Assessment of the Prevalence of Neonatal Hearing Loss at Moi Teaching and Referral Hospital (MTRH)

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ABSTRACT

Neonatal hearing impairment is a significant public health concern that can adversely affect cognitive, language and social development if undetected. Although universal newborn hearing screening (UNHS) is a routine program in high- income countries its implementation in Sub-Saharan Africa nations including Kenya remains limited as a result of resource constraints, cultural barriers and rural- urban unequal healthcare access, despite recent Kenya national policy prioritizing early detection. This study aimed to determine the prevalence and associated risk factors of neonatal hearing loss at Moi Teaching and Referral Hospital (MTRH). A prospective cross-sectional study was conducted from March to May 2025, involving 2,982 infants aged 0-3 months screened using Distortion Product Otoacoustic Emissions (DPOAE) and Automated Auditory Brainstem Response (AABR) technologies. Demographic and clinical data were obtained from hospital records and structured guardian interviews with follow-up testing for those who failed the initial screening. Screening coverage reached 98.7% exceeding Joint Committee on Infant Hearing (JCIH) targets. The initial referral rate of 20.9% decreased to 5.2% after second stage testing with higher referrals among infants in the newborn unit and Maternal and Child Health clinic. The study demonstrates that a two-stage screening protocol effectively reduces false positives and is feasible for integration into routine newborn care at MTRH. The strengthening of supporting policy, funding, caregiver awareness and staff training is essential for advancing early hearing detection and intervention in Kenya.

Keywords: *Universal Newborn Hearing Screening, Newborn Unit, Neonatal Intensive Care Unit, Otoacoustic Emissions, Automated Auditory Brainstem Response, Prevalence, Moi Teaching and Referral Hospital.*

INTRODUCTION

Neonatal hearing loss, or congenital hearing loss present at birth, is a condition where a baby has difficulty hearing sounds and ranges from mild to profound, affecting one or both ears. Neonatal hearing loss is a significant health issue which has profound implications on a child's development. Early childhood hearing impairment can significantly delay speech acquisition, limit academic achievement, and hinder social integration (World Health Organization [WHO], 2021). Congenital hearing loss affects an estimated 1–3 per every 1,000 live births in developed countries with universal newborn hearing screening (UNHS) programs (Joint Committee on Infant Hearing [JCIH], 2019). However, in low- and middle-income countries (LMICs), including Sub-Saharan Africa, the prevalence is considerably higher, with rates ranging between 5–9 per 1,000 live births. This is due to limited healthcare infrastructure, inadequate screening practices, and a high burden of preventable risk factors (Olusanya et al., 2014).

In economically developed countries, early detection of neonatal hearing loss through UNHS enables timely intervention, reducing long-term disabilities (Smith et al., 2024). According to the WHO, by 2050, more than 700 million people will have hearing loss that can lead to disability, with the majority of these cases occurring in LMICs (WHO, 2021). Early detection and timely intervention can mitigate the long- term consequences of hearing impairment. However, these benefits are largely inaccessible in many parts of Africa, where screening is limited and diagnosis often occurs too late for effective treatment (Swanepoel & Clark, 2019).

Africa experiences unique challenges in tackling neonatal hearing loss. This is primarily due to limited healthcare access, socio-cultural beliefs, and economic constraints (Olusanya & Newton, 2007). Evidence from studies from Nigeria, South Africa, and Uganda shows the significant burden of this issue. This burden is exacerbated by a shortage of specialized personnel, widespread stigma, and a shortage of hearing screening programs (WHO, 2021). Most African countries have yet to implement widespread newborn screening programs, complicating the collection of reliable prevalence data (Wroblewska-Seniuk et al., 2020). Early diagnosis is even more challenging due to the difficulty in accessing healthcare, especially in rural areas. In sub-Saharan Africa, the situation is even more severe. Less than 10% of countries in this region have established neonatal hearing screening programs, compared to 95% in high-income nations (WHO, 2025). Many health facilities lack the necessary audiological equipment and trained professionals to conduct hearing tests. Cultural myths and misconceptions about hearing loss also discourage affected families from seeking necessary medical attention (Wanjau et al., 2022).

These challenges are evident in Kenya, where neonatal hearing loss is still a largely overlooked public health issue despite its significant developmental impact (World Health Organization [WHO], 2021; Kenya Ministry of Health, 2023). The Kenya National Ear and Hearing Care Strategy (Kenya Ministry of Health, 2023) was launched to tackle this public health challenge, emphasizing the need for early

identification and intervention (World Health Organization [WHO], 2021; Ndegwa et al., 2024). However, practical challenges remain, including inadequate resource allocation, limited accessibility of healthcare services, and deep-rooted societal attitudes towards hearing impairments (WHO, 2021; Mulwafu et al., 2016). The few screening programs in Kenya are concentrated in urban centers, leaving many neonates at risk., especially those in rural and marginalized communities, without access to early diagnosis and treatment (World Health Organization [WHO], 2025; Kenya Ministry of Health, 2023).

Neonatal hearing loss results from a variety of factors spanning the prenatal, perinatal, and postnatal stages. Prenatal causes include genetic disorders, such as connexin 26 mutations, and maternal infections, such as rubella and cytomegalovirus (CMV) (World Health Organization [WHO], 2021; Korver et al., 2022). Perinatal variables, including hyperbilirubinemia, birth asphyxia, and preterm birth, significantly increase the risk (Joint Committee on Infant Hearing [JCIH], 2019). Hearing impairment often results from postnatal factors which include exposure to ototoxic drugs (e.g., gentamicin), neonatal meningitis, and severe jaundice (Olusanya et al., 2020). These risk factors highlight the importance of targeted screening, especially in settings with limited resources where preventable causes are still common.

Specialized tools, such as distortion product otoacoustic emissions (DPOAE) and automated auditory brainstem response (AABR) screening, are essential for diagnosing neonatal hearing loss (American Academy of Pediatrics [AAP], 2007). However, these tools are not widely available in Kenya, particularly outside major hospitals (Wanjau et al., 2022). Many Kenyan public hospitals lack the capacity to provide comprehensive hearing care, resulting in undiagnosed and untreated cases of hearing impairment in affected neonates (Mulwafu et al., 2016). Untreated hearing loss imposes a significant economic burden, exacerbating disparities by imposing substantial costs on families seeking interventions like cochlear implants (Swanepoel & Clark, 2019).

Access to treatment is especially challenging in Kenyan communities where poverty and logistical constraints limit access to specialized healthcare services. For many families, accessing audiological services presents significant challenges, often requiring travel over long distances to urban centers like Nairobi and Eldoret, imposing financial and social burdens (Wanjiru et al., 2023; Kenya Ministry of Health, 2023). Furthermore, the expense of diagnostic tests, hearing aids, and rehabilitation services amplifies existing disparities, endangering the hearing and developmental well-being of the most vulnerable newborns.

Untreated neonatal hearing loss has a significant impact, resulting in delayed language acquisition, poor academic performance, and social isolation (Smith et al., 2024). Children affected by these issues often face challenges with communication if early intervention is not provided. This can hinder their ability to successfully integrate into mainstream education and employment settings (Moeller, 2000). The long-term financial impact on families and society is significant, as individuals with untreated hearing loss require additional support in areas such as education, employment, and access to social services (WHO, 2021). A

multifaceted strategy is required in order to address these challenges, involving policy reforms, resource allocation, public awareness campaigns, and upgrading healthcare infrastructure (Olusanya et al., 2014; WHO, 2025).

OBJECTIVE

General Objective

This study assesses the prevalence and risk factors of neonatal hearing loss at Moi Teaching and Referral Hospital (MTRH), Eldoret, Kenya.

Specific Objective

1. Determine screening results rates (pass/refer) using DPOAE and AABR
2. Identify demographic and clinical risk factors associated with hearing loss (e.g., NICU admission, maternal history).
3. Comparing the generated localized data and its findings with Sub-Saharan African tertiary centers.
4. Advocate for scalable solutions such as task-shifting and tele-audiology (Olusanya et al., 2014).

By addressing these challenges, the study aligns with global efforts to reduce the lifelong impact of hearing loss (WHO, 2025).

HYPOTHESIS

Hearing loss among babies born at and attending MTRH MCH is similar to other tertiary centers in Sub-Saharan Africa.

REVIEW OF LITERATURE

Global Burden of Neonatal Hearing Loss

Neonatal hearing loss affects 1-3 per 1,000 live births in high-income countries with universal newborn hearing screening (UNHS) programs, rising to 5-9 per 1,000 live births in low-resource settings (Olusanya et al., 2020). The World Health Organization (WHO, 2021) projects that by 2050, over 700 million people globally will require hearing rehabilitation, with 80% of the cases occurring in low- and middle-income countries (LMICs). Untreated hearing loss in neonates leads to delayed language development, poor academic achievement, and reduced economic productivity (Smith et al., 2024). Parents of children affected by hearing loss often face financial challenges in paying for specialized education and hearing treatment.

Challenges in Sub-Saharan Africa

Hearing loss is a growing concern in Africa, where healthcare disparities hinder early detection and intervention. The WHO estimates that Africa has around 40 million people with hearing loss, a figure projected to increase to 97 million by 2050 (WHO, 2021). Many African countries lack national newborn hearing screening policies, and where screening exists, it is often restricted to major urban hospitals. Fewer than 10% of African nations have implemented UNHS as compared to 95% of economically developed countries (WHO, 2025). This huge disparity is due to a combination of factors which include shortages in funding, infrastructure, and workforce. Studies conducted in Nigeria, South Africa, and Uganda have revealed that neonatal hearing loss prevalence in Africa is underreported due to systemic obstacles, risk

factors framework, and gaps in screening and interventions. Additionally, there is little public awareness about the importance of early detection and intervention.

Systemic obstacles

This disparity is made worse by systemic barriers such as cultural stigma where by 68% of families in Africa attribute hearing loss to spiritual causes (Swanepoel & Almec, 2008), Such cultural beliefs cause challenges in accessing diagnostic and treatment services, leading to delayed interventions severe workforce shortages, the African workforce averages <1 audiologist per 500,000 people; (Mulwafu et al., 2016), and diagnostic limitations where by only 12% of rural clinics have an audiology equipment; (Wroblewska-Seniuk et al., 2020).

Risk Factor Framework

The risk factor framework is in line with JCIH (2019) guidelines, risk factors range from prenatal, perinatal, and postnatal. Prenatal risk factors include maternal infections like cytomegalovirus (CMV), rubella, and syphilis [WHO, 2021c] as well as genetic syndromes that account for 30% of the cases (Olusanya et al., 2020). Perinatal factors include birth asphyxia [OR = 3.2, 95% CI: 2.1–4.9; (Ndegwa et al., 2024), preterm birth, low birth weight, neonatal jaundice requiring phototherapy, and neonatal sepsis (Joint Committee on Infant Hearing [JCIH], 2019). Jaundice, specifically when bilirubin levels become critically high, has been associated with auditory neuropathy, which leads to permanent hearing impairment if untreated (Nelson et al., 2008) and prolonged NICU stays >5 days (AAP, 2007). Postnatal risk factors contributing to hearing impairment include exposures to ototoxic medications, e.g., gentamicin (Moeller, 2000), and recurrent otitis media (Olusanya & Newton, 2007). 6

Gaps in Screening and Intervention

Despite the global standardization of DPOAE/AABR screening (JCIH, 2019), low- and middle-income countries (LMICs) contend with prohibitive costs in which AABR machines cost more than >$10,000 (Swanepoel & Clark, 2019), high attrition rates that lead to a 60% loss to follow-up on screened patients (Wanjau et al., 2022), and unaffordable treatments where the cost of cochlear implants is equivalent to 5× Kenya's GDP per capita (WHO, 2021a).

Kenya's Policy Context

Kenya faces significant challenges in implementing neonatal hearing screening due to policy gaps, financial constraints, and healthcare system limitations. The 2023 Kenya National Ear and Hearing Care Strategy aims to increase screening rates, but the lack of widespread infrastructure remains a key obstacle (Kenya Ministry of Health, 2023). Many hospitals do not have trained audiologists or the necessary equipment to conduct hearing tests, particularly in rural areas (Ndegwa et al., 2024). Due to limited resources, healthcare facilities in these rural areas prioritize providing primary care services. Socioeconomic barriers further limit parental follow-up, as caregivers often lack awareness of hearing loss and its long-term impact. Cultural stigma regarding hearing impairment also discourages families from seeking medical intervention (Olusanya & Newton, 2007). In some communities, children with hearing loss face exclusion from school due to the lack of

specialized educational support, further compounding their developmental challenges (Nelson et al., 2008). Besides affecting the child's learning, this exclusion from school also reduces their opportunities for social integration and future economic participation

Innovative Solutions

Improving neonatal hearing screening in Kenya and Africa requires a multi-sectoral approach. (Olusanya et al., 2014) recommends integrating hearing screening into maternal and child health services to enhance accessibility. Training healthcare providers in hearing screening techniques and establishing referral pathways for follow-up care are critical for program success. In addition, international partnerships and government investments in assistive hearing technologies, such as hearing aids and cochlear implants, will improve access to treatment for affected children (Ndegwa et al., 2024). Public health campaigns addressing cultural misconceptions about hearing loss can also encourage greater acceptance of screening programs (Olusanya & Newton, 2007). Moving forward, incorporating digital health technologies and mobile screening units may help overcome geographical and logistical barriers to neonatal hearing care in Kenya and other LMICs. Investments in tele-audiology services have shown promise in remote regions, offering access to early diagnosis and intervention through digital platforms (Swanepoel & Hall, 2010). Additionally, with advancements in artificial intelligence, there is a potential for automating and improving the efficiency of the screening process.

Need of the study

Neonatal hearing loss, if it goes undetected can lead to delayed speech, language and cognitive development. While early detection through universal newborn screening is standard in many high-income countries, such programs implementation is limited in Kenya. At Moi Teaching and Referral Hospital, no published data currently exist on the burden and risk factors of neonatal hearing loss.

METHOD

Aim of the study

The study aimed to determine the prevalence and associated risk factors of neonatal hearing loss among infants born at or attending the Riley Postnatal Ward, Newborn Unit (NBU), Newborn Intensive Care Unit (NICU), and MCH Clinic in Eldoret, Uasin Gishu County

Study Design

The study employed a prospective cross-sectional design to assess the prevalence and associated risk factors of neonatal hearing loss among infants born in or admitted to the MTRH Riley Postnatal Ward, Newborn Unit (NBU), Newborn Intensive Care Unit (NICU), and MCH Clinic in Eldoret, Uasin Gishu County

Study Duration

The study was conducted over a three-month period (March-May 2025) to ensure adequate enrollment of infants and in alignment with maternal and child clinic schedules.

Study Setting

The study was conducted at Mother and Baby Hospital (RMBH), where enrollment of newborns was done immediately after delivery. The Newborn Unit (NBU) and Neonatal Intensive Care Unit (NICU) were included for high-risk neonates (e.g., preterm, low birth weight, and prolonged admission)

Sampling

Based on MTRH's monthly average of approximately 1,000 births per month, about 3000 neonates were enrolled using convenience sampling.

Inclusion criteria

1. All children born at MTRH Riley Mother & Baby Hospital
2. All children who attend the MCH clinic
3. All children discharged from the NICU

Exclusion criteria

1. All babies older than 3 months
2. All children with congenital malformation of the ears
3. Those who do not consent

Ethical Consideration

Ethical approval to conduct the study was obtained from the MTRH/Moi University Institutional Research Ethics Committee (IREC). A signed informed consent was obtained from all subjects involved in the study. All data were handled in compliance with ethical guidelines for medical research involving human subjects

Study personnel

The study team comprised the Principal Investigator (PI), who was the lead audiologist, and two registered nurses working in the NBU and RMBH. The PI supervised the study and ensured quality control.

The PI managed the study and ensured that project activities were conducted according to the study protocol. The parents or guardians were contacted by the PI regarding the scheduling of tests and visits.

Research assistants enrolled participants into the study, facilitated data collection, and ensured the timely submission of weekly and monthly reports.

A statistician collected all the study questionnaires from the research assistants on a daily basis and ensured that the questionnaires were completed accurately and that data entry was performed correctly.

The principal investigators trained the research assistants on how to obtain informed consent and conduct screening. The PI confirmed all screening test results and conducted all diagnostic tests.

Data Collection

Collection of clinical history

A detailed clinical history was obtained from the child's hospital electronic and manual records (ERP files), followed by an interview with the guardian. Informed consent was obtained after careful and detailed explanation of the purpose of the study and its potential benefits and risks (see Figure 1.).

A clinical examination of each baby was conducted, specifically to detect any malformations. Babies with bilateral

external auditory canal atresia were excluded from the study.

Hearing screening was conducted for all children less than 3 months of age, including newborns and those attending the 6- and 10-week MCH immunization clinics.

Screening tests

All babies in the MTRH Postnatal ward, newborn unit, NICU, and those under 3 months presenting at the MCH clinic for immunizations were screened for hearing.

For healthy children born through normal delivery, screening was done between 12–24 hours post-delivery, and at 3 days for those born via caesarean section. A case history was obtained, followed by hearing screening using Distortion Product Otoacoustic Emissions (DPOAEs) and Automated Auditory Brainstem Response (AABR). Those who met the inclusion criteria and consented underwent hearing screening using DPOAEs and AABR. The study was conducted Monday to Friday; babies born over the weekend were screened the following Monday.

DPOAE screening was conducted at the bedside in a designated quiet room by presenting a click sound stimulus through a small probe placed in the ear canal. The tones were presented as follows: L1 = 65 dB, L2 = 55 dB SPL. A signal-to-noise ratio of 6 dB in three out of four tested frequencies (2–5 kHz) qualified as a "pass." 9

AABR screening was conducted by presenting a click sound through insert earphones, with surface electrodes placed on the baby's head to record responses. Results for both DPOAEs and AABR were displayed as either "pass" or "refer." Screening results were communicated to the parent/guardian, and explanations were provided. No further testing was done for babies who passed the screening. Those who had abnormal results ("referred") underwent a confirmatory diagnostic ABR, scheduled six weeks after discharge, at the special audiology clinic in the ENT Head and Neck Department.

All babies admitted in the NICU for more than 3 days underwent automatic AABR hearing screening before discharge. Those who passed were not tested further. Babies who referred were scheduled for a rescreen within six weeks. A diagnostic ABR was performed within 3 months for those who referred the rescreen. No further testing was conducted for those with normal ABR results.

Confirmatory ABR testing

A Diagnostic tone burst ABR was conducted by presenting a sound stimulus through an insert earphone placed in the baby's ear canal. Surface electrodes were placed on the baby's head to record the response. Hearing loss greater than 30 dB HL, whether bilateral or unilateral, was considered as permanent congenital hearing loss. Referrals were made to ENT specialists for further management and audiological rehabilitation.

Data management and quality control

A data analysis tool was developed to ensure proper handling of data from collection to analysis. Questionnaires and results were consistently checked for completeness and accuracy. Patient identity was coded to maintain confidentiality.

Quantitative data from structured field questionnaires were entered into a computer database developed using Microsoft Access. Regular backups were performed on external

storage devices for data recovery in case of loss. Random selection of entries was done to detect inconsistencies and confirm the quality of the data.

Statistical analysis

Upon completion of data entry, cleaning and validation were carried out to generate a clean dataset, which was then exported into IBM SPSS version 25.0 for analysis. Descriptive statistics, such as frequencies and proportions, were used to summarize all categorical variables. Pearson's Chi-square test was used to assess differences across points of enrollment. The threshold for statistical significance was set at $p < 0.05$. Data collection tools were tested and validated before use. Questionnaires were reviewed daily for completeness and consistency. To verify data quality, 25% of the babies were randomly selected for repeat hearing screening to confirm the results.

RESULTS

A total of 3020 babies were eligible for screening between March to May 2025; of these, 2982 of the mothers consented to participate, yielding a screening coverage of 98.7%. Those who were not screened for reasons of early discharge or death of a baby were 1.3%. The results are presented in three sections: (1) Screening Location, (2) Background characteristics, and (3) Screening results.

Screening Location

Screening of all eligible babies was conducted at three locations: the Postnatal ward, MCH clinic and NBU (see Figure 2.). Postnatal ward constituted the largest location of screened babies at 81.6%, followed by NBU at 12.1%, with the least being at the MCH clinic at 6.3%

Neonatal and Maternal Background Characteristics

Table 1 presents the neonatal and maternal background characteristics (see Table 1.). The highest number of neonates screened was from the postnatal ward (81.6%), with 12.1% from the NBU and 6.3% from the Immunization Clinic. Of the 362 newborns admitted to the NBU, 57.7% were admitted to the NICU. Of the 209 admitted to the NICU, 22.5% stayed for more than 5 days, a condition considered a risk factor for hearing impairment.

Regarding gestation age, most of the deliveries reached full term (39–40 weeks), amounting to 48.8%, while 31.3% were early term (37–38 weeks). A smaller percentage were preterm 1.1%, and 0.9% contributed to post-term.

There was a comparable gender distribution, with the male 49.0% which was slightly lower to the female 51.0% distribution among the infants. A majority of the infants, 89.1% had normal birth weight (2,500–4,200 grams), with a small proportion of 8.8% having low birth weight and 0.4% with very low birth weight, 1.7% amounted to overweight. Nearly all deliveries occurred in

health facilities 99.9%, with 88.8% taking place at MTRH specifically.

Screening results

First Stage Hearing Screening

The number of babies referred at the initial screening is illustrated in Table 2, which indicates that Initial hearing screening was conducted across all three units (see Table 2.). The majority of the referrals were done in the postnatal ward; of the 2,432 neonates screened, 526 neonates, amounting to 21.6%, were referred for further testing. In the newborn Unit, among 362 neonates, 209 were from the NICU; of these, 37 neonates, amounting to 26.1%, failed the screening. In total, 40 neonates, that is 17.7% of NBU, were referred. MCH Clinic had a referral rate of 10.6%, out of 188 neonates, a total of 20 were referred.

Overall, 623 out of 2,359 neonates amounting to 20.9%, did not pass the initial hearing screening and were categorized as "REFER,". These neonates were referred for the second-stage screening due to failed or inconclusive results.

Second Stage Screening Outcomes

Of the 623 neonates referred after the initial first-stage screening, a second screening was conducted, and the final results, as shown in Table 3, showed that out of the 2982 screened, 2827 neonates passed, accounting for 94.8 % (see Table 3.). The remaining 155 neonates that amounted to 5.2% of the neonates were referred for further diagnostic evaluation, confirming a prevalence of suspected hearing loss of 5.2% in the screened population The results from the screening location indicated that the postnatal ward accounted to the largest number of referrals due to its high birth volume, 113 neonates. The highest proportional referrals were observed in the Newborn Unit (NBU + NICU), 28 neonates (7.7%), and the MCH clinic had 14 neonates (7.4%) compared to the postnatal ward (4.6%).

Confirmation of hearing loss

A total of 155 babies were referred for diagnostic hearing testing and ENT consultation for a comprehensive assessment that will be conducted by an audiologist to determine the type, degree, and cause of hearing loss.

Chi-square Test of Association Between Screening Location and Referral Outcome

A chi-square test of independence was conducted to determine if these differences were statistically significant, as illustrated in Table 4 (see Table 4.). The results indicated a significant association between screening location and referral outcome ($\chi^2 = 7.38$, df = 2, p = 0.025). This suggests that the likelihood of neonates being referred varied meaningfully depending on their screening location.

Test Summary;

χ^2 Value = 7.38, Degrees of Freedom (df) = (3-1) × (2-1) = 2, p-value = 0.025, Effect Size (Cramer's V) = 0.05, Interpretation: Significant association ($\alpha = 0.05$)

DISCUSSION

This was a pilot study, conducted at Moi Teaching and Referral Hospital (MTRH), demonstrating the feasibility of implementing a UNHS program, the prevalence of neonatal hearing loss, and

evaluating the effectiveness of a two-stage hearing screening protocol.

The study attained a screening coverage of 98.7%, exceeding the Joint Committee on Infant Hearing (JCIH) recommended threshold of 95% for effective newborn hearing screening programs (JCIH, 2019). This high coverage reflects both the feasibility and effectiveness of implementing universal newborn hearing screening (UNHS) in a large tertiary referral facility in Kenya. This rate mirrors outcomes in several Sub-Saharan African countries where similar initiatives have been piloted. Nigeria reported a screening coverage of 98.7% in a tertiary hospital program (Olusanya et al. 2008). In Abidjan, Côte d'Ivoire, a pilot universal newborn hearing screening program was implemented, attaining a 96.7% screening rate among eligible neonates (Kouassi et al. 2019), which demonstrates feasibility even in French-speaking West African contexts. Similarly, a study in Uganda reported that although coverage varied due to resource challenges, initial screening rates in urban hospitals ranged between 91% and 94% (Kaspar et al. 2018), indicating strong potential with appropriate infrastructure and system support.

In Kenya, a pilot program conducted at PCEA Kikuyu Hospital revealed significant barriers to universal newborn hearing screening but also showed that when implemented with trained personnel and appropriate tools, screening coverage could exceed 90% (Wanjau et al. 2022). More recently, a multi-site study conducted in Kenyan hospitals reported screening uptake rates ranging from 85% to 94% (Ndegwa et al., 2024), depending on location and equipment availability.

A key contributor to the high coverage in this study was maternal willingness to participate in the screening process, which was achieved through educating mothers on the causes of hearing loss, what surprised most is when they learned that it was not caused by cultural beliefs. The importance of hearing screening and the early detection of hearing loss, as well as the effects hearing loss could have on a child's development of speech and cognitive development. These findings collectively affirm that high newborn hearing screening coverage is achievable in diverse Sub-Saharan African settings when adequate infrastructure, trained personnel, and parental engagement are in UNHS success.

The final prevalence of suspected neonatal hearing loss in this study was 5.2%, a rate that is clinically significant and aligns with referral rates reported in similar hospital-based screening initiatives across Sub-Saharan Africa (Kaspar et al., 2018; Olusanya et al., 2008). In Kenya, the prevalence is 4.8 per 1,000 live births (Ndegwa et al., 2024), particularly among neonates with risk factors such as NICU admission, prematurity, neonatal jaundice, and exposure to ototoxic medications. This figure highlights the importance of early hearing screening and intervention programs within the first weeks of life.

The largest volume of referrals came from the postnatal ward, primarily because it accounted for the highest number of deliveries. However, when comparing proportional referral rates, the Newborn Unit (7.7%) and MCH Clinic (7.4%) exhibited the highest referral rates. These results indicate that neonates from these units face a higher risk of hearing impairment, likely due to a greater concentration of vulnerable infants,

such as those with low birth weight, perinatal infections, or those requiring extended NICU admission. This aligns with (JCIH, 2019) and (WHO, 2021) recommendations that targeted screening should focus on high-risk neonates, even in the absence of complete UNHS coverage.

The drop-in referral rates from the first stage (20.9%) to the second stage (5.2%) demonstrate the effectiveness of a two-stage screening protocol. Many newborns who fail initial otoacoustic emissions (OAE) testing may present with temporary conditions, such as vernix obstruction, transient middle ear fluid, or environmental testing artefacts, which typically resolve within days of birth (Kanji & Khoza-Shangase, 2016). Re-screening minimizes false-positive results and prevents unnecessary parental anxiety and overburdening of diagnostic services.

Despite the promising screening coverage of 98.7%, well above the JCIH-recommended 95% threshold (JCIH, 2019), gaps remain in structured follow-up systems. While nearly all neonates were born at term with normal weight and delivered in healthcare settings (99.9%), as observed in this study, compared to home births, could be attributed to free maternity services provided in public hospitals in Kenya. Still, many lack clear pathways for diagnostic evaluation and intervention after a failed screening. Early hearing detection is critical, as undiagnosed hearing loss can impair speech, language, and cognitive development in early childhood. Without a coordinated system, children with confirmed hearing loss risk missing the critical window for early auditory and language development, which is most effective when interventions begin before six months of age (Yoshinaga-Itano et al., 1998).

Furthermore, although the screening coverage at MTRH was high, its sustainability relies on the ongoing training of healthcare providers, procurement and maintenance of screening devices, and integration into routine neonatal care workflows (Wanjau et al. 2022). However, systemic challenges such as funding limitations, a shortage of trained audiologists, and low parental awareness continue to slow down scaling efforts in other regions of Kenya.

The findings also revealed a statistically significant difference in referral rates across the different screening units, with the NBU/NICU and MCH clinics showing higher proportions of referrals compared to the postnatal ward. The chi-square test ($p=0.025$) confirmed that the differences were unlikely due to chance, pointing to a possible association between neonatal care environments and hearing screening outcomes. This variation could be attributed to the clinical profiles of neonates in these units. Infants in the NICU and NBU were more likely to have experienced high-risk conditions such as prematurity, low birth weight, hyperbilirubinemia or maternal infections, which are well-documented risk factors for hearing loss (JCIH,2019; WHO,2021). These findings support the importance of targeted screening protocols and reinforce the need for heightened surveillance among high-risk neonates. The result also supports the empirical justification for prioritizing resources and diagnostic follow-up in units with higher risk burdens, aligning with existing literature advocating risk-based and universal screening in resource-limited settings (Olusanya et al., 2020; Kaspar et al., 2018)

In summary, this study emphasizes the importance of implementing routine hearing screening for newborns, particularly in tertiary hospitals that serve large populations. With structured follow-up systems and policy-level support, early detection and intervention for neonatal hearing loss are both achievable and essential.

CONCLUSION

This study underscores the importance of integrating routine newborn hearing screening into maternal and child health services in tertiary hospitals. The prevalence of 5.2% suspected hearing loss is a strong indicator that undetected congenital hearing loss is a real and present concern in the population served by MTRH. Notably, infants from the Newborn Unit and MCH Clinic recorded the highest referral rates, indicating a concentration of clinical risk factors such as NICU admission, prematurity, neonatal infections, and hyperbilirubinemia. all of which are recognized contributors to early hearing loss.

Although the majority of neonates passed the screening, the 155 infants referred for further evaluation represent a significant public health concern. The study also revealed critical gaps in follow-up systems and access to confirmatory diagnostic services. Despite successful initial screening, the lack of structured referral pathways and specialized hearing care services poses a barrier to timely intervention, especially for children who require audiological rehabilitation. Early identification and timely intervention can make the difference between normal and delayed speech, language, and cognitive development. The findings strongly support the need for scaling universal newborn hearing screening as a standard part of postnatal and pediatric care at MTRH, with special emphasis on high-risk neonates, systemic coordination, and policy-level support to ensure that children with hearing loss receive timely care.

With appropriate resources, trained personnel, maternal education, and policy support, UNHS can be successfully integrated into routine neonatal care, leading to early identification and improved developmental outcomes for infants with hearing impairment.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed to enhance early identification and management of neonatal hearing loss at MTRH. There should be an introduction of a Universal Newborn Hearing Screening (UNHS) as a standard care in all maternity and neonatal units, including the postnatal ward, NICU, and MCH clinics. This will ensure that all infants, regardless of risks, are screened before discharge or within the first month of life.

The need to Strengthen the Two-Stage Screening Approach by using the two-tier system (initial and repeat screening), this model should be adopted particularly in high volume centers; it will reduce false positives and ensure only true at-risk cases are referred for diagnostic audiology services and ENT consultations. To improve diagnostic accuracy and avoid unnecessary referrals.

Developing and enforcing a structured referral and follow-up pathway for babies who fail the initial screening. These should

include timelines for diagnostic ABR testing and mechanisms to track and support affected families through appropriate interventions, including hearing aids or cochlear implants. The poor loss to follow-up rates which is a challenge to for hearing screening programs, will reduce making early intervention achievable.

Enhancing staff training and capacity building for healthcare providers, especially nurses, pediatricians, audiology technicians, clinical officers and also midwives on the knowledge and skills to conduct hearing screenings, the importance of early hearing screening, interpretation of results, and how to guide parents through the process and also provide appropriate counselling to caregivers. MTRH should also consider hiring more or partnering with audiologists to support program implementation and management.

Investing in screening equipment and Infrastructure through the allocation of funds and partnering with other institutions to procure and maintain screening tools, otoacoustic emissions (OAE), and auditory brainstem response (ABR), especially for high-volume areas like the postnatal ward and NICU, to ensure sustainability.

Enhance community and parental awareness through education campaigns being launched to inform the caregivers about the importance of hearing screening and risks associated with delayed interventions. This communication will be ideal in prenatal classes and during postnatal care visits. Empowering parents with knowledge encourages compliance with follow-up appointments.

And lastly, through policy Integration, the Ministry of Health should formally advocate for the inclusion of newborn hearing screening within Kenya's child health policies and routine immunization schedules to institutionalize early hearing detection and intervention (EHDI) programs. The policy support will facilitate scale-up and ensure consistent funding, monitoring and evaluation.

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APPENDIX A: - FIGURES AND TABLE

Figure 1.

Study Flow Chart

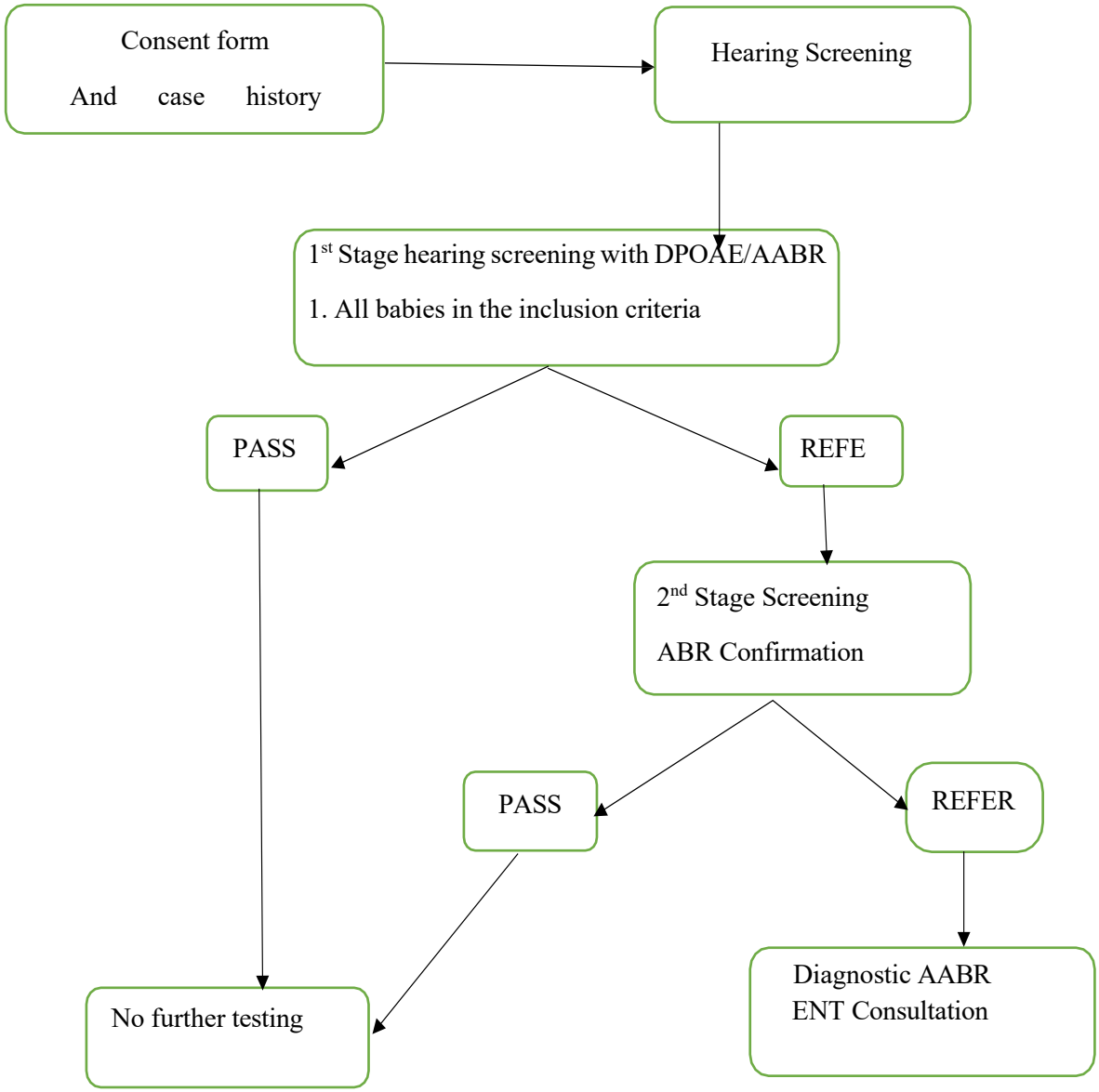

Figure 2.

Screening Location distribution

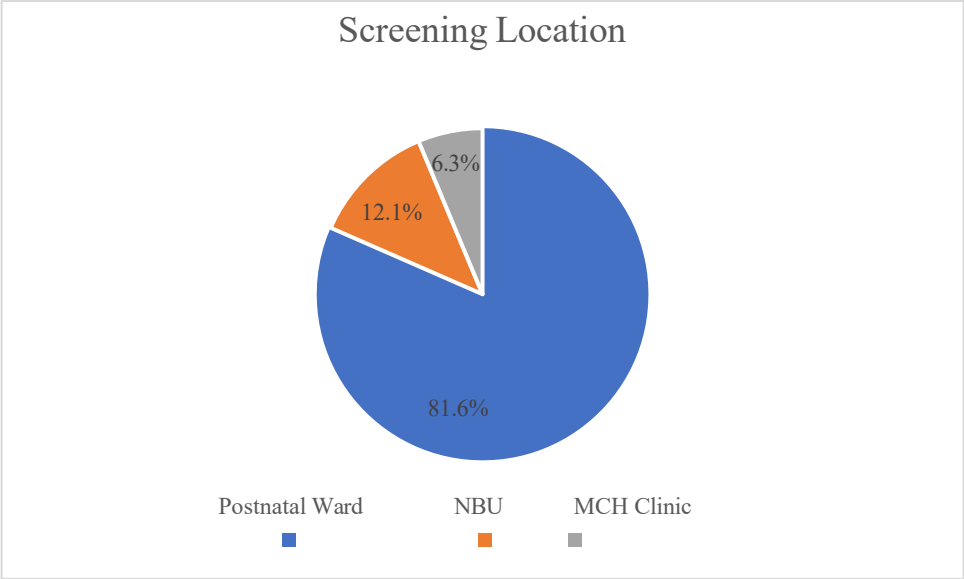

Table 1.

Neonatal and Maternal Background Characteristics

Neonatal and Maternal Background Characteristics		
Variables	**N=2982**	**Percentage**
Location code		
Postnatal Ward	2432	81.6
NBU	362	12.1
MCH Clinic	188	6.3
Patient was admitted to the NICU from NBU		
Yes	209	57.7
No	153	42.3
Length of stay in NICU, in days (n=209)		
>5 days	47	22.5
<=5 days	162	77.5
Gestation age classification (in weeks)		
Preterm (<34 weeks	32	1.1
Late preterm (34 - 36 weeks)	206	6.9
Early term (37 - 38 weeks	933	31.3
Full term (39 - 40 weeks)	1456	48.8
Late-term (41 - 42 weeks)	327	11.0
Post-term (>42 weeks)	28	0.9
Gender of the baby		
Male	1461	49.0
Female	1521	51.0
Birth weight		
Very low (<1500g)	11	0.4
Low (1501g - 2499g)	263	8.8
Normal (2500g - 4200g)	2657	89.1
Overweight (>4200g)	51	1.7
Place of birth		
Health facility	2978	99.9
Home	4	0.1
Health facility (n=2978)		
MTRH	2645	88.8
Other	333	11.2

Table 2.

Summary of Initial Screening Results

Summary of 1st Stage Screening Results					
Screening Outcomes	**Postnatal ward (n=2432)**	**Newborn Unit (n=362)**		**MCH Clinic (n=188)**	**Total (n=2982)**
		NBU	**NICU**		
PASS	1906	113	172	168	2359
REFER	526	40	37	20	623
TOTAL	2432	153	209	188	2982

Table 3.

Comprehensive Summary of 2nd stage screening

Comprehensive Summary after the 2nd Stage Screening Results					
Screening Outcomes	**Postnatal ward (n=2432)**	**Newborn Unit (n=362)**		**MCH Clinic (n=188)**	**Total (n=2982)**
		NBU	**NICU**		
PASS	2319	138	196	174	2827
REFER	113	15	13	14	155
TOTAL	2432	153	209	188	2982

Table 4.

A chi-square test table of independence

Location	Pass	Refer	Total	Expected Referrals	$(O-E)^2 / E$	Contribution to χ^2 (%)
	n (%)	n (%)	n	(E)O-E		
Postnatal Ward	2,329 (95.4%)	113 (4.6%)	2,442	127.4	1.63	22.10%
NICU/NBU	334 (92.3%)	28 (7.7%)	362	18.9	4.38	59.30%
MCH Clinic	175 (92.6%)	14 (7.4%)	189	9.7	1.94	26.30%
Total	**2,838 (94.8%)**	**155 (5.2%)**	**2,993**		**$\chi^2 = 7.38$**	**100%**