Systematic review

The relationship between mental health conditions and hearing loss in low- and middle-income countries

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Abstract

Objective: Hearing loss can have far-reaching effects on social, emotional, and cognitive development, but few studies have addressed the link with mental health conditions. We conducted a systematic review of the association between hearing loss and mental health conditions in low-and middle-income countries (LMICs).

Methods: We searched six electronic databases using predetermined criteria to retrieve original research reporting mental health in people with hearing loss. We considered quantitative studies measuring any type of mental health conditions according to the ICD10 classifications of "Mental and behavioural disorders" in relation to any measure of hearing loss. We assessed risk of bias using a set of criteria according to the SIGN50 guidelines.

Results: We included 12 studies evaluating 35,604 people with hearing loss in 10 countries. Poorer mental health (measured as (stress and anxiety, depression, and/or behavioural and emotional disorders) was more common among people with hearing loss compared to those without in 10 studies. One study found no difference in mental health outcomes between people with hearing, visual and no impairment. Another study reported that after hearing aids, those with severe hearing loss had significant improvement in psychosocial function, compared to no change among those without hearing loss. Overall, one study was judged to be high quality, 7 medium quality and 4 low quality.

Conclusions: Included studies showed a trend towards poorer mental health outcomes for people with hearing loss than for those without. However, our findings indicate that very few high-quality studies have been conducted in LMICs.

Keywords: Hearing loss, mental health, low and middle-income country

Introduction

Hearing loss is an important issue in public health worldwide. In 2018, WHO estimated that over 5% of the world's population – or 466 million people – has disabling hearing loss (1). It is estimated that by 2050 over 900 million people – or one in every ten people – will have hearing loss (2). Approximately one-third of people over 65 years of age are affected by hearing loss (1). The majority of people with hearing loss live in low and middle-income countries (LMICs), with identified causes being lack of access to health services and higher risk of exposure to factors such as childhood infections and ototoxic drugs (3).

The impact of hearing loss can be far-reaching. Early-onset hearing loss in children can cause delay in speech development and language skills (4-7).Language skills are important for communication, and so difficulties in this area can have a cascading effect on emotional and social development, family interconnectedness, social inclusion and over all perceived quality of life (8-10). Consequently, children with early-onset hearing loss are more likely to experience social isolation, low self-esteem and depression (11-14). Hearing loss in adults has an impact on verbal communication, increases social exclusion and the risk of development of cognitive and functional impairments, particularly among older people (≥65) (15). Furthermore, adults with hearing loss can experience greater dependence on others, and increased vulnerability to neglect, discrimination or violence (16). Consequently, age-related hearing loss is often associated with sadness, feelings of low self-worth or guilt, a loss of interest in daily activities, and disturbed appetite or sleep, which affect concentration (17, 18).

It is therefore not surprising that a range of studies have found an increased prevalence of mental health conditions, including depression and anxiety, among people with hearing loss (19). A Lancet review found extensive evidence from 15 studies in high-income settings that complex mental conditions such as depression, anxiety, paranoid ideation, and interpersonal sensitivity are substantially more common among older people with hearing loss than in people without hearing loss (15). Further evidence shows adults with hearing loss in high-income countries are likely to experience emotional and social loneliness (20, 21), poor cognitive function (22, 23), depressive symptoms (24-26), anxiety symptoms (27-29), and other psychiatric conditions (30-33). Children with hearing loss are also vulnerable to a range of mental health conditions such as depression or behavioural problems (e.g. oppositional defiant disorder), and less consistently, anxiety and psychological distress (34-39). There is a lack of data from LMICs, even though these risks may be magnified due to a lack of hearing services or trained staff, little awareness about how to manage hearing loss (1), and higher levels of poverty, inequality, and unemployment among people with hearing loss (9). Therefore, the aim of this study was to conduct a systematic review of the peer-reviewed literature from LMICs and summarize the evidence from studies that examined the link

between hearing loss and mental health conditions.

Methods

The systematic review was performed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (40). The search was conducted in February 2018 for peer-reviewed articles that presented research findings on mental health conditions among people with hearing loss in LMICs.

Eligibility criteria

Studies were eligible if they met the following criteria: (1) original quantitative research that included people with hearing loss; (2) results reported measure of mental health for people with hearing loss, in comparison to people without hearing loss; (3) research was undertaken in LMICs as defined by the World Bank country classification 2017; (4) articles in English or Chinese. The language restriction was done for pragmatic reasons, as authors were familiar with these languages. Studies were excluded if the full text was not available after exhausting all options (i.e. library requests, contacting author for full texts). Duplicate reports from the same study were either combined if they reported different results, or excluded if the results were the same.

Types of mental health measures

We considered studies measuring any type of mental health conditions according to the ICD10 classifications (41) of "Mental and behavioural disorders" including:

- Mood [affective] disorders (e.g. depression)
- Neurotic, stress-related and somatoform disorders (e.g. anxiety disorders)
- Behavioural and emotional disorders with onset usually occurring in childhood and adolescence (e.g. conduct disorder)

We were predominantly interested in the hypothesis that hearing loss increased vulnerability to mental health conditions, and so excluded conditions where the direction of causation is likely to be in the reverse, while recognising that this review cannot aim to infer causality. These conditions include mental and behavioural disorders due to psychoactive substance use (e.g. dependence syndrome), schizophrenia, behavioural disorders associated with psychological disturbances and physical factors (e.g. sleep disorders or anorexia), disorders of adult personality and behaviour (e.g. personality disorders), intellectual disability, and disorders of psychological development (e.g. autism). We also excluded dementia, though there is a complex relationship between sensory loss in older age, and co-occurrence of dementia, which

together increase vulnerability to depression. Though it has been argued that hearing loss is a contributory cause for almost 10% of dementia (42), it has been pointed out that this ignores potential early neurodegenerative factors leading to both hearing loss and dementia (43). Theoretically then, the association between mental conditions and physical/neurological conditions like hearing loss may be due to common biological or environmental factors, in addition to being a result of the experience of hearing loss having mental health consequences.

Types of hearing loss measures

We considered studies measuring hearing loss using any measure (i.e. clinical or self-reported measures).

Information sources

Six databases (EMBASE, Global Health, CINAHL, Web of Science, MEDLINE, and PSYCINFO) were searched. No limits were placed on date of publication. The search strategy key words for the following three concepts: LMICs, hearing loss, and mental health. Terms were developed using MeSH or equivalent as well as from other reviews on similar topics. Boolean, truncation, and proximity operators were used to construct and combine searches for the key concepts as required for individual databases. Systematic reviews identified through the search were reviewed for eligible included studies. If study protocols were identified, a search was made to determine whether the results of the study had been published.

Study selection

All studies identified through the search process were exported to a bibliographic database (EndNote version X7) for removal of duplications and screening. Two review authors (TB and FJ) independently examined the titles, abstracts, and keywords of electronic records according to the eligibility criteria. Results of the initial screening were compared and full-text records obtained for all potentially relevant studies. Two review authors (FJ and CK) screened the full texts using eligibility criteria for final inclusion in the systematic review. Any disagreements in the selection of the full text for inclusion were resolved by discussion with a third author (TB).

Data collection process

Data were extracted into a Microsoft Excel database developed for the purposes of this review. One author (FJ) extracted all data and this was independently examined by two other reviewers (TB and CK) to ensure accuracy. Data were extracted on the following study components:

- General study information: including author, year of publication

- Study design, sampling, and recruitment methods
- Study setting and dates conducted
- Population characteristics including age, sex, sample size and means of assessing disability
- Research outcomes (main findings related to mental health and hearing loss)

Any differences between the reviewers were discussed and resolved my mutual agreement. We did not conduct a meta-analysis due to the variation in included study designs, measures of mental health condition and hearing loss assessment. Instead, a narrative synthesis was conducted.

Risk of bias in individual studies

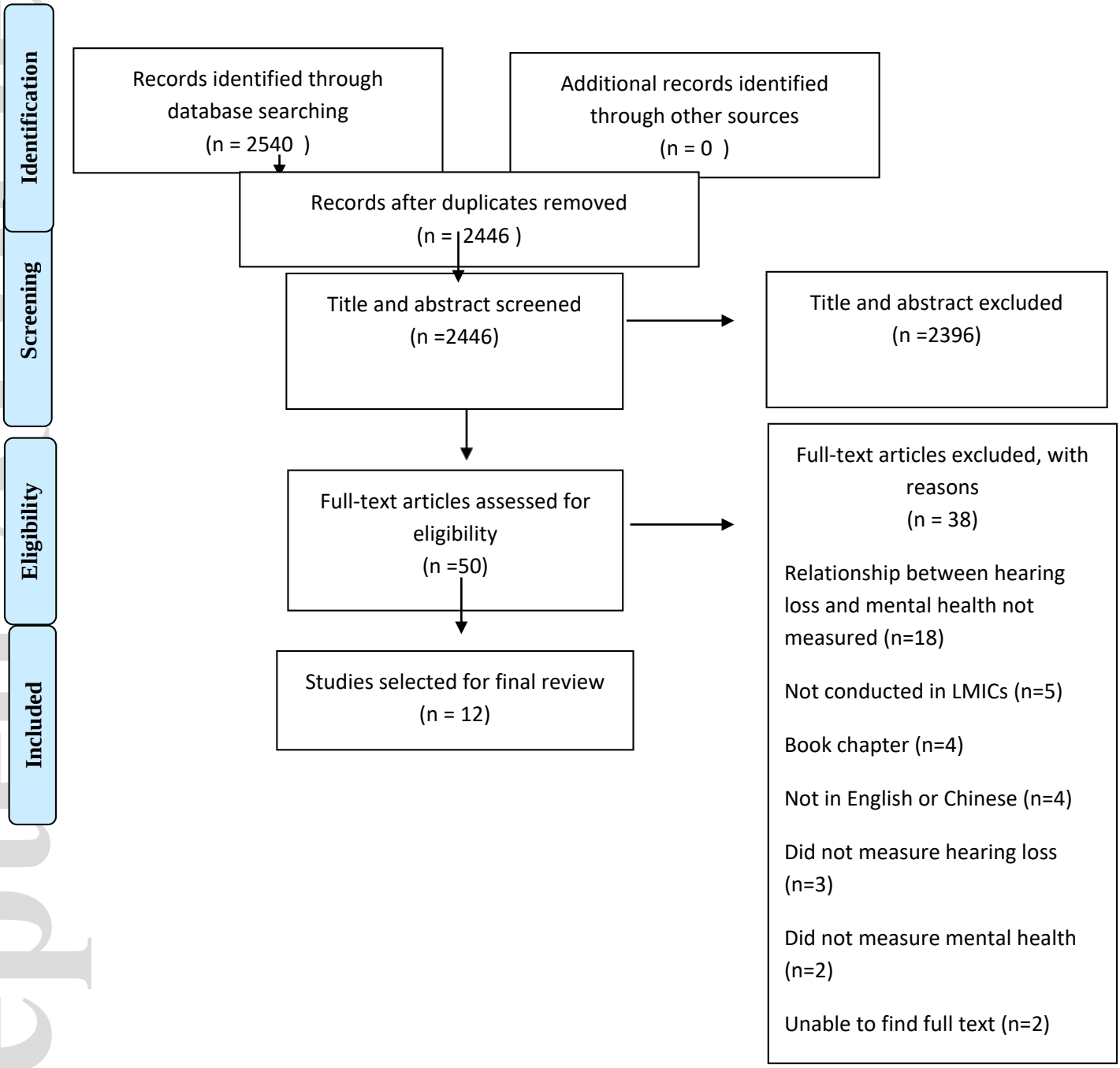
Quality assessments of all eligible studies were carried out independently by two reviewers (TB and FJ). We evaluated studies based on a set of criteria according to the SIGN50 guidelines (44).

Results

Study selection

A total of 2540 studies were initially identified by the electronic searches, of which 94 were duplicates and removed. A further 2396 were excluded during title and abstract screen, yielding 50 potentially eligible studies for which full texts were sought. After full text review, 33 studies were excluded; the full text could not be identified for one article, and four articles were not written in the English language and could not be reviewed by the team (two in Portuguese, one in Spanish, one in Turkish) (Figure 1). 12 studies were selected for inclusion and provided data for 35,604 people in 10 countries.

Figure 1



Study characteristics

Included studies were published between 1988 and 2018, mostly from 2010 onwards (n=9; 75%). Study designs included were case-control studies (n=10) and cross-sectional studies (n=2).

Participants

Overall, six studies (50%) only included children and young people (defined as 0-25 years for the purposes of this review) and three studies (25%) only included adults (18+ only) (Table 1). One study (8%) included both children and adults (15-65 years) and the remaining two studies (17%) did not specify the age range. Studies were conducted in a variety of settings, including special schools (n=5), clinics (n=4), residential institutions (n=1), and both special schools and rehabilitation centres (n=1). One study (8%) was a population-based survey and included 34,129 participants. More than half of studies (n=10, 84%) were conducted in urban locations. The studies included in this review were undertaken in India (3), China (2), Turkey (2), Nigeria (2), Pakistan (1), Ethiopia (1) and multiple countries (China, Russia, India, Mexico, South Africa and Ghana) (1). By region, three (25%) studies were conducted in Sub-Saharan Africa, four (33%) in South Asia, two (17%) in East Asia/Pacific, two (17%) in the Europe and central Asia, and one (8%) in multiple regions. Based on the World Bank classification at the time of the survey, 10 (84%) were conducted in middle-income countries, one (8%) in a low-income country, and one (8%) was conducted in across six countries of varying income levels.

Hearing loss was assessed through self-reported in one (8%) study and pure-tone audiometry in five (42%) studies, while half of the included studies did not clearly describe the means for assessing hearing loss.

Outcome types

Three types of mental health conditions were measured, each using different tools/scales:

- Six studies evaluated stress and anxiety, including through the Stress Inventory for Disabled Children (45), two questions from the Perceived Stress Scale (46), The Fear Survey Schedule for Children-Revised (FSSC-R) and Revised Children's Manifest Anxiety Scale (47), Beck Anxiety Inventory (BAI) (48), Self- Rating Anxiety Scale (SAS) (49) and Spielberger State and Trait Anxiety Inventory (50).
- In three studies, depression was evaluated using the Geriatric Depression Scale-15(51), Beck Depression Inventory (BDI) (48), and Superego Paranoid Depression Scale (50).
- Another five studies measured behavioural and emotional disorders, using the Human Figure Drawing Test, Child Behaviour Checklist (CBCL) (52), Strengths and Difficulties Questionnaire (SDQ) (53), Rutter's Scale B-2 (54), or an unspecified standardised interview (55).

Risk of bias within studies

Only one study was judged as high-quality (46). Seven studies were assessed to be of medium quality due to deficiencies in at least one of the domains: sample size (n=7), reliable assessment of mental health or hearing loss (n=1), clear definition of cases and controls (n=2), validated statistical test (n=1), or complete outcome data (n=1)). Four studies were of low quality. The domains most commonly contributing to low quality were small sample size (n=4), unclear definition of cases and controls (n=3), unreliable assessment of mental health or hearing loss (n=2) and lack of validated statistical test (n=1).

Results of individual studies

Eight (67%) of the 12 included studies found that people with hearing loss had poorer mental health than those without (Table 2). Two studies (17%) reported that people with hearing loss had poorer mental health than people with other impairments. One (8%) study found no difference in mental health outcomes between people with hearing, visual and no impairment. Finally, one (8%) study reported that after hearing aids, those with severe hearing loss had significant improvement in psychosocial function, compared to no change among those without hearing loss.

Stress and anxiety

Two studies assessed stress disorder in people with hearing loss. Stubbs et al. (2018) analysed data from WHO's Study on Global Ageing and Adult Health (SAGE) across six LMICs (China, Ghana, India, Mexico, Russia and South Africa) between 2007 and 2010. They found that adults aged 50+ who have self-reported hearing loss had significantly higher stress levels in all study countries except South Africa (46). Reddy et al. (1991) reported children (11-17 years) with hearing loss experience more stress than children who have physical impairment in residential institutions of India (45).

Five studies reported the relationship between anxiety disorder and hearing loss. Xie et al. (2015) recruited 110 labourers with high-frequency hearing loss from hospital in China between 2012 to 2013 and found that their anxiety symptoms were significantly worse than in people without hearing loss (49). In a sample of 180 subjects (21-30 years) from a hospital in Turkey in 2007, patients with hearing loss were found to have a significantly higher prevalence of anxiety than people without hearing loss (48). Li et al. (2010) found higher levels of anxiety and fear in 61 Chinese children and adolescents (8-19 years) from special residential schools than in a control group with normal hearing (47). Nehra recruited 145 people (15-65 years) with different level hearing loss (moderate to profound) from an Indian hospital and found that the greater the severity of hearing loss, the higher the chance of significant improvement in anxiety

with the intervention of hearing aids (50). Mosaku et al. (2015) compared 52 adolescents with hearing loss and 52 adolescents with normal hearing, and found a higher prevalence of anxiety in the hearing-impaired group (7.7%) than in controls (1.9%) (55).

Depression

Four studies measured the association between depression and hearing loss. Sogebi et al. (2015) assessed 130 elderly patients (60-94 years) with clinically diagnosed hearing loss from Nigeria and found that people with hearing loss had significantly higher levels of depression than controls without hearing loss ($p<0.05$) (51). Cetin (48) found people with hearing loss had higher depression scores than control subjects ($p<0.05$). Nehra (50) found that increasing severity of hearing loss was related to higher levels of depression, but also greater chances of significant improvement in depression after hearing aid fitting. In Mosaku's study, the prevalence of depression was more than twice as high in people with hearing loss (3.8%) as in controls (1.8%) (55).

Behavioural and emotional disorders

Five studies examined the relationship between mental and behavioural disorders and hearing loss. One study in Turkey assessed emotional problems of 117 children and adolescents (6-18 years) in primary and secondary schools for children with hearing loss and mainstream schools (controls). They found that students with hearing loss showed significantly more emotional problems than controls (52). In Ethiopia, Mekonnen et al. (2015) found that the impact of emotional problems was greater for 103 fourth-grade students with hearing loss than for children without hearing loss (53). Mosaku et al. measured psychopathology (attention deficit hyperactivity disorder, unspecified non-organic psychosis, and other behavioral disorders), and 7.6% of adolescents with hearing loss had some form of diagnosable psychopathology versus 0% in the control group ($p<0.05$).

Comparisons have been made of the link between mental health and hearing loss and with other types of impairment. In a study conducted in Pakistan, 32 children (12-18 years) with hearing loss from rehabilitation centres were found to have a significantly higher risk of psychological conditions than the control group of children with intellectual disabilities(56). In contrast, an Indian study by Singh et al. (1988), found a similar proportion (15%) of 275 children (4-16 years) in each of three groups (hearing loss, visual impairment, and controls) had classifiable mental health conditions (i.e. stammering, thumb sucking, emotional disturbance) (54).

Discussion

There was limited evidence on the relationship between hearing loss and mental health from LMICs with only 12 studies included in the review. The majority of studies were conducted among children, and the studies were generally of moderate or low quality. The included studies were heterogeneous in terms of how both hearing loss and mental health were measured, making it difficult to compare results across studies.

Ten of these 12 studies provided evidence that the prevalence of mental disorders is higher in people with hearing loss than in comparison groups without hearing loss. Furthermore, Abbas and Reddy found that hearing loss was also associated with higher incidence of mental health conditions than conditions associated with other impairments (56). Nehra et al. (1997) found the severity of hearing loss was related to the improvement in mental function after intervention (hearing aids) (50).

Although few reports exist of the link between hearing loss and mental health in LMICs, our findings tended to concur with the evidence from high-income countries that have indicated that people with hearing loss are at greater risk of mental health conditions. Even across different cultures, it is reasonable to think that there are many of the same mechanisms at play, linking mental health and hearing loss, given the universal nature of language acquisition, parent-child bonding, attachment, and the strong links between communication, social connectedness and mental health (57). However, a major distinction between countries with different levels of resources may be the proportion of children able to access sign language (with their families) and/or cochlear implants and hearing aids at an early age, and to be part of a wider sign-using community (all protective factors more available in high income settings) (58).

The evidence from LMICs as well as from in high income countries is therefore discussed below in terms of each of the key areas of mental health identified in our review. The findings from both income level groupings are generally supportive of those from our review.

Anxiety and stress

Two studies in the United States and Australia found a statistically significant higher prevalence of anxiety disorder or stress in people with hearing loss than in those without (59, 60). A large study reported the prevalence of an ICD-9 diagnosis in a sample of 5,043 hearing-impaired people and 20,172 matched controls from a Taiwanese insurance database. It found an 11% lifetime prevalence of clinically diagnosed "unspecified anxiety disorder" in people with hearing loss versus 5.4% in the controls (p <0.05) (61). Jones compared 216 older adults (70+ years) with hearing loss from the United Kingdom with 441 age- and area-matched controls, and found there was a consistently strong association between hearing loss and anxiety (62). A retrospective study of data on 2319 patients with severe to profound hearing loss in The

Swedish Quality Register of Otorhinolaryngology indicated greater levels of anxiety and stress among patients with severe or profound hearing loss than in the general population (63). The World Health Survey sample of 6,159 randomly selected people with self-reported hearing loss and 165,869 controls across 42 countries found a pooled prevalence of anxiety using a single self-report question of 19.1% in people with hearing loss versus 8.7% in people without hearing loss(64). This study did not report the results by country income group, and so was not included in our review.

Depression

In our review, only three studies measured depression, but more evidence exists from high-income countries. Investigators in the United Kingdom identified a fourfold increase in symptoms of depression in those with hearing loss when compared with the general population (65). In a community sample of 5,832 subjects from Korea, self-reported hearing loss was associated with significantly higher prevalence of depression and this association was magnified among those with dual hearing and visual impairment (66). The United States National Health And Nutrition Examination Survey (NHANES) survey data showed that hearing loss was associated with increased frequency of depression using the PHQ-9 measurement (67). Another investigation based on clinical interviews with parents in Austria showed that the point and lifetime prevalence of depression were higher in a representative sample of deaf schoolchildren than in children without hearing loss (34). A study from Netherlands which compared three groups of children (children with cochlear implantation, conventional hearing aids and normal hearing) reported significantly more symptoms of depression in children with hearing loss than their peers with normal hearing, even with assistive devices (68). A community survey carried out in Italy recruited 1191 community-dwelling elders and also found hearing loss was significantly and independently associated with increased risk for depression (69).

Behavioural and emotional disorders

The majority of studies in our review focussed on the relationship between behavioural and emotional disorders among children with hearing loss. In a recent meta-analysis of epidemiologic studies, investigators identified hearing loss as a risk factor for psychosis outcomes, including hallucinations, delusions, other psychotic symptoms (70). A school-based study in the Netherlands also reported that pupils with hearing loss in mainstream schools may feel isolated, and consequently show lower self-esteem in relation to peer relationships (71). A large-scale study in Greece that followed up more than 11,000 new-born children at ages 7 years and 19 years established a significant association between hearing loss and self-reported psychotic symptoms at age 19 years (72). In another study from the

Netherlands, self-reported hearing loss was associated with increased frequency of psychotic symptoms among younger persons using a hearing aid (73). Among adults, investigators using a sign-language-based interview in Sweden noted that older people with hearing loss had higher levels of insomnia than did hearing individuals (74). Researchers in the USA found significant differences between hearing-impaired inpatient groups in the frequency of impulse control disorders (23% versus 2%), pervasive developmental disorders (10% versus 0%), substance use disorders (20% versus 45%), mild mental retardation (33% versus 3%), and personality disorders (17% versus 43%) (75).

Implications

Further evidence is needed in order to better understand the link between hearing impairment and mental health in LMICs, and these future studies should be of higher quality, and include older populations, who are currently under-represented in this literature(76). In future studies, appropriate measurement of mental health is important, including validated interview schedules where possible, and not relying only on self-report. Future studies are also needed to understand how the degree of hearing loss be related to the level of mental health symptoms (dose being one factor in starting to infer causality). Importantly, evidence is needed to understand appropriate interventions that can address mental health among people with hearing loss, tailored according to the type of mental health condition, and the age of the person (76, 77). Screening for mental health conditions, such as depression and anxiety, in people with hearing loss seems a pragmatic intervention in relevant populations, and will be important for guiding policymakers' and professionals' decisions regarding investment in interventions and health services (78).

Limitations

There were some limitations that should be taken into account when interpreting the findings of this review. We predominantly restricted our search to the English and Chinese languages for pragmatic reasons, which would bias the results towards countries where these languages are used. For instance, we may have missed studies from countries in Latin America or Francophone Africa. A further limitation of our review is the scope of the question, which related only to correlates. Hence, no inference about the cause of heightened mental health prevalence in people with hearing loss can be drawn from these results.

Conclusions

The studies identified in this systematic review of the relationship between mental health and hearing

loss in LMICs showed a trend towards poorer mental health outcomes for people with hearing loss, with some evidence of the positive impact on mental health of interventions to improve hearing. However, the systematic review identified very few high-quality studies. The vast majority of studies were conducted among children, with very little evidence for working age adults and elderly populations. Further robust evidence is needed from a range of LMICs before strong conclusions can be drawn.

However, the findings of the review would imply that several of the factors that drive worse mental health outcomes can be addressed through public health interventions, health and education sector services, and within international development and disability communities, in common with successful approaches elsewhere (79,80). First, reduction of preventable hearing loss through vaccination (for meningitis, measles, mumps), appropriate use of ototoxic medication (quinine, streptomycin), and reduction of exposure to excessive noise. Second, early identification of hearing loss and addressing hearing loss through treatment of infection, and of provision of hearing aids (though costs and weak systems may be a challenge)(81). Third, inclusive education with routine teaching of sign language (including families, teachers and schoolmates), and strengthening of networks of deaf communities and representative disabled persons' organisations. Finally, mental health services tend not to be accessible for people who are deaf and hard of hearing. Provision of care by therapists with appropriate communication skills would allow those who require support to benefit from inclusive services.

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Table 1: Characteristics of included studies

Characteristic	Subgroup	N	%
Age of participants	Children and young people (0-25)	6	50
	Adults (18+ only)	3	25
	All ages	3	25
Source of participants	Clinic	4	33
	Population	1	8
	Special school and rehabilitation centre	7	59
Country of study	India	3	25
	China	2	17
	Turkey	2	17
	Nigeria	2	17
	Pakistan	1	8
	Ethiopia	1	8
	Multiple countries	1	8
Region	Sub Saharan Africa	3	25
	South Asia	4	33
	East Asia Pacific	2	17
	Europe and central Asia	2	17
	Latin America	0	0
	Multiple regions	1	8
Country income group (World Bank classification)	Low income	1	8
	Low middle income	6	50
	Upper middle income	4	34
	Multiple	1	8
Community location	Urban	10	84
	Rural	1	8

Table 2 Summary of included studies

Author	Country	Definition of hearing loss used	Description of hearing loss in sample	Age range in years	Measure-Hearing loss	Measure-Mental health	Case	Controls (comparison group)	Summary of results	Quality rating
Stress/anxiety										
Reddy (1991)	India	Unclear	Unclear	11-17 (children)	Unclear.	Stress Inventory for Disabled Children (stress)	People with hearing loss were recruited from residential care. (n=30)	children with physical impairment who were drawn through random sampling from the same residential institutions as cases (n=30)	Children with hearing loss experience more stress than children with physical impairment except in motor activities ($p<0.05$).	Low
Li (2010)	China	Unclear	78% hard of hearing 11% deaf 11%	8-19 (children)	Unclear	FSSC-R (Fear Survey Schedule for Children-Revised)	Children with hearing loss attending a special	Children from a rural middle school and high school in the same study area as	Children with hearing loss reported higher levels of total fears, total anxieties, fear of the unknown, fear of	Medium

			missing degree of loss			RCMAS (Rived Children's Manifest Anxiety scale) (anxiety)	residential school for children with hearing loss (n=61)	cases. (n=64)	injury and small animals, fear of medical procedures, and concentration anxiety than children without hearing loss ($p<0.05$)	
Stubbs (2018)	China Ghana India Mexico Russia South Africa	Unclear	Unclear	≥50 (adults)	Self-reported	Perceived Stress Scale (stress)	Adults aged 50+ who reported hearing loss (n=1911)	Adults aged 50+ who did not report hearing loss (n=32218)	Hearing loss associated with higher stress levels ($p<0.05$)	High
Xie (2015)	China	Unclear	Unclear	Unclear (adults)	Pure tone audiometry	SAS (Self-evaluation Anxiety Scale) (anxiety)	Laborers with high frequency hearing loss and meet the following	People who worked in the environment with high frequency noise >1 year and without any hearing and cognitive	People with hearing loss had higher anxiety scores than people with normal hearing. ($P<0.05$)	Medium

							inclusion criteria: 1 Mini-mental state examination≥ 27; 2 without cognitive impairment; 3without other physical disease or impairment; 4 work in the environment with high frequency noise>1 year; 4 normal speech ability	impairment. (n=108)		

							(n=110)			
Nehra (1997)	India	ISHA Battery (Kacker 1990)	64% with moderate 36% severe to profound hearing loss	15-65 (adults and children)	Unclear	Spielberger state and trait anxiety inventory (Spielberger,1973) (anxiety)	Patient with hearing loss recruited from the speech and hearing section of the outpatient department of otolaryngology and head and neck surgery of hospital (n=88)	Age-gender-education-locality matched people with normal hearing from residence within the catchment area. (n=60)	Higher severity of hearing loss, the higher the chance of improvement in anxiety after hearing aids. ($p<0.05$)	Medium
Centin (2010)	Turkey	WHO criteria	20% Mild 27.8% moderate 34.5%	21-30 (adults)	Pure tone audiometry	BAI (Beck Anxiety Inventory) (anxiety)	Adult patients with acquired unilateral hearing loss	Healthy individuals who were admitted to the same Ear, Nose and Throat	People with hearing loss had higher levels of anxiety, than controls ($p<0.05$),	Medium

			severe 17.7% profound				recruited from ENT department of Military Hospital Turkey. (n=90)	Department with case group. (n=90)		
Mosaku (2015)	Nigeria	Unclear	Unclear	Unclear (children)	Unclear	ICD 10 (International Classification of Disease Diagnostic) (anxiety)	Children with hearing loss from special schools (n=52)	Students matched for age and sex, from the same school as cases but without any form of hearing loss. (n=52)	The prevalence of anxiety was 7.7% in the children with hearing loss compared to 1.9% among the control group	Medium
Depression										
Sogebi (2015)	Nigeria	Unclear	47.4% had no functional impairment 52.6% had	60-94 (adults)	Pure tone audiometry	Geriatric Depression Scale (depression)	Participants were clinically diagnosed with hearing loss by ENT	Comparable patients attending the same clinic with case group but who did not have a history of	People with hearing loss had higher depression than controls ($p<0.05$)	Medium

			functional impairment				clinic, which was confirmed by audiometric finding of bilateral sensorineural hearing loss. (n=78)	hearing loss and in whom pure tone audiometry = confirmed normal hearing. (n=52)		
Centin (2010)	Turkey	WHO criteria	20% Mild 27.8% moderate 34.5% severe 17.7% profound	21-30 (adults)	Pure tone audiometry	BDI (Beck Depression Inventory) (depression)	Adult patients with acquired unilateral hearing loss recruited from ENT department of Military Hospital Turkey.	Healthy individuals who were admitted to the same Ear, Nose and Throat Department with case group. (n=90)	People with hearing loss had higher depression scores than controls ($p<0.05$),	Medium

							(n=90)			
Nehra (1997)	India	ISHA Battery (Kacker 1990)	64% with moderate 36% severe to profound hearing loss	15-65 (adults and children)	Unclear	Superego paranoid depression scale (Pasricha,1975) (depression)	Patient with hearing loss recruited from the speech and hearing section of the outpatient department of otolaryngology and head and neck surgery of hospital (n=88)	Age-gender-education-locality matched people with normal hearing from residence within the catchment area. (n=60)	Higher severity of hearing loss, the higher the chance of improvement in depression after hearing aids. ($p<0.05$)	Medium
Mosaku (2015)	Nigeria	Unclear	Unclear	Unclear (children)	Unclear	ICD 10 (International Classification of Disease	Children with hearing loss from special schools	Students matched for age and sex, from the same school as cases but without any form	The prevalence of depression was 3.8% in case group compared to 1.8% in control group.	Medium

						Diagnostic) (depression)	(n=52)	of hearing loss. (n=52)		
Behavioural and emotional disorders										
Abbas, (2016)	Pakistan	Unclear	Unclear	12-18 (children)	Unclear	Human Figure Drawing Test (behavioral and emotional disorders)	Children with hearing loss attending special schools and rehabilitation centers (n=32)	Children with intellectual disability from same special schools and rehabilitation centers with case group (n=35)	Children with hearing loss more at risk of emotional disturbance than children with intellectual disability ($p<0.05$)	Low
Singh (1988)	India	Unclear	Unclear	4-16 (children)	Unclear	Rutter's Scale B-2 (behavioural and emotional disorders)	Children with hearing loss attending two special schools (n=91)	1) Children with visual impairment from the same two special schools with case group. (n=79) 2) Children without hearing or visual impairment from a residential school in	No difference between children with = visual impairment, children with hearing loss, and children without hearing or visual impairments	Low

								the same area as cases. (n=105)		
Konuk (2006)	Turkey	Unclear	Moderate 2.7% dB Severe 8.3% Profound 88.8%	6-18 (children)	Pure tone audiometry	CBCL (Child Behavior Checklist) (behavioural and emotional disorders)	Children was recruited from primary and secondary residential school for children with hearing loss. (n=72)	Age-gender-matched children and adolescents from primary and secondary schools for normal children in the same area with cases. (n=45)	Children with hearing loss showed significantly higher prevalence emotional and behavioral problems than the controls ($p<0.001$)	Medium
Mekonnen (2015)	Ethiopia	Unclear	98.3% with severe to profound hearing loss 1.7% hard of hearing	10-22 (children)	Unclear	SDQ (Strength and Difficulty Questionnaire) (behavioural and emotional disorders)	Children with hearing loss from special schools and special classes attached to regular schools	Students with normal hearing from regular school (n=43).	Students with hearing loss experienced more severe socio-emotional problems than controls ($p<0.05$)	Low

							(n=60)			
Mosaku (2015)	Nigeria	Unclear	Unclear	Unclear (children)	Unclear	ICD 10 (International Classification of Disease Diagnostic) (behavioural and emotional disorders)	Children with hearing loss from special schools (n=52)	Students matched for age and sex, from the same school as cases but without any form of hearing loss. (n=52)	The prevalence of attention deficit hyperactivity disorder, unspecified non organic psychosis, and other behavioral disorders NOS was 1.9%, 3.8% and 1.9% in case group compared to 0% in all these three disorders in control group.	Medium