Open Journal of Otolaryngology

ISSN: 2639-3603 | Volume 4, Issue 1, 2021

DOI: https://doi.org/10.22259/2639-3603.0401002

A Review on New-Born Hearing Loss in Sub-Saharan Africa

Chisom J Nwankwo[1], Bariika N Vite[2], Osinachi A Ekeagwu[3]

[1]Department of Public Health and Health Promotion, Faculty of Health Sciences, Brunel University London. United Kingdom.

[2]and [3]Faculty of Health, Education, Medicine and Social Care, Anglia Ruskin University, Cambridge, United Kingdom.

***Corresponding author:** Chisom J Nwankwo, Department of Public Health,Faculty of Health, Education, Medicine and Social Care, Anglia Ruskin University, Cambridge, United Kingdom. Bariika N Vite,Osinachi A Ekeagwu,Faculty of Health, Social Care and Education, Anglia Ruskin University, Cambridge, United Kingdom.*

Abstract

An estimated two-thirds of people with hearing impairments reside in developing countries and this constitutes social and economic implications.Since the introduction ofscreening for early identification of hearing loss in new-born in hospitalised settings and community care centres across Sub-Saharan Africa, there has been an increase in the number of new-borns diagnosed with developmental delays and hearing loss. Screening in the region frequently applies alternative models such as community-based model and hospital-based model. Each of the models is comprised of different attributes such as resources involved, timeframe, setting, and the procedural elements. The effectiveness of both models relies of early detection as well as the awareness and participation of the parents or caregivers of the new-born, healthcare centres and practitioners.

Keywords: *Parents' perception; New-born screening; Hearing loss; Systematic literature review; Sub-Saharan Africa.*

Introduction

Hearing loss describes disorder associated with the partial or total inability to hear due to malfunctioning or damage to the ear. It is considered both a clinical and psychological issue (Stephens and Jones, 2006; MacConville, 2007; Schacht and Fay, 2008) characterised by the elimination of incoming sound by an invisible acoustic filter, store, or smear (Stephens and Jones (2006). The individual suffering from this impairment is unable to hear any sound or voice even from a short distance (MacConville, 2007). Schacht and Fay, (2008), have critically explained it by connecting it with the functioning of the sound system and the mechanism of hearing. They stated that the frequency (pitch) is the key component in relation to the measurement of hertz (Hz) and intensity (loudness).

Clinically, the normal range for effective hearing is recognised between the frequencies of 20 and 20,000 Hz and between 0 to 140 decibels (dB). Hence, any range at which an individual is unable to hear the sound from on-sight distance is considered as suffering from hearing loss (Booth et al, 2016). Furthermore, the listening system in the body functions by transducing the sound into the neural impulses. These impulses are further interpreted by the central nervous system. Any defect or problem in one or more stages of the system can result in hearing loss (MacConville, 2007).

In similar context, the definition given by the WHO clarifies the differences between hearing loss and deafness. The regulatory body identifies hearing loss as a deficiency in the abilities to process auditory information while deafness is referred to as a severe issue associated with the need of hearing aids as well as cochlear implantation (World Health Organization, 2018). These different views have further helped in clarifying the understanding about the several categories of hearing loss associated with the risk factors causing such loss. Hearing loss can be categorised into unilateral hearing loss or bilateral

hearing loss based on the level of effect on ears. It can be stable, progressive, fluctuating, or transient (Hillock-Dunn et al. 2015). The categorisation of the hearing loss can be based on the onset of the disorder such as onset of hearing loss at the time of birth (referred to as congenital hearing loss), onset and the initiation of the childhood age (early-onset), and onset experience while reaching the age of adult (late-onset). Furthermore, it can be analysed from the review of past studies that different clinicians have identified a set of common factors leading to hearing loss in children by connecting it with the underlying pathologies (Schacht and Fay, 2008).

Hearing loss experienced by the New-born or infants in the first few months of birth is referred to as Newborn hearing loss. Based on the age of a child, a variety of screening methods to assess the hearing ability of such child may be selected (Tye-Murray, 2008). Generally, the New-born hearing loss is subjected to the identification of the hearing problem within the first few months of life. However, different clinical authorities have specified different age limits for defining the New-born hearing loss such as the National Institutes of Health (NIH) United States. They identified 3 months' specific age for the accomplishment of the New-born hearing loss screening program. On the other hand, the National Board of Health and Welfare (NBHW) Sweden, considers the age group for one year as the suitable age for consideration in the universal hearing loss program. Also, the National Deaf of children society United Kingdom, identifies that approximately 80% of the cases of Newborn hearing loss can be identified within 12 months from birth (Tye-Murray, 2008). In discussing the early onset of hearing loss in the New-born babies, specifically focusing on the discussion of shift of moving from prevention to intervention, researchers highlighted the need to adopt an effective strategy for preventing the expectant mothers from being infected with cytomegalovirus (CMV). They found that it is the viral infection, which can pose a great risk to the mothers expecting to deliver their babies, subsequently putting their infants at the risk of hearing loss. The findings have revealed that proper prenatal care is necessary to reduce the risk factors associated with the New-born hearing loss. The other major factors include infections caused by toxoplasmosis, syphilis, German measles, and herpes. The use of technology and medical advances have been regarded as highly complementary globally for helping the New-born babies with effective support and intervention to help them develop language and communication competencies to make them function like normal children (Packer, 2015).

Prevalence of New-born Hearing Loss

The early identification of hearing loss in new-born has become a recommended practice across the multiple geographical regions. Globally, statistics show that out of every 1000 children, between 1 and 3 are affected by hearing loss (Burrows and Owen, 2015). These estimations include prevalence rates among the infant groups of both well-babies as well as neonatal intensive care units' babies. The American Speech-Language Hearing Association (ASHA) defines hearing loss as the disorder associated with the problems of the inner, outer, or middle ear. The disorder associated with the problems in the inner ear is defined as nerve-related hearing loss while the disorder associated with the damage in the outer or middle ear is defined as a mixed hearing loss (American Speech Language Hearing Association, 2018). ASHA further highlights variation in the intensity of the loss based on the types and categories of the hearing loss. Among the different causes of hearing loss identified in the new-born include birth defects (congenital hearing loss), after birth issues (acquired hearing loss), ear infections (otitis media), Ototoxic medications (medication effects) (American Speech Language Hearing Association, 2018) Other factors behind the hearing loss in new-born include family history or noise exposure.

Annually, approximately 740,000 children (about 6/1000 live births) from low- and middle-income countries (LMICs) have sensorineural hearing impairment in their early stage of life in comparison with 28,000 children (roughly 2/1,000 live births) in high-income countries (HICs) (Ravi et al. 2018). According to World Health Organization (WHO), 7.5 million children under five years of age globally, have disabling hearing loss, where LMICs account for about 80% of the children (World Health Organization, 2018). The affected children, without proper intervention, have the risks of facing permanent speech and audiological complications and most importantly, progressive deficiencies that cause severe restrictions on their academic and career

accomplishments. Moreover, when this disorder is not given serious medical attention at an early stage of development, it is usually accompanied by profound adverse consequences that cuts across all areas of development, leading to substantial and frequently permanent shortfalls in gross and fine motor skills, intellectual accomplishments, speech and linguistic progression and psychosocial development (Nahar et al. 2012).

Although it is known that the level of cognitive, emotional, physical, and social development of every child varies, a child with hearing loss, experiences moredifficulties than other children without such condition. The social and economic implications of hearing loss may impact the affected individual as well as their family and the public in general. For instance, a study indicates that it will cost a lifetime estimate of $115,600 to educate a child with hearing loss(Park, 2015). It has also been observed that the affected individuals earn around 40%-45% lesser that those without hearing loss andare more likely to be underemployed compared to those with other disabilities(Shannon, Grind and Cox, 2003). It is imperative that a child canutilise their hearing senses from infancy for effective development in speech, language, and cognitive skills.

Hearing disability is one of the most known congenital diseases and its occurrence has been estimated to be two times more than the overall disabilities that can be detected by screening in new-borns. For example, research indicates that hearing loss occurs in 1-3 new-borns per 1000 live births (Mick and Pichora-Fuller, 2016). The actual prevalence of new-born hearing disorder in Nigeria is not known, however, the findings of a community-based hearing screening programme of infants attending clinics indicates a prevalence over 28 per 1000 (Olusanya, Wirz, and Luxon, 2008). In South Africa, a similar community-based has recorded a prevalence of 1.5 per 1000 (Friderichs, Swanepoel, Hall, 2012). The estimate in Nigeria was recognised as the highest in world (Labaeka, et al., 2018).

Why Screen for New-born Hearing Loss?

In Sub-Saharan Africa, perpetual hearing loss is a prevalent sensory ailment in children. Compared to other developed countries, the prevalence of hearing loss is higher in developing countries, including Nigeria due to not having appropriate screening and early detection measures like the developed world (Angela, 2017). Hearing loss hinders the speech, linguistics, and intellectual advancement vital for optimum educational and career accomplishment from childhood. It is usually linked with severe perinatal and postnatal cases that emanates from predominantly impoverished healthcare and socio-economic situations. Attempts on addressing the increasing number of hearing loss in Nigeria and in other developing countries are presently carried out via vaccination, enhanced childbearing methods/ procedures and continuous public health education. These comprises necessities such as skilled childbearing assistants, emergency obstetric care and efforts designed to discourage unverified home delivery to mitigate the occurrence of threat issues related to hearing loss (Stephen and Jones, 2006).

The expanded program of immunization (EPI) is a program initiated with the primary aim of immunising 0-2 years old (including pregnant women) and to achieve a greater percentage of coverage (>85%) to eliminate or reduce vaccine preventable diseases (VPD) (Fowler, 2017). Some prominent risks issues such as mumps, rubella and meningitis that relates to hearing loss are included in the EPI in Nigeria. However, the country's maternal and childcare centres where these programs are carried out are dilapidated and the likelihood to limit the frequency of preventable hearing loss is very minimal.

Screening is a simple and fast medical strategy employed in identifying the possible occurrence of any disorder from individuals with the disorder and those without it in a large population. The principal aim of New-born hearing screeningat infancy is largely to minimise the effect of hearing loss on language, cognitive, social, and emotional advancements, socio-economic status, poor socialization skills, depression and satisfy the requirements for 'health, rehabilitation and education' (Halliday, Tuomainen and Rosen, 2017). Another crucial aspect of screening relates to the financial difficulties of hearing loss in line with the high cost of treatment and rehabilitation in a situation where examination and early intervention is delayed (Weinstein, 2016).

Since nearly half of the children affected by hearing loss exhibit no signs of hearing loss at birth and during early stage of development, thus, the significance of public hearing screening program for new-borns as a strategy to reduce the percentage of hearing loss for early intervention is apparent.

Screening for New-born Hearing Loss

According to studies by Olusanya, et al (2009) and Olusanya, Wirz and Luxon, (2005), hearing impairment is not easily noticeable by behavioural observations. Such impairments are suspected by the parents through the abnormal attention of the baby towards the sound. This poses a problem of early and timely identification or detection. In most cases, hearing impairment is not detected until the infant is well over 18 months of age. These outcomes have further stressed the need to understand the level of parental awareness and education related to the behavioural factors associated with the hearing loss. Lack of education and awareness of the Parents about the behavioural factors results in misconceptions to screening for hearing loss programs.

Inherited hearing loss, genetic abnormalities or congenital influences and extraneous hearing loss related to low standard of living, persevere. Additionally, the actual cause of hearing loss in most cases are usually arduous to identify. As a secondary prevention approach, there is need for a programme that can help detect and intervene on hearing loss early. The public health service often uses screening as a secondary prevention strategy to identify some disease cases among the population targeted. For example, developed countries presently adopt the universal New-born hearing screening as a strategy for detecting permanent congenital and early-onset hearing loss (PCEHL). (Narayanan and Merlyn, 2015).

Similarly, regarding the evidence of New-born hearing loss identified in Nigerian population, Olusanya, Wirz and Luxon, (2008) have specified on the existence of high proportion of development for disadvantaged children in the country. Currently, the burden of permanent congenital and early-onset hearing loss (PCEHL) is quite higher in Nigeria. The current standard of maternal and child health care in the country is bad, which ultimately leads to theunsustainable implementation of the primary prevention of PCEHL (Olusanya, Wirz and Luxon, 2008).

In this century, the country is still practicing the traditional method of delivery (childbirth) outside the regular hospitals, for this reason, most of the births occur outside the regular hospitals. If births occur outside the regular hospitals where immunization is not carried out, for example, homes of individuals, churches or traditional herbalists, parents become reluctant in taking their child to the hospitals for the routine immunisation and screenings. This makes the routine childhood immunisation programs as well as universal hearing screening programs ineffective (Kemper et al. 2006). Currently, the healthcare authorities in Nigeria have started considering focussing on both the hospital and non-hospital-based settings to implement the universal New-born hearing loss screening. From the prevalence of the conventional methods, it can be analysed that community-based universal hearing screening are more widely used in Nigerian compared to hospital-based screening processes (Engelman, 2014).

Screening Models

Research in Sub-Saharan Africa confirms the use of alternative models for screening for hearing loss. These models include the community-based model and hospital-based model. Each of the models is comprised of different attributes such as resources involved, timeframe, setting, and the procedural elements. Hospital-based screening models are more concerned with the National policy and screening programs relative to the community-based models (Olusanya, 2009).

Hospital-based screening programs are subjected to receive high level of support. Researchers have confirmed the importance of hospital-based hearing in the context of mean age needed to complete a screening process (Firoozbakht et al. 2014). With approximately 2-6 days' meantime, hospital-based universal hearing screening of new-borns before discharge was identified as feasible in Nigeria. This mean age time is associated with goals set for different screening stages including stage I of efficient tracking and stage II of follow up the system (Gilani, Roditi and Bhattacharyya, 2016). The protocol was identified as a helpful return rate of diagnosing as well as confirming the most suitable age of hearing loss screening. Hospital-based screening needs to look after the medical condition of the baby priorto recommendation for screening for hearing loss. Specifically, in Iran, this protocol is currently used for universal hearing loss screening whereby at 3 days of life or after being discharged from the maternity ward it is recommended for the healthy babies to screen for hearing loss. However, for the group of seriously ill baby such screening is recommended after the completion of primary care related to the illness or medical condition (Firoozbakht et al. 2014).

The effectiveness of the community-based program is also dependent on the government's financial health insurance system. Researchers stated that without the cooperation of the hospitals and obstetric clinics, community centres are also not able to implement their screening model effectively on helping the timely detection of hearing loss (Lin et al. 2004). Differential analysis of alternative models such as community-based model and hospital-based model would further help in assessing the parental perceptions of the Nigerian population in relation to the new-born hearing loss screening programs. For example, in one of the academic studies, researchers Grill, et al. (2006), have investigated the costs and effectiveness of new-born hearing screening systems in England. The methodology conducted by the researcher was based on the findings of the national new-born hearing screening program (NHSP). Markov model and Quality-weighted child months (QCM) were considered for the analysis. The findings of the study revealed that both hospital and community programs are highly significant in England and other parts of the world. The findings of the study have further confirmed that simulated costs of the hospital-based screening are 48% lower in-hospital trials (Grill et al. 2006).

Additionally, Rivera, et al (2017), investigated the costs of new-born screening to the society by discussing the impact of lost wages and decreased employment rate in directing individuals to participate or to reject participation in any of such programs. On the other hand, implementing this high-level screening program is also identified as a high budget impact program. Therefore, hospital-based screening offers great support in availing the intervention and benefits associated with such interventions.

New-born hearing loss screening in developing countries is limited by the set of financial elements integrated with the socio-economic factors. These factors contributed vitally to shaping the maternal behaviours towards the hearing loss screening. However, the effectiveness of the hospital-based screening program is also dependent on numerous factors.Evidence has suggested that the hospital programs are unable to create significant public awareness about the early diagnosis and intervention in timely manner (Krishnan and Donaldson, 2013). Lack of awareness results in a delay in coming to audiological certainty. Toassess the impact of hospital-based screening, there are sets of quality indicators. These quality indicators include 'coverage rate, initial referral rate, return for follow-up rate, ages of diagnosis and intervention'. These indicators, if implemented, will enhance the effectiveness of the screening program (Mukari and Abdullah, 2006).

Methods of Screening

Studies have identified the importance of adopting different approaches to screening such as Oto-Acoustic Emissions (OAE) and auditory brainstem response (ABR) test. Dhar and James (2011), defined OAE hearing screening as the screening process highlighting the use of low-level sound emissions emitted by the cochlea in response to an auditory stimulus. This screening test is used across the globe for obtaining the information about the functioning of outer hair cells. This approach is identified as effective in the evaluation of hearing loss in infants. OAE is considered as one of the effective methods to identify a range of abnormalities associated with the dysfunctional middle ear disorder and outer hair cells. The test was effective in diagnosing the differences in the normal peripheral auditory function and hearing sensitivity within the normal limits in relation to the peripheral auditory dysfunction and degree of hearing loss (Dhar and James, 2011).

The Auditory Brainstem Response (ABR) test is also heavily discussed in the existing literature in relation to the identification of abnormalities with the inner ear. The test is identified as highly effective in identifying the brain pathways and their functionality in making the hearing process effective. In simple words, ABR is recognised as a neurological test associated with auditory brainstem functioning in relation to the auditory stimuli. Academic researchers have also analysed the sensitivity of the different clinical approaches and tests used for the screening of hearing loss in New-borns (Olusanya, Wirz and Luxon, 2008). One such study, Grosse et al. (2017), estimated the rate of hearing loss detected by first stage otoacoustic emissions test but missed by the second stage automated ABR testing. The sample size selected for the investigation was 17,078 infants. The findings revealed that 24% of the sample failed the OAE screening test but passed the ABR hearing screening tests. ABR was identified as highly sensitive to identify the permanent hearing loss of 25dB. However, the

researchers suggested the need to investigate further, the sensitivity of the diverse response detection methods of ABR devices to substantiate further, the effectiveness of the method.

Sininger (2016), have further investigated the comparative effectiveness of the two screening tests such as distortion product otoacoustic emissions (DPOAEs) and automated auditory brainstem response (AABR) in community-based midwife obstetric units in South Africa. The results showed that screening technology has significant impacts on effective diagnostic assessment of bilateral sensorineural hearing loss. The performance of AABR group was identified as highly effective in comparison to the DPOAEs. It can be analysed that hospital-based screening may be effective in terms of commerce and budget saving however community-based screening is highly valuable due to its efficacy on coverage, referral and follow up returns rates.

Research literature has also provided evidence regarding the outsourcing of the hospital-based screening program for new-born hearing loss to address the factors necessary for increasing the effectiveness of such program. In many of the states, such outsourcing is done to target the issues of hiring, training, and evaluating the personnel needed for screening, to look after the technical details associated with the neonatal intensive care unit (NICU) and to increase the awareness among the families to direct them to voluntarily opt-in the screening process. However, the impact of such outsourcing programs can also be limited based on the range of factors such as technologies selection for testing the infants, screening procedures, methods used for tracking and surveillance of infants, and cost -related factors such as billing and collection practices (Winston-Gerson and Roush, 2016).

Summary

New-born hearing loss is a public health challenge in developing countries, particularly those in Sub-Saharan Africa. Through new-born hearing screening, babies can be diagnosed, and the impairment identified. Earlydetection of the disorder remains an effective approach and necessary to deal with the complexities associated with new-born hearing deficiencies. There are various models and approaches for screening andthe significance of these screening approaches can help to shape the development of the good quality of health care for the new-borns. A review on the prevalent perceptions of the parents or caregivers of the new-born is necessary considering that the success of the screening programs relies on their cooperation.

References

1. American Speech Language Hearing Association, (2018) Hearing Loss. [Online] Available at: https://www.asha.org/public/hearing/Causes-of-Hearing-Loss/ [Accessed 06 March 2018].
2. Angela Boland, G. and Dickson, R., (2017) Doing a Systematic Review: A Student's Guide. New Dehli: SAGE.
3. Booth, A. et al. (2016) Systematic Approaches to a Successful Literature Review. London: SAGE. 1(2), p34-37.
4. Burrows, D. and Owen, W., (2015) Universal New-born Hearing Screening: A Statistical Analysis of Probabilities. Audiology Online, 4(1), p. 21.
5. Dhar, S. and James, W. (2011) Otoacoustic Emissions: Principles, Procedures, and Protocols. Plural Publishing. 2(2), p.11.
6. Engelman, D. (2014) The Status of Neonatal Hearing Screening in SubSaharan. City University of New York.
7. Firoozbakht, M. et al. (2014) Community-based newborn hearing screening programme for early detection of permanent hearing loss in Iran: An eight-year cross-sectional study from 2005 to 2012. Journal of Medical Screening, 21(1), pp.10-17.
8. Fowler, K. (2017) Targeted Screening for Cytomegalovirus and Hearing Loss. The Hearing Journal, 70(10), p.10.
9. Friderichs, N., Swanepoel, D. and Hall, J. (2012) Efficacy of a community-based infant hearing screening program utilizing existing clinic personnel in Western Cape, South Africa. International Journal of Pediatric Otorhinolaryngology, 76(4), pp.552-559.
10. Gilani, S., Roditi, R. and Bhattacharyya, N. (2016). Grade repetition and parents' perception of hearing loss: An analysis of data from children in the United States. The Laryngoscope, 127(3), pp.741-745.

11. Grill, E., Uus, K., Hessel, F., Davies, L., Taylor, R., Wasem, J. and Bamford, J. (2006). Neonatal hearing screening: modelling cost and effectiveness of hospital- and community-based screening. BMC Health Services Research, 6(1).

12. Grosse, S., Riehle-Colarusso, T., Gaffney, M., Mason, C., Shapira, S., Sontag, M., Braun, K. and Iskander, J. (2017). CDC Grand Rounds: Newborn Screening for Hearing Loss and Critical Congenital Heart Disease. MMWR. Morbidity and Mortality Weekly Report, 66(33), pp.888-890.

13. Halliday, L., Tuomainen, O. and Rosen, S. (2017). Language Development and Impairment in Children With Mild to Moderate Sensorineural Hearing Loss. Journal of Speech Language and Hearing Research, 60(6), p.1551.

14. Hillock-Dunn, A., Taylor, C., Buss, E. and Leibold, L. (2015). Assessing Speech Perception in Children With Hearing Loss. Ear and Hearing, 36(2), pp.e57-e60.

15. Kemper, A., Uren, R., Moseley, K. and Clark, S. (2006). Primary Care Physicians' Attitudes Regarding Follow-up Care for Children With Positive Newborn Screening Results. PEDIATRICS, 118(5), pp.1836-1841.

16. Krishnan, L. and Donaldson, L. (2013) Newborn Hearing Screening in Developing Countries: Understanding the Challenges and Complexities of Implementation. Perspectives on Global Issues. Communication Sciences and Related Disorders, 3(2), pp. 54-61.

17. Labaeka, A.A., Tongo, O.O., Ogunbosi, B.O. and Fasunla, J.A., 2018. Prevalence of hearing impairment among high-risk newborns in Ibadan, Nigeria. Frontiers in pediatrics, 6, p.194.

18. Lin, C. et al. (2004) Community-based newborn hearing screening program in Taiwan. International Journal of Pediatric Otorhinolaryngology, 68(2), pp. 185-189.

19. MacConville, R. (2007) Looking at Inclusion: Listening to the Voices of Young People. SAGE. 2(22), p.16.

20. Mick, P. and Pichora-Fuller, M. (2016) Is Hearing Loss Associated with Poorer Health in Older Adults Who Might Benefit from Hearing Screening? Ear and Hearing, 37(3), pp.194-201.

21. Mukari, S. and Abdullah, A. (2006) A pilot project on hospital-based universal newborn hearing screening: lessons learned. International journal of pediatric otorhinolaryngology, 70(5), pp. 843-851.

22. Narayanan, S. and Merlyn, M. (2015). Newborn Hearing Screening Project, 2012-2014 on the Threshold of Effective Population-Based Universal Newborn Hearing Screening. Biomedical and Pharmacology Journal, 8(octoberSpl Edition), pp.681-684.

23. Olusanya, B. (2009) Follow-up default in a hospital-based universal newborn hearing screening programme in a low-income country. Child Care Health Dev, 35(2), pp. 190-198.

24. Olusanya, B. et al. (2009) Costs and performance of early hearing detection programmes in Lagos, Nigeria. Opthomalogy, 103(2), pp. 179-186.

25. Olusanya, B. Luxon, L. and Wirz, S., (2005) Screening for early childhood hearing loss in Nigeria. Journal of Medical Screening, 12(3), pp. 115-118.

26. Olusanya, B. Wirz, S. and Luxon, L., (2008) Community-based infant hearing screening for early detection of permanent hearing loss in Lagos, Nigeria: a cross-sectional study. Bulletin of the World Health Organization, Volume 86, pp. 956-963.

27. Park, S. (2015) Newborn Hearing Loss and Newborn Hearing Screening. Hanyang Medical Reviews, 35(2), p.72.

28. Pryjmachuk, S. et al. (2014) Chapter 2: Systematic reviews and meta-analysis: methods. NHR Journal Library. 3(9), p.35.

29. Rivera, A. et al. (2017) The Cost-Effectiveness and Budget Impact of a Community-based Universal Newborn Hearing Screening Program in the Philippines. Acta Medica Philippina, 51(1), pp. 28-.

30. Shannon, P., Grinde, L. and Cox, A. (2003). Families ' Perceptions of the Ability to Pay for Early Intervention Services. Journal of Early Intervention, 25(3), pp.164-172.

31. Sininger, Y. (2002). Otoacoustic emissions in the diagnosis of hearing disorder in infants. The Hearing Journal, 55(11), pp.22-26.

32. Schacht, J. and Fay, R. (2008) Auditory Trauma, Protection, and Repair. New York: Springer Science & Business Media. 7(22), p.211-213.

33. Tye-Murray, N. (2008) Foundations of Aural Rehabilitation: Children, Adults, and Their Family Members, Cengage Learning. 2(7), p.77-79.

34. Weinstein, B. (2016) Revisiting Age-Related Hearing Loss Screening – Part 1. The Hearing Journal, 69(12), p.12.

35. Weinstein, B. (2017) Revisiting Age-Related Hearing Loss Screening - Part 2. The Hearing Journal, 70(1), p.10.

36. Winston-Gerson, R. and Roush, J. (2016) Outsourcing Hospital-Based Newborn Hearing Screening: Key Questions and Considerations. The Journal of early Detection and Intervention, 1(1), pp. 21-25.

37. World Health Organization, (2018) Prevention of Blindness and Deafness; [Online], Available at: http://www.who.int/pbd/deafness/world-hearing-day/2016/en/ [Accessed 29 April, 2018].

Citation: **Chisom J Nwankwo, Bariika N Vite, Osinachi A Ekeagwu.** *"A Review on New-Born Hearing Loss in Sub-Saharan Africa. Open Journal of Otolaryngology. 2021; 4(1): 6-13. DOI: https://doi.org/10.22259/2639-3603.0401002*