1044/2016_AJA-15-0060. PMID: 27367972.

[126] Bess FH, Tharpe AM. Unilateral hearing impairment in children. Pediatrics. 1984 Aug; 74(2):206-216. PMID: 6462820.

[127] Ross M, Giolas TG. Effect of three classroom listening conditions on speech intelligibility. Am Ann Deaf. 1971 Dec; 116(6):580-584. PMID: 5132418.