

Review Article

The role of the health system in the prevention of hearing loss among children in Sub-Saharan Africa

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ABSTRACT

Around 1.2 million children living in Sub-Saharan Africa have a hearing impairment (HI) or hearing loss (HL). Limited attention and scarce resources dedicated to this condition means that such children often receive no management for their problem. This has substantial negative effects on their development, and ultimately results in poverty. Half of the number of cases of HI in such countries results from preventable causes. Formulation of effective prevention strategies to address the causes requires an understanding of the factors that lead to the causes of HI in Sub-Saharan Africa.

A number of preventable causes were shown to significantly contribute to the prevalence of HI. The most significant causes include perinatal problems, middle ear problems, infective diseases, and ototoxic drugs. These causes persist because there are few effective prevention strategies in place, and those

which exist are poorly implemented. There is little public and health care worker awareness about HL and its prevention. Few resources are allocated to the prevention of HL, meaning that these issues are not addressed.

Evidence have shown that current failings in the prevention of HI from such causes include widespread limited resources, inadequate staff training, and absent or ineffectual prevention guidelines. The burden of HL has been shown to be significantly reduced through effective prevention strategies, both in the developed and developing world, justifying the need for increased attention and more resources in Sub-Saharan Africa.

Key words: Causes of hearing loss; Children; Hearing impairment; Hearing loss; Prevention of hearing loss; Sub-Saharan Africa.

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INTRODUCTION

Hearing loss (HL) is a significant public health problem in Sub-Saharan Africa (SSA) and other developing countries. Of the 278 million people with HL worldwide, more than two thirds live in developing countries [1]. Within such countries, over 180,000 babies with a significant HL are born annually [2]. This review focuses on SSA, where over 1.2 million children aged 5-14 years are estimated to have a moderate to severe HL [3].

The negative impact of a HL on the child is substantial and has been well documented. Without intervention, children with a HL struggle to learn and communicate effectively [1]. This in turn limits the development of cognition [4, 5] and renders such children unlikely to complete primary education [6]. Children with a HL therefore, pose a challenge to the vision of the Millennium Development Goal (MDG) , which aims to provide universal primary education [7]. The negative impact continues into adulthood and it varies in significance ranging from high vulnerability to contract HIV infection as a result of abuse/rape, poor general health indicators to less likelihood to gain employment, resulting in poverty and dependence [6, 8].

Scarce resources in SSA countries are often preferentially allocated to funding the prevention and control of conditions with a high mortality rate. Chronic conditions, such as HL, are given less priority, despite the significant burden they pose [1]. As a result, services for the prevention, detection, and management of HL are 'dire' [9], and the disability is largely 'neglected' [10].

Early intervention has been demonstrated to effectively limit the negative impact of HL on the child's development. Indeed, it has been shown that if intervention is initiated prior to 9 months of age, a child has the potential to develop and reach the same goals as others who do not have a HL [11-13]. Early intervention is only possible when children

with a hearing impairment (HI) are identified early. Generally, routine clinical examination cannot discover early stages of HL, special screening is required [14]. As such, universal newborn hearing screening (UNHS) programmes are widely used in developed countries. However, few such programmes exist in SSA countries [15], meaning impairments are usually only identified once delays in speech and language development become apparent. This is usually around the age of 2 years, at which point interventions are less effective [16].

More than half of the causes of HL have been shown to be preventable, and causes and risk factors related to HL have been well documented [17]. This knowledge has allowed the prevention of a significant proportion of HL in developed countries, as reflected by the reduced incidence. Unfortunately, this knowledge has had little impact on prevention of HL in developing countries, where incidence continues to rise [6].

Where diagnoses have been made, access to effective interventions has been limited [1]. Although hearing aids have been shown to be beneficial for individuals with a moderate to profound HL, only one in 42 of those who live in the developing world has them [1]. Similarly, there is very limited access to specialised education facilities for children with impaired hearing, as few such facilities exist in Sub-Saharan Africa. Hearing impaired children who attend mainstream schools generally suffer due to the widespread lack of awareness and the limited facilities needed to meet their needs [6].

The 'persistent inadequacy' in the prevention, detection and management of HL has long been recognised, leading the 48th World Health Assembly to pass a resolution on the 'major causes of hearing loss, within the context of primary care' [18]. However, despite this, there has been no significant impact reported in SSA countries, and estimates by the World Health Organisation (WHO) demonstrate that the number of people who have a disabling HI,

has in fact increased twofold since the publication of the report [6].

The significant burden of disease and poor level of services that countries in SSA allocate to HL warrant this to be considered as an important public health problem requiring primary prevention.

Effective prevention of causes of HL in SSA can be best achieved through implementation of an evidence based prevention programme. Formulation of such a programme will require an in depth analysis and understanding of why the prevalence rates are so high in individual countries.

The aim of this review is to analyse why the prevalence of HL is higher in SSA countries, draw conclusions from the results and suggest ways on how the health system in different countries could deal with the problem.

METHODS

Preliminary background information was sought by conducting internet searches, with most information obtained from the WHO website. Subsequently, relevant studies were retrieved through two detailed database searches. Data bases utilised include: Web of Science, Global Health, Pubmed, and Scopus. Searches were limited to English language and publication date after 1995. The same key search terms were used to search each of the databases listed.

Primary search

The first literature search aimed to establish the main causes of HL in SSA. The combination of search terms that were used is illustrated in Figure 1.

Combination of search terms				
DEAF*	or	HEARING	or	HI
and				
AETIOLOGY/ETIOLOGY	or	CAUSES	or	RISK FACTORS
and				
AFRICA	or	SSA	or	DEVELOPING

Figure 1: Search terms that were used to establish the main causes of hearing impairment (HI) in Sub-Saharan Africa (SSA).

The relevance of studies within the context of this review was analysed according to their title. Inclusion and exclusion criteria as listed below were applied, and all studies considered irrelevant were excluded. The remaining studies were read in full and analysed. Any relevant cited studies within these articles and any subsequent studies citing these articles were also sought for consideration. Overall this yielded 11 studies to be analysed in depth.

Secondary search

The second literature search aimed to build on the information gained from the first. A number of causes of HL were identified in the studies obtained from the primary search. These were examined in greater detail to increase the validity of results, and to gain an understanding of why these preventable causes continue to exist in SSA. A similar combination of search terms were used, although the terms, 'aetiology', 'causes' and 'risk factors' were replaced

Combination of search terms 2															
DEAF*			or	HEARING			or	HI							
and															
AFRICA			or	SSA			or	DEVELOPING							
and															
ASPHYXIA	or	JAUNDICE	or	CONSANGUINITY	or	OTITIS MEDIA	or	CERUMEN IMPACTION	or	MEASLES	or	MENINGITIS	or	MUMPS	NUTRITION

Figure 2: Combination of search terms used to establish the main causes of hearing impairment (HI) in Sub-Saharan Africa (SSA).

with the causes that had been identified in the literature obtained from search 1 (See Figure 2).

Inclusion and exclusion criteria

To be included, studies had to consider the causes of HL in SSA. Studies considering disability generally, with limited attention to HL specifically were excluded. Studies conducted outside of SSA or published before 1995 were also excluded.

RESULTS

The first literature search revealed 11 suitable aetiological studies, which provide the main evidence base for the causes of HL in this review. The second search revealed 21 suitable studies which considered specific causes of HL individually, increasing the evidence base surrounding the causes of HL in SSA, and also providing greater detail about why these causes persist.

Details of the main findings of the 11 principle studies follow (Table 1).

Table 1: Details of aetiological studies

Study number	Study title [Reference]
1	Challenges in the management of sensorineural hearing loss in sub-Saharan Africa [22].
2	Predictors of early-onset hearing loss in malnourished infants in sub-Saharan Africa [38].
3	Adverse perinatal conditions in hearing impaired children in a developing country [19].
4	Predictors of hearing loss in school entrants in a developing country [14].
5	Profound bilateral sensorineural hearing loss in Nigerian children: Any shift in etiology? [40].
6	Place of birth and characteristics of infants with congenital and early onset hearing loss in a developing country [43].
7	Aetiology of deafness among children at the Buguruni school for the deaf in Dar es Salaam, Tanzania [41].
8	Middle ear disease and hearing impairment in northern Tanzania. A prevalence study of schoolchildren in the Moshi and Monduli districts [44].
9	Hearing loss in Mozambique: current data from Inhambane province [42].
10	Cross-sectional survey of hearing impairment and ear disease in Uganda [45].
11	Sensorineural deafness in Tanzanian children- Is ototoxicity a significant cause? A pilot study [36].

Table 2 demonstrates the main preventable causes of HI identified in the literature, and the relative contributions of each cause to the overall burden.

Table 2: Preventable identified causes of hearing impairment (HI).

Cause	Significance of cause [Reference]
Genetic	Reported as a cause of between 4% [45], and 25% [22] of cases across studies.
Unknown	Reported as a cause of between 10% [22], and 35% [40] of cases across studies.
<i>Perinatal problems:</i>	Reported as a cause of between 9% [22] and 10% [40] of cases across studies.
- Birth asphyxia	Birth asphyxia and neonatal jaundice, alone or associated with difficult delivery, all separately showed statistically significant increases in the risk of developing a HI [40].
- Neonatal jaundice	
- Difficult/ prolonged delivery	
<i>Middle Ear problems:</i>	Several studies reported OM as a risk factor.
Otitis Media (OM)	OM was reported as a cause of between 5% [22] and 27% [42] of cases across studies. Children with OM were also shown to be more than 3 times more likely to have a HI [44].
Impacted cerumen	Impacted cerumen was reported as a cause in 9% in one study [10]. Another study showed that more than half of subjects with HI had evidence of impaction [42].
<i>Infectious Diseases:</i>	Measles was reported as a cause of between 4% [41] and 14% [5] of cases across studies.
- Measles	Mumps was reported as a cause of between 7% [40] and 16% [41] of cases across studies.
- Mumps	
Meningitis	Meningitis was reported as a cause of between 7.8 [22] and 23% [41] of cases across studies.
Ototoxicity	Reported as a cause of between 4% [40] and 36% [36] of cases across studies.

Causes of HL in SSA

Unknown and Genetic causes

Although the aim of this review is to focus on preventable causes of HL, genetic and unknown causes are included here in light of their significant contribution to the overall burden of the disease. It is likely that some cases of HL with an 'unknown' cause were in fact secondary to one of the listed causes which has been undiagnosed. However, a proportion of unknown causes are also likely to be truly idiopathic, meaning primary prevention methods will have no impact on their incidence. The only intervention options for such individuals are secondary and tertiary prevention, which requires effective screening and management.

Genetic causes have been shown to be responsible for a significant proportion of cases of HL. A general lack of genetic counselling services across SSA means that genetic causes are unlikely to be investigated or managed effectively [17]. Again, secondary and tertiary prevention are the only effective management options where this is the case.

Perinatal problems

Perinatal problems, including birth asphyxia and neonatal jaundice by themselves or as complications of difficult delivery, increase the risk of a HL in infants. These problems have been shown to be more likely to occur if births are outside of a hospital and not attended by a skilled attendant [19]. As a result, infants are at increased risk of developing a HL if delivered outside of a hospital [20]. Delivering outside of a hospital, and without the presence of a skilled birth attendant is common practice in many communities in SSA. This practice is also likely to continue [21]. Mothers who deliver at home are less likely to have had contact with health services and be offered any sort of follow up after delivery [20]. The absence of skilled attendants at difficult deliveries can mean mothers are less informed about the increased risks posed to themselves and their infants, which

could make them less likely to actively seek follow up or screening for a HI [20].

Middle ear problems

Otitis media

Otitis media (OM), a middle ear infection, is common in developed countries, but rarely leads to HL. This is due to good general awareness of the condition amongst lay people, and also to the ease of access to diagnosis and effective treatment in primary care. Risk factors for persistence of OM include poor hygiene, nutrition, and housing [32]. These are more pronounced in SSA countries as is reflected in the high prevalence rates in such countries [22-24]. Indeed, OM is often cited as the most common cause of HL in developing countries. As such, the WHO produced a manual for the correct diagnosis and management of OM in 1995 [25]. However, the accurate diagnosis and appropriate management of OM remains a problem in SSA countries [26].

Cerumen Impaction

Impacted cerumen has been shown to account for significant proportion of the cases of HI in SSA. Cerumen impaction is unlikely to lead to HI in developed countries, due to rapid presentation of patients at health centres following symptoms, and subsequent correct diagnosis and management [28]. Diagnosis and treatment are possible with otoscopy and aural toileting. This requires minimal training but depends on the availability of an otoscope [14].

Infectious diseases

Measles

HL is a recognised complication following measles infection. Measles is no longer a significant cause of HL in developed countries, owing to widespread immunization. This is also true for many developing countries, where effective immunisation programmes have been implemented. This produced a 'sharp

decline' in measles induced HL [27]. High rates of measles-induced HL have been directly attributed to inadequate immunization [3]. The significant disease burden related to measles and its complications has been recognised by the WHO. The WHO aims to eliminate measles by aiming for more than 90% coverage of immunization as part of their global immunization vision and strategy [28]. However, there are some countries within SSA where immunization rates in infants remain at less than 60% [29].

Mumps

Mumps infection has been shown to cause a number of cases of HL that is comparable with that caused by measles. An effective mumps vaccine exists, and has been deemed cost effective for industrialised countries. The WHO is not currently promoting widespread coverage with the mumps vaccine in developing countries owing to the lower burden of the disease, compared to other infections, and the limited resources available for wide implementation of vaccines [28]. Currently, no countries in SSA use the mumps vaccine as part of their national immunization schedule [30].

Meningitis

Meningitis epidemics are common in SSA, occurring frequently within countries in the "meningitis belt" which extends across 25 countries. HL is a recognised complication of meningitis and the drugs used in its management. Such complications occur more commonly in developing countries [31]. Several effective vaccines against meningitis exist, and a specific vaccine has been developed for use in the "meningitis belt". The aim is to introduce this vaccine by 2015 [32].

There appear to be few established protocols for audiology referral, and limited audiological services for children following meningitis infection in countries within the "meningitis belt". The only

information regarding audiological follow up in SSA came from South Africa, where few children are referred for audiological assessment following meningitis infection [33]. The picture across other SSA countries is likely to be similar.

Ototoxicity

The ototoxic side effects of many drugs have been recognised and well documented several years ago. In order to address the problems posed by their widespread use, WHO released a document listing 'strategies for the prevention of HL from ototoxic drugs' [34]. However, the impact of this report is questionable, and the use of ototoxic drugs remains to be a significant cause of HL. Indeed, all of the identified drugs causing HL from one study from 2005 appear on the list of recognised ototoxic drugs produced by WHO 10 years previously [22]. The continuing use of such drugs can partly be attributed to the need to prescribe effective drugs in life threatening circumstances, where there are no alternatives that are readily available [35]. This example is highlighted by the results of a study conducted in Tanzania where quinine and gentamycin were used as the main drugs in most cases of malaria [36]. Children in developing countries, where malaria is prevalent, and ototoxic drug use is common are more likely to be underweight than children in developed countries. This makes the possibility of overdose more likely, if doses are not prescribed according to a child's weight, as is often the case [35]. When such drugs are administered, there is little monitoring or follow up, which further promotes ototoxicity [36, 37].

Under-nutrition

Although under-nutrition has not been identified as a specific cause of HL, it is noteworthy since it has been shown to be a significant risk factor in its development [38, 39] Furthermore, the causes identified are more likely to lead to a HL in undernourished children

[39]. The first millennium development goal is to 'eradicate poverty and hunger' [7]. Although there has been progress towards achieving this goal, one in four children in SSA countries remain underweight [7]], which contributes to the burden of HL in such countries.

DISCUSSION

The most remarkable finding of this review is the lack of available literature that considers the causes of HL in SSA, reiterating the point that HL receives little attention in such countries. Results of this review must be considered in light of this limited evidence base, regardless of how significant they appear to be. The scarcity of evidence ultimately negatively affects the validity of any conclusions drawn. This point becomes even more relevant when considering the scale of the area considered. Sub-Saharan Africa (SSA) comprises 47 countries, many of which are not considered at all in the obtained literature. Although there are trends in health problems and the availability of resources across countries in SSA, the area is large and diverse, and findings of studies conducted in one country should not be considered to accurately apply to another.

The reliability of the information presented should be considered in light of the reliability of the evidence base. There are no major contradictions in the literature identified, and results corroborate with those from studies conducted in other developing countries, suggesting that they are reliable. There are a few minor inconsistencies in the literature, most notably, in the reported relative contribution of each cause of HI to the overall disease burden. Such differences can largely be attributed to the different study designs adopted; varying methods were used to assess different outcomes in different populations.

Although HL was the consistent outcome across the literature, the definition of this varied. Different

forms of HL exist, and they affect individuals to varying degrees. The WHO has defined levels of HL according to hearing threshold levels at different frequencies [10].

The level of HL considered varied across studies from slight to more severe, and these definitions did not always corroborate with those provided by the WHO. The type of HL also varied and included sensory-neural, conductive, unilateral and bilateral. Often, the type and level of HL was not stated. The slight variations in outcome were considered not to be important since the aim of the review was to consider the causes of HL as a whole, rather than causes of specific forms or levels of HL.

Weaknesses in the designs of some studies could make the obtained results less valid. For example, a significant portion of studies were retrospective [19, 22, 40-42] and several relied on the recall of information by patients [19, 41, 42], which could be considered a weakness, owing to the potential for bias.

Outcomes were assessed by a range of methods across studies. For example, some of the methods used to assess hearing may not be considered to produce accurate results, which limits the validity of those obtained. Establishing a standardised method of audiological assessment to be used in future studies would allow more accurate comparison of results across studies.

In conclusion, the results of this review demonstrate that the prevalence of HL is higher within countries in SSA because of failings in the primary prevention of preventable causes of HL. The overall disease burden of HL is consequently much greater relative to developed countries. Such causes have been shown to persist within individual countries because of a lack of attention to HL, and little allocation of resources to their prevention. The overwhelming lack of literature available regarding the causes of HL in sub-Saharan countries clearly indicates the low priority of HL there. The high prevalence rates of HL reported in

SSA warrant attention.

International recognition of the significant burden of HI has led to the formulation of strategies to prevent some of the causes identified. In general, where such strategies exist, they have been ineffective in most countries in SSA, owing to their poor implementation. This demonstrates that written guidelines alone are insufficient in preventing these causes of HL. It appears that health care workers have limited awareness of the existing prevention strategies, and are provided with little guidance on how to implement them. Limited available resources make adopting some of the strategies difficult. For example replacing ototoxic drugs with safer, more expensive ones is not possible without increased funding. Where prevention strategies have been well implemented in both developed and developing countries, they have been shown to reduce the incidence of HL. This demonstrates that such strategies have the potential for success if they are implemented effectively. For several of the causes identified, there are currently no prevention programmes or strategies in existence, which partly explains their considerable contribution to the overall HL burden in SSA.

Although this review considers the primary prevention of HL, it is accepted that all causes of HL cannot be eliminated using primary prevention. This highlights the need for comprehensive, effective secondary and tertiary prevention as well. There appears to be limited audiological follow up of patients who suffer from a causative insult to their hearing, and few Newborn Hearing Screening Survey (NBHS) programmes exist. This makes early diagnosis less likely, limiting the possible beneficial effects secondary and tertiary prevention would hold for those with an established HL. Delayed diagnosis has particular significance for the developing child, where a lack of auditory input can drastically impact upon communication skills and cognition. Not only do more people suffer with a HL in SSA, the scarcity of secondary and tertiary

prevention services available to most people in such countries means that they are likely to experience the full impact of the negative impact of the HL.

The failings discussed are largely attributable to the limited allocation of resources for preventing and managing HL. Although resources are limited, the major burden posed by this impairment, can be significantly reduced through effective prevention and management, thereby justifying the need for increased attention towards hearing impairments in SSA.

A way forward: what is the role of the health system? Strategic evidence based prevention programmes have failed to control many of the causes of HL, and it is beyond the scope of this review to address in detail how each of the listed causes can be prevented by strengthening the functioning of the health system. However, there are common reasons why each of the causes persists, which will be analysed further.

Ineffective implementation of prevention guidelines:

Although strategies and guidelines exist to address several of the causes identified, poor implementation has limited their efficacy. In order to be adequately implemented, guidelines must be fully promoted within the health sector of each country [36]. Health care workers should have full access to guidelines and implementation manuals at all facilities, and they should also be provided with the resources required to implement guidelines. For example, although guidelines for management of OM in primary care were published by the WHO several years ago, little training or resources were supplied at these levels, leading to low impact upon the incidence of HL due to OM in SSA.

Guidelines for the appropriate use of ototoxic drugs were also issued by the WHO, which led to the formulation of control policies for the use of such drugs in several countries [36]. The side effect profile of ototoxic drugs should therefore be promoted and guidelines should be widely distributed to health care

workers across facilities. For cases where the use of ototoxic drugs is inevitable, guidance on their correct administration should be provided. The need to administer doses according to the weight of patients, and the need for continual monitoring and in case of use of other drug, drug-drug interaction should be made clear.

There appear to be few guidelines for audiological follow up of patients who have experienced the causative conditions discussed. Protocols for audiology referral following illness due to the causes listed should be established and implemented.

Poor public and health care worker awareness:

Many of the identified conditions lead to HL because of a lack of awareness of their complications and limited follow up after recovery. The disease burden of HL warrants the need for public education campaigns. Parents should be encouraged to attend follow up appointments and seek advice as soon as speech and language delays are noticed. Health care workers should be aware of the complications of the conditions listed and should inform parents of such complications. All individuals should also be offered follow up appointments following their recovery from any causative HI condition.

Lack of resources:

A lack of resources impedes the efforts to prevent HL. Increased resources would provide many beneficial effects, including; the opportunity to replace ototoxic drugs with alternatives that incur a better side effect profile; enabling rapid implementation of widespread immunization programmes; the provision of otoscopes and the required training for their use

in primary care; and also the implementation of large educational campaigns designed to raise awareness of HI amongst the population. This list is not exhaustive, and increased resources would enable the preventable causes of HI to be tackled in many other ways that are beyond the scope of this review. Preventing the conditions listed would have the combined effect of decreasing morbidity and mortality from the conditions themselves as well as reducing the prevalence of HL. Procuring the resources to fund all of such suggestions is idealistic and unrealistic. However, the burden posed by HI does warrant some level of increased attention and funding.

Importantly, the implementation of any prevention strategies will require monitoring and evaluation of their effectiveness. This point is most poignantly demonstrated by the example of the limited impact of strategies to reduce the effects of ototoxic drugs. Despite the publication of these strategies 10 years ago, the use of ototoxic drugs remains a significant contributor to the burden of HI today.

The need for secondary and tertiary prevention:

Some causes of HI, such as genetic causes, are not amenable to primary prevention and some preventable causes will inevitably cause HL, even with effective prevention strategies in place. In such cases secondary and tertiary prevention is necessary, facilitated by effective screening and management. This must be appropriate to the context and resources available within each country. Establishing the most effective options for countries in SSA requires further research.

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