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Global, regional, and national burden of hearing loss in children and adolescents, 1990–2021: a systematic analysis from the Global Burden of Disease Study 2021

Zhifeng Guo[1], Wangquan Ji[2], Ping Song[1], Jingli Zhao[1], Mengqing Yan[2], Xianan Zou[1], Fanghui Bai[3], Yu Wu[1], Zhe Guo[1*] and Linlin Song[1*]

Abstract

Background Hearing loss in children and adolescents is attracting increasing attention as a growing public health problem. This study aimed to analyze the burden of hearing loss in children and adolescents from 1990 to 2021 to provide a new basis for further epidemiological research, disease prevention, and public health policy development.

Methods The prevalence and years lived with disability (YLDs) of hearing loss in children and adolescents from 1990 to 2021 at the global, regional, and national levels were extracted from the Global Burden of Disease 2021 database. The estimated annual percentage change (EAPC) was used to assess trends in prevalence and YLDs. Pearson correlation analysis was used to assess the relationships between sociodemographic index (SDI) and prevalence and YLDs.

Results In 2021, approximately 97.83 million children and adolescents under the age of 20 years were affected by hearing loss globally, resulting in approximately 3.91 million YLDs. From 1990 to 2021, the prevalence rate increased from 3537 per 100,000 to 3711 per 100,000, with an EAPC of 0.15% (95% CI: 0.12–0.17). The burden of hearing loss was greater in low-middle-SDI region and low-SDI region. Mild hearing loss accounted for 62.1% of the total cases and was the predominant type of hearing loss. Otitis media was the leading preventable cause of hearing loss, with 46.9% of hearing loss attributed to otitis media. Moreover, in children under 5 years of age, 68.7% of hearing loss was attributed to otitis media. Pearson correlation analysis revealed that the prevalence rates and YLDs rates of hearing loss were negatively correlated with the SDI ($R = -0.57$, $P < 0.001$; $R = -0.64$, $P < 0.001$).

Conclusions The burden of hearing loss in children and adolescents has increased over the past three decades and remains high. The burden is greater in less economically developed countries or regions. Policymakers should pay attention to the increasing burden of hearing loss in children and adolescents and take targeted measures to control this burden.

*Correspondence:
Zhe Guo
zguo.nych@foxmail.com
Linlin Song
linlinson@163.com

Full list of author information is available at the end of the article

Keywords Hearing loss, Children, Adolescents, Prevalence, Years lived with disability

Background

Hearing loss was identified as the fourth and third leading cause of disability in the Global Burden of Disease (GBD) 2015 and GBD 2019 studies, respectively [1, 2]. The GBD 2019 Hearing Loss Collaborators reported that in 2019, approximately 1.57 billion people globally suffered from varying degrees of hearing loss, representing one-fifth of the world's total population and that the number of people with hearing loss will increase to 2.45 billion by 2050 [2]. As a growing public health problem, the effect of hearing loss is widely recognized by several stakeholders, including researchers, clinicians, policymakers, and people living with this condition [3]. In 2019, the Lancet Commission on Global Hearing Loss announced the convening of expert working groups on prevention, policy, technology, and conservation aimed at examining ways to reduce the burden of hearing loss [4]. In 2021, the WHO released the first World Report on Hearing, which aims to guide Member States on integrating ear and hearing care into their national health plans. Reducing the burden of hearing loss has become an important issue in global health [5].

Hearing loss has profound effects on children and adolescents, impacting their speech, language, development, education, and cognitive outcomes [6]. It also negatively affects mental health, leading to reduced quality of life and difficulties in interpersonal interactions and future employment [7–9]. These effects can continue into adulthood and even have lifelong consequences. The UN Sustainable Development Goals and the WHO Global Strategy for Women's, Children's and Adolescents' Health emphasize the importance of health policies and plans to prevent and reduce the burden of diseases in children and adolescents [10, 11]. However, previous studies have mainly reported on the global burden of hearing loss in people of all ages and in older adults [12–14], and no study has yet analyzed the global burden of hearing loss in children and adolescents in depth.

Therefore, this study provides a comprehensive and detailed analysis of the prevalence and years lived with disability (YLDs) due to hearing loss in children and adolescents under 20 years of age from 1990 to 2021 at the global, regional, and national levels. We stratified these trends by age, sex, region, country, sociodemographic index (SDI), and cause of hearing loss. This study aimed to analyze the burden of hearing loss in children and adolescents based on the GBD 2021 database and to provide a new basis for further epidemiological research, disease prevention, and public health policy development.

Methods

Data sources

The data for this study were obtained from GBD 2021, which provides a comprehensive assessment of health losses from 371 diseases and injuries and 288 causes of death in 204 countries and territories using recent epidemiological data and improved standardized methods [15, 16]. The estimation process for GBD is based on identifying multiple sources of relevant data, including censuses, household surveys, civil registration and vital statistics, disease registries, health service utilization, and other sources. In this study, the prevalence and YLDs of hearing loss by age, sex, region, country, and SDI from 1990 to 2021 were obtained through the Global Health Data Exchange query tool (https://vizhub.healthdata.org/gbd-results/), including estimates and 95% uncertainty intervals (UIs). Furthermore, understanding the attributable risk factors for hearing loss in children and adolescents is important for the development and improvement of effective prevention strategies. Therefore, this study conducted further analyses based on potential causes of hearing loss, including otitis media, meningitis, congenital birth defects, and age-related and other hearing loss. Other hearing loss refers to conditions not previously listed, including hearing loss due to noise exposure, trauma, and the ototoxic effects of certain drugs [2, 16].

Definition of hearing loss

Hearing loss was defined as the average intensity of the softest sound that can be heard in one or both ears at frequencies between 500 and 4000 Hz being greater than or equal to 20 dB. Furthermore, hearing loss was categorized into six categories based on average intensity, including mild hearing loss (thresholds at 20–34 dB), moderate hearing loss (thresholds at 35–49 dB), moderately severe hearing loss (thresholds at 50–64 dB), severe hearing loss (thresholds at 65–79 dB), very severe hearing loss (thresholds at 80–94 dB), and total hearing loss (thresholds over 95 dB) [2].

SDI

The SDI is a composite average of income, educational attainment, and fertility conditions used to quantify the sociodemographic development, educational attainment, and fertility status of a country or territory [17]. The 204 countries and territories were then categorized into five regions based on the SDI, namely, low (<0.47), low-middle (0.47–0.62), middle (0.63–0.71), high-middle (0.72–0.81), and high (>0.81) [18].

Statistical analysis

Previous studies have explained the methodology of the GBD 2021 study in detail [15, 16]. In this study, the prevalence and YLDs of hearing loss were analyzed at the global, regional, and national levels, and 95% UIs was calculated for each variable. All rates were calculated per 100,000 people.

The estimated annual percentage change (EAPC) was used to assess the trend in rates, and its calculation has been described in detail in previous studies [19]. When the lower 95% confidence interval (CI) of the EAPC is greater than 0, the rate tends to increase; conversely, when the upper 95% CI of the EAPC is less than 0, the rate tends to decrease.

Correlations between SDI and prevalence and YLDs were measured using the Pearson method, with strong associations if the coefficients were between 0.8 and 1, strong (or moderate) between 0.5 and 0.8, fair (or weak) between 0.2 and 0.5, and poor (or very weak) at less than 0.2.

All the above statistical analyses and graphs were performed in R 4.3.2 with a test level of $\alpha = 0.05$.

Results

Overview of the global burden

The population of children and adolescents under the age of 20 increased from 2258.6 million in 1990 to 2635.8 million in 2021 (Table S1). Tables 1 and 2, and Fig. 1 show the prevalence and YLDs of hearing loss in children and adolescents under the age of 20 years globally. The number of prevalent cases of hearing loss increased from 79,885.7 thousand (95% UI: 71923.9-88395.4) in 1990 to 97,825.3 thousand (95% UI: 88023.9-108548.5) in 2021, and the prevalence rate increased from 3,537.00 per 100,000 (95% UI: 3184.48-3913.77) in 1990 to 3,711.35 per 100,000 (95% UI: 3339.5-4118.17) in 2021, with an EAPC of 0.15 (95% CI: 0.12–0.17). In 2021, the region with the highest prevalence rate of hearing loss was South Asia [4689.65 (95% UI: 4194.1-5222.14)], followed by Southeast Asia [4168.49 (95% UI: 3736.07-4636.97)] and Eastern Sub-Saharan Africa [4051.56 (95% UI: 3645.86-4496.57)], and the country with the highest prevalence rate of hearing loss was Madagascar [5302.18 (95% UI: 4647.39-6040.75)], followed by India [4902.07 (95% UI: 4371.33-5466.75)] and Kenya [4773.45 (95% UI: 4231.20-5370.84)] (Table S2). The number of YLDs associated with hearing loss increased from 3155.7 thousand (95% UI: 2063.4-4485.4) in 1990 to 3905.5 thousand (95% UI: 2539.2-5552.6) in 2021, and the YLDs rate increased from 139.72 per 100,000 (95% UI: 91.36-198.59) in 1990 to 148.17 per 100,000 (95% UI: 96.33-210.66) in 2021, with an EAPC of 0.18 (95% CI: 0.14-0.22). In 2021, the region with the highest YLDs rate of hearing loss was Southeast Asia [187.00 (95% UI: 122.73-263.91)], followed by South Asia [185.39 (95% UI: 120.88-267.84)] and Western Sub-Saharan Africa [163.93 (95% UI: 109.02-234.82)], and the country with the highest prevalence rate of hearing loss was Madagascar [256.33 (95% UI: 167.03-375.63)], followed by Kenya [236.55 (95% UI: 156.65–335.50)] and Myanmar [229.69 (95% UI: 150.55-327.17)] (Table S3).

In 1990 and 2021, the prevalence and YLDs of hearing loss were greater in males than in females, but the EAPC was greater in females than in males. The prevalence, YLDs, and EAPC of hearing loss increased with age. The highest burden of hearing loss was in the 15–19 years age group, followed by the 10–14 years, 5–9 years, and less than 5 years age group. For the different SDI regions, the burden of hearing loss was lowest in the high-SDI region, and the greatest burden of hearing loss was in the low-middle-SDI region, followed by the low-SDI region. More information is shown in Tables 1 and 2, and Fig. 2.

The burden of different categories of hearing loss

Table S4 and Fig. 3 show the burdens caused by different categories of hearing loss in 2021 across different sex and age groups. Mild and moderate hearing loss were the main contributors to the total number of hearing loss cases, accounting for more than 80% of the cases across all sex and age groups. Approximately 34.1 million and 14.2 million males under the age of 20 suffered from mild and moderate hearing loss, respectively; approximately 26.7 million and 11.7 million females under the age of 20 suffered from mild and moderate hearing loss, respectively. The smallest number of cases had complete hearing loss (among males < 20 years: 327,677; among females < 20 years: 302,717). Moderate hearing loss caused the most YLDs, followed by severe and mild hearing loss. The percentage of YLDs due to complete hearing loss increases with age.

Burden of hearing loss attributable to different causes

Table S5 and Fig. 4 show the burden of hearing loss attributable to different causes in 2021 across gender and age groups. The highest number of cases of hearing loss were attributed to age-related and other causes, especially in the 15–19 years age group. Otitis media is the leading cause of hearing loss in individuals < 5 years of age, accounting for more than 60% of cases. The proportion of hearing loss attributable to otitis media decreases with age. Hearing loss attributable to congenital birth defects was more frequent in the < 5 years age group than in the other age groups. Hearing loss attributable to meningitis is the least prevalent, at less than 1%. Age-related and other hearing loss is the leading cause of hearing loss in YLDs in all age groups, especially in the 10–14 years age group and 15–19 years age group. In the < 5 years age group, more than half of the YLDs were caused by otitis

Table 1 Prevalence of hearing loss in children and adolescents under the age of 20 for all locations in 1990 and 2021, with the EAPC from 1990 to 2021

Location	Case no. in 1990 (95% UI)	Rate in 1990 (95% UI)	Case no. in 2021 (95% UI)	Rate in 2021 (95% UI)	EAPC (95% CI) (%)
Global	79885.7 (71923.9-88395.4)	3537.00 (3184.48-3913.77)	97825.3 (88023.9-108548.5)	3711.35 (3339.50-4118.17)	0.15 (0.12-0.17)
Sex					
Male	44236.8 (39785.9-48946.2)	3822.17 (3437.60-4229.06)	54417.5 (48943.7-60287.1)	4005.72 (3602.79-4437.78)	0.14 (0.11-0.17)
Female	35648.9 (32075.1-39506)	3237.28 (2912.75-3587.55)	43407.8 (38969.2-48214.9)	3398.28 (3050.79-3774.62)	0.15 (0.13-0.17)
Age					
<5 years	12466.1 (11137.2-13735.1)	2010.87 (1796.50-2215.55)	13582.1 (12115.4-15008.3)	2063.62 (1840.77-2280.31)	0.06 (0.04-0.07)
5-9 years	19522.8 (17106.8-22500.6)	3345.64 (2931.60-3855.94)	23327.8 (20431.2-26796.8)	3395.34 (2973.74-3900.24)	0.08 (0.06-0.09)
10-14 years	20635.1 (17901.4-23466.5)	3852.12 (3341.80-4380.67)	26643.2 (22986.4-30402.4)	3996.66 (3448.12-4560.57)	0.14 (0.13-0.15)
15-19 years	27261.7 (24334.7-30306.3)	5248.44 (4684.95-5834.60)	34272.2 (30396.6-38146.1)	5492.51 (4871.41-6113.36)	0.15 (0.14-0.17)
SDI region					
High	5820.8 (5313.3-6351.8)	2316.09 (2114.15-2527.38)	5349.9 (4872.2-5855.4)	2298.84 (2093.57-2516.05)	-0.02 (-0.03-0.00)
High-middle	11837.8 (10715.5-13024.7)	3197.97 (2894.79-3518.61)	9861.7 (8917.9-10899.4)	3250.79 (2939.68-3592.86)	-0.02 (-0.09-0.05)
Middle	27840.4 (25078.8-30758.9)	3641.40 (3280.19-4023.11)	28467.9 (25575.1-31549.9)	3799.81 (3413.70-4211.19)	0.13 (0.10-0.17)
Low-middle	23740.5 (21361.4-26356)	4016.84 (3614.31-4459.38)	31558.4 (28271.2-35178)	4128.59 (3698.54-4602.11)	0.08 (0.07-0.10)
Low	10583.3 (9550.1-11746.8)	3785.50 (3415.92-4201.65)	22521.8 (20188.2-25096.3)	3855.12 (3455.67-4295.79)	0.04 (0.02-0.06)
GBD region					
Andean Latin America	485.8 (440.5-532.2)	2562.54 (2323.72-2807.43)	621.3 (560.9-681)	2624.55 (2369.13-2876.44)	0.10 (0.08-0.13)
Australasia	136.6 (124.1-149.6)	2177.47 (1978.72-2384.17)	162.2 (147.4-178.2)	2150.96 (1953.82-2363.01)	-0.02 (-0.04--0.01)
Caribbean	430.9 (389.6-474.5)	2853.81 (2580.15-3142.35)	439.2 (395.7-483)	2877.33 (2592.84-3164.65)	0.07 (0.05-0.09)
Central Asia	950.7 (858.4-1047.9)	3010.60 (2718.20-3318.09)	1041.7 (936.9-1148.6)	3008.55 (2705.76-3317.23)	-0.04 (-0.14-0.05)
Central Europe	1263.4 (1139.2-1398.1)	3217.40 (2900.97-3560.35)	754.7 (679.7-834.0)	3203.53 (2885.53-3540.44)	-0.12 (-0.18--0.07)
Central Latin America	2351.2 (2131.2-2584)	2845.45 (2579.20-3127.14)	2520.6 (2281.9-2778.9)	2955.51 (2675.67-3258.32)	0.13 (0.12-0.13)
Central Sub-Saharan Africa	1107.9 (993.5-1232.1)	3575.10 (3206.12-3976.14)	2671.4 (2384.1-2991.4)	3631.57 (3241.05-4066.63)	-0.01 (-0.05-0.02)
East Asia	15630.4 (14136.1-17180.1)	3396.87 (3072.12-3733.67)	11827.3 (10697.1-13066.4)	3428.69 (3101.03-3787.89)	0.01 (-0.06-0.09)
Eastern Europe	2180.0 (1965.9-2416.2)	3240.41 (2922.2-3591.47)	1513.5 (1361.0-1678.4)	3278.77 (2948.46-3636.06)	-0.20 (-0.33--0.06)
Eastern Sub-Saharan Africa	4313.3 (3886.1-4811.0)	3889.44 (3504.22-4338.25)	9220.7 (8297.4-10233.5)	4051.56 (3645.86-4496.57)	0.10 (0.07-0.12)
High-income Asia Pacific	1211.7 (1106.2-1325.4)	2407.73 (2197.95-2633.52)	727.2 (663.1-795.6)	2361.86 (2153.6-2584.02)	-0.04 (-0.06--0.02)
High-income North America	1541.9 (1390.8-1688.4)	1886.60 (1701.75-2065.82)	1759.0 (1599.7-1935.2)	1964.10 (1786.23-2160.86)	0.14 (0.11-0.17)
North Africa and Middle East	5668.4 (5100.0-6303)	3206.61 (2885.09-3565.61)	7668.9 (6877.5-8516.1)	3242.79 (2908.15-3601.00)	-0.06 (-0.09--0.02)
Oceania	109.5 (99.0-121.1)	3251.81 (2940.81-3597.58)	206.9 (186.9-229.7)	3240.08 (2927.14-3597.35)	0.01 (-0.01-0.03)
South Asia	24111.3 (21584.1-26847.1)	4445.07 (3979.17-4949.43)	32053.5 (28666.5-35693)	4689.65 (4194.10-5222.14)	0.19 (0.18-0.20)
Southeast Asia	8967.2 (8060.5-9983.5)	4077.81 (3665.51-4539.98)	9557.2 (8565.7-10631.3)	4168.49 (3736.07-4636.97)	0.07 (0.05-0.09)

Table 1 (continued)

Location	Case no. in 1990 (95% UI)	Rate in 1990 (95% UI)	Case no. in 2021 (95% UI)	Rate in 2021 (95% UI)	EAPC (95% CI) (%)
Southern Latin America	412.6 (375.0-453.7)	2129.20 (1934.94-2341.02)	427.0 (388.8-470.5)	2188.66 (1992.89-2411.53)	0.07 (0.06-0.08)
Southern Sub-Saharan Africa	885.5 (805.5-977.4)	3346.52 (3044.04-3693.76)	1065.0 (963.7-1173.2)	3406.53 (3082.26-3752.39)	0.04 (0.01-0.07)
Tropical Latin America	2294.7 (2056.3-2542.9)	3313.03 (2968.95-3671.39)	2211.9 (1985.9-2447.3)	3321.86 (2982.44-3675.32)	0.01 (-0.03-0.04)
Western Europe	2156.0 (1972.1-2350.4)	2192.23 (2005.24-2389.96)	1988.7 (1817.0-2170.5)	2168.47 (1981.25-2366.63)	0.04 (0.02-0.05)
Western Sub-Saharan Africa	3676.8 (3242.2-4152.1)	3420.46 (3016.18-3862.64)	9387.2 (8267.9-10603.4)	3495.19 (3078.42-3948.00)	-0.06 (-0.11--0.01)

Note The number of cases is in thousands. The rate is measured in terms of per 100, 000. EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval

media and congenital birth defects, but the proportion of YLDs caused by otitis media and congenital birth defects decreased with increasing age.

Correlation between the burden of hearing loss and SDI

Based on the findings of differences in the burden of hearing loss across SDI regions, the correlation between hearing loss and SDI was further explored. The results of the Pearson correlation analysis showed that the SDI was negatively correlated with the prevalence rate (R = -0.57, P<0.001; Fig. 5A) and YLDs rate (R = -0.64, P<0.001; Fig. 5B) of hearing loss in 204 countries and that the SDI was negatively correlated with the prevalence rate (R = -0.70, P<0.001, Figure S1A) and YLDs rate (R = -0.76, P<0.001; Figure S1B) of hearing loss in different regions. In other words, the lower the SDI is, the greater the burden of hearing loss in the country or region.

Discussion

The burden of hearing loss on children and adolescents as a growing public health problem requires urgent and adequate attention. This study systematically analyzed the burden of hearing loss in children and adolescents under 20 years of age from 1990 to 2021 at the global, regional, and national levels. This study found that more than 97 million children and adolescents under the age of 20 suffered from hearing loss globally in 2021, resulting in a total of 3.91 million YLDs. From 1990 to 2021, the global burden of hearing loss in children and adolescents generally increased. Hearing loss is predominantly mild and moderate, and the leading cause of hearing loss is otitis media. Countries and regions with a lower SDI had a greater burden of hearing loss. Governments should take measures to prevent and reduce the burden of hearing loss among children and adolescents, such as strengthening health services for children with hearing loss, implementing early identification and intervention programs, and establishing laws and regulations to control noise [20, 21].

Hearing loss in children and adolescents can impact speech, learning, and emotional health, affecting their cognitive and social development [6, 7]. These facts emphasize the importance of early identification and intervention for hearing loss. The available data indicate that the burden of hearing loss among children and adolescents has remained high and has been on the rise in the last three decades, which is a cause for alarm. This study indicates that the impact of hearing loss is generally more significant in males across various age groups of children and adolescents. A previous study also noted a higher prevalence of hearing loss among males under similar noise exposure conditions [22]. The disparity could be attributed to gender-specific lifestyle and behavioral differences, along with the protective role of estrogen in females' auditory systems [22–24]. Age remains a major associated factor for hearing loss [25], and this study found that hearing loss was common in the age group of 10–19 years. This may be related to longer exposure to risk factors. Therefore, the implementation of early identification and intervention programs and raising awareness in the community may help to control disabling losses and improve quality of life.

This study revealed that more than 60% of hearing loss in children and adolescents worldwide is mild hearing loss. This means that primary hearing health care and the promotion of hearing screening techniques in this population can minimize further deterioration of hearing loss. However, mild hearing loss is often overlooked, as it is not considered to cause significant difficulties in speech and communication. Mild hearing loss can also adversely affect function, and mild hearing loss may impair speech processing, particularly when speech is delivered quickly

Table 2 Years lived with disability of hearing loss in children and adolescents under the age of 20 for all locations in 1990 and 2021, with the EAPC from 1990 to 2021

Location	Case no. in 1990 (95% UI)	Rate in 1990 (95% UI)	Case no. in 2021 (95% UI)	Rate in 2021 (95% UI)	EAPC (95% CI) (%)
Global	3155.7 (2063.4-4485.4)	139.72 (91.36-198.59)	3905.5 (2539.2-5552.6)	148.17 (96.33-210.66)	0.18 (0.14-0.22)
Sex					
Male	1743.4 (1140.3-2470.2)	150.63 (98.53-213.43)	2161.1 (1404.0-3077.5)	159.08 (103.35-226.54)	0.16 (0.11-0.20)
Female	1412.3 (926.0-2020.9)	128.25 (84.09-183.52)	1744.4 (1141.0-2491.6)	136.56 (89.33-195.06)	0.20 (0.17-0.23)
Age					
<5 years	467.0 (303.0-700.9)	75.32 (48.87-113.06)	514.1 (328.2-771.8)	78.12 (49.87-117.26)	0.09 (0.06-0.13)
5-9 years	769.6 (495.1-1127)	131.89 (84.85-193.14)	927.3 (597.2-1361.4)	134.97 (86.92-198.16)	0.12 (0.09-0.15)
10-14 years	881.6 (582.6-1263.3)	164.57 (108.75-235.83)	1143.7 (751.2-1642.5)	171.56 (112.69-246.39)	0.16 (0.15-0.18)
15-19 years	1037.6 (685.9-1487.0)	199.75 (132.06-286.28)	1320.3 (872.3-1877.9)	211.60 (139.8-300.96)	0.18 (0.17-0.20)
SDI					
High	185.4 (119.7-265.4)	73.77 (47.63-105.6)	172.9 (111.8-248.2)	74.30 (48.02-106.65)	0.00 (-0.03-0.03)
High-middle	430.6 (280.5-612.9)	116.33 (75.78-165.59)	363.4 (237.6-515.8)	119.78 (78.32-170.03)	0.04 (-0.06-0.13)
Middle	1098.0 (715.9-1560.6)	143.62 (93.63-204.12)	1125.7 (737.7-1602.5)	150.26 (98.46-213.90)	0.15 (0.10-0.21)
Low-middle	979.6 (646.0-1404.6)	165.75 (109.30-237.65)	1279.8 (830.6-1831.0)	167.42 (108.67-239.54)	0.01 (-0.02-0.03)
Low	459.7 (305.2-656.9)	164.43 (109.15-234.95)	961.2 (636.3-1370.3)	164.53 (108.92-234.56)	-0.04 (-0.06--0.01)
Region					
Andean Latin America	15.1 (9.7-21.7)	79.88 (51.26-114.61)	19.4 (12.5-27.5)	81.82 (52.60-116.05)	0.14 (0.08-0.20)
Australasia	4.1 (2.6-6.0)	65.50 (41.99-95.98)	4.9 (3.1-7.1)	64.37 (40.53-93.60)	-0.06 (-0.08--0.04)
Caribbean	14.0 (9.0-20.1)	92.72 (59.30-132.88)	14.2 (9.0-20.3)	92.77 (58.83-132.84)	0.06 (0.03-0.08)
Central Asia	33.7 (21.8-48.5)	106.72 (69.03-153.66)	36.7 (23.7-52.3)	105.90 (68.59-151.08)	-0.09 (-0.19-0.01)
Central Europe	44.7 (28.7-63.8)	113.95 (72.99-162.49)	26.4 (17.0-37.6)	112.04 (72.01-159.50)	-0.19 (-0.25--0.13)
Central Latin America	75.5 (48.3-108.2)	91.34 (58.40-130.93)	80.5 (51.7-115)	94.40 (60.62-134.82)	0.11 (0.10-0.12)
Central Sub-Saharan Africa	50.7 (33.4-70.7)	163.77 (107.88-228.15)	119.1 (78.0-169.4)	161.89 (106.06-230.22)	-0.14 (-0.19--0.08)
East Asia	572.8 (374.8-821.0)	124.49 (81.45-178.43)	444.7 (290.9-631.1)	128.92 (84.32-182.94)	0.13 (0.01-0.26)
Eastern Europe	78.9 (50.6-112.6)	117.26 (75.22-167.44)	54.3 (35.0-77.8)	117.71 (75.91-168.60)	-0.25 (-0.40--0.10)
Eastern Sub-Saharan Africa	187.9 (124-268.8)	169.4 (111.80-242.36)	391.1 (257.2-555.6)	171.86 (113.01-244.13)	0.01 (-0.02-0.04)
High-income Asia Pacific	33.9 (21.7-49.5)	67.34 (43.20-98.34)	20.2 (13.0-29.3)	65.52 (42.23-95.27)	-0.06 (-0.08--0.04)
High-income North America	54.1 (35.3-77.6)	66.14 (43.14-94.96)	61.6 (40.4-88.0)	68.73 (45.10-98.25)	0.11 (0.06-0.16)
North Africa and Middle East	235.4 (156.2-337.5)	133.16 (88.38-190.93)	309.3 (205.9-443.0)	130.77 (87.04-187.3)	-0.17 (-0.21--0.13)
Oceania	4.0 (2.6-5.7)	118.43 (75.84-169.33)	7.5 (4.8-10.7)	117.01 (75.92-167.59)	-0.01 (-0.03-0.02)
South Asia	985.6 (643.9-1427.4)	181.69 (118.71-263.16)	1267.2 (826.2-1830.7)	185.39 (120.88-267.84)	0.06 (0.05-0.08)
Southeast Asia	408.2 (270.5-575.3)	185.61 (123.00-261.64)	428.7 (281.4-605.1)	187.00 (122.73-263.91)	0.04 (0.00-0.08)
Southern Latin America	13.0 (8.4-18.9)	67.31 (43.38-97.61)	13.4 (8.5-19.4)	68.75 (43.64-99.62)	0.04 (0.02-0.06)
Southern Sub-Saharan Africa	29.4 (18.8-42.3)	111.16 (71.14-159.77)	34.9 (22.4-49.6)	111.62 (71.55-158.7)	0.04 (0.01-0.06)
Tropical Latin America	78.6 (49.8-113.7)	113.47 (71.95-164.18)	75.2 (47.5-108.1)	112.89 (71.38-162.33)	-0.02 (-0.07-0.03)
Western Europe	61.1 (39.2-86.9)	62.18 (39.83-88.35)	56.2 (35.6-81.0)	61.23 (38.81-88.35)	0.02 (0.01-0.04)
Western Sub-Saharan Africa	175.0 (116.4-251.2)	162.79 (108.24-233.68)	440.3 (292.8-630.7)	163.93 (109.02-234.82)	-0.16 (-0.24--0.09)

Note The number of cases is in thousands. The rate is measured in terms of per 100, 000. YLDs, years lived with disability; EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval

or in unfamiliar accents or voices, or when multiple talkers in a large room produce reverberating noise [26, 27]. Individuals with mild hearing loss may also be dissatisfied with their independence, have decreased emotional well-being, and feel more restricted [28, 29]. For school-age children, even mild hearing loss can impact their emotional and academic well-being, with more severe forms of hearing loss exacerbating these effects and leading to a complex set of social issues [30]. Therefore, there is a need for early identification, individualized intervention,

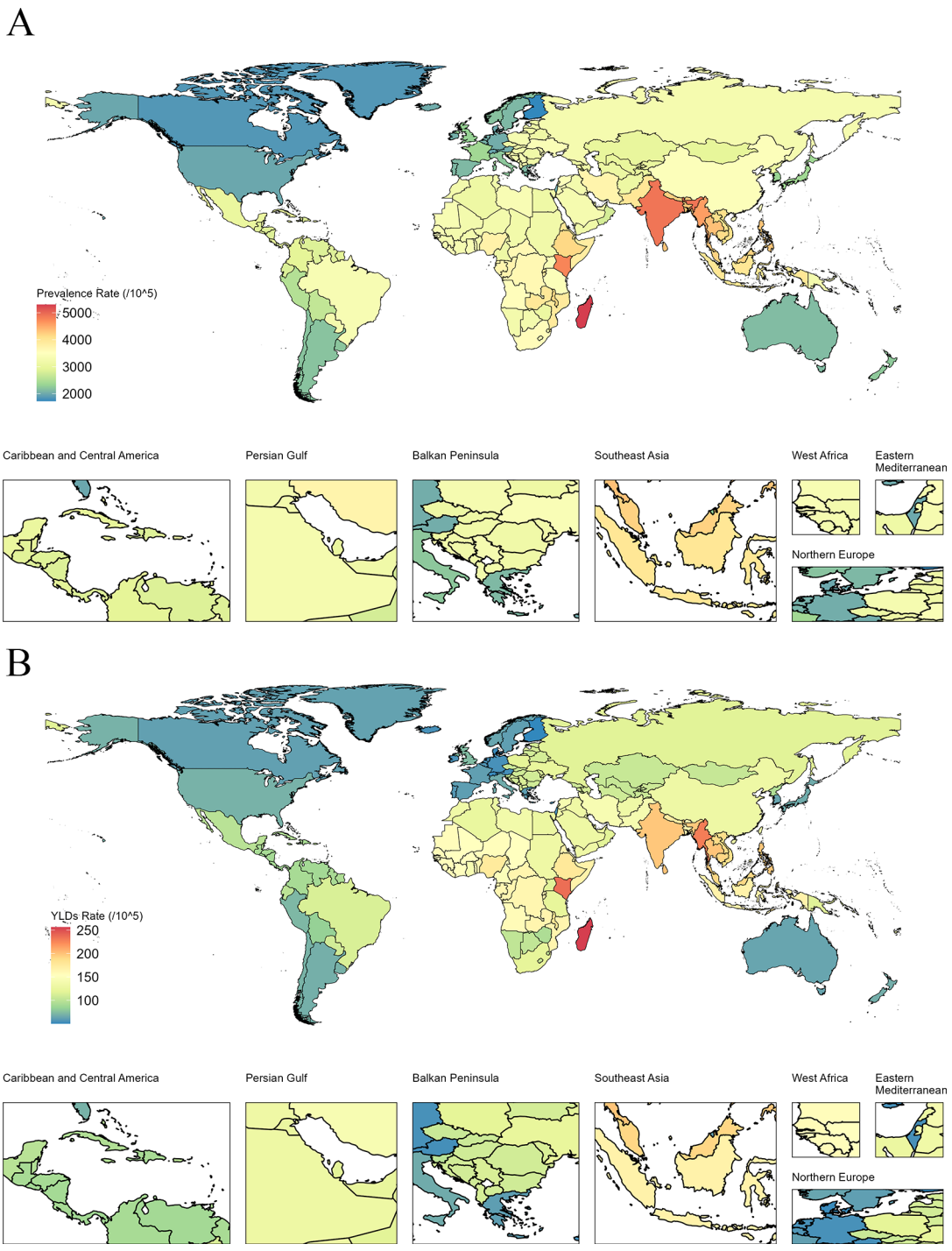

Fig. 1 Prevalence rates and YLDs rates of hearing loss in children and adolescents under the age of 20 in 204 countries and territories in 2021. YLDs, years lived with disability

clinical treatment, and follow-up in the child and adolescent population to improve hearing health care for cases with mild hearing loss and reduce the long-term burden on families and society.

Hearing loss is a combination of genetic, health condition, lifestyle, and environmental factors. This study further explored hearing loss caused by otitis media, meningitis, congenital birth defects, age-related factors and other causes. Otitis media and meningitis are preventable causes of hearing loss in children and adolescents. This study revealed that otitis media is the leading cause of hearing loss in children under 5 years of age. The

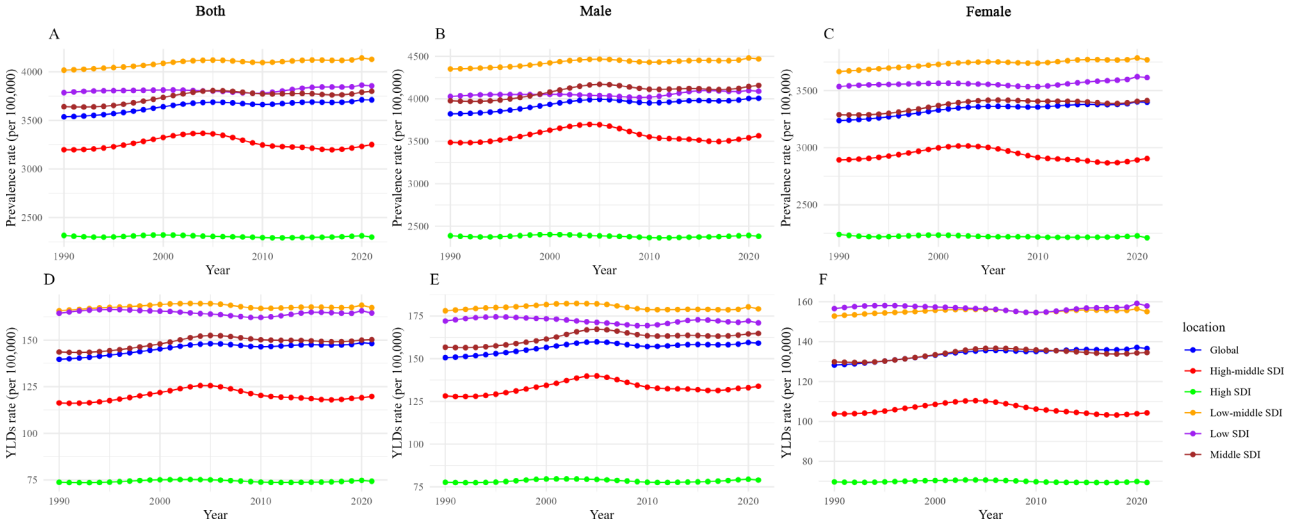

Fig. 2 Global and regional trends in the prevalence rates and YLDs rates of hearing loss in children and adolescents under the age of 20 from 1990 to 2021. YLDs, years lived with disability

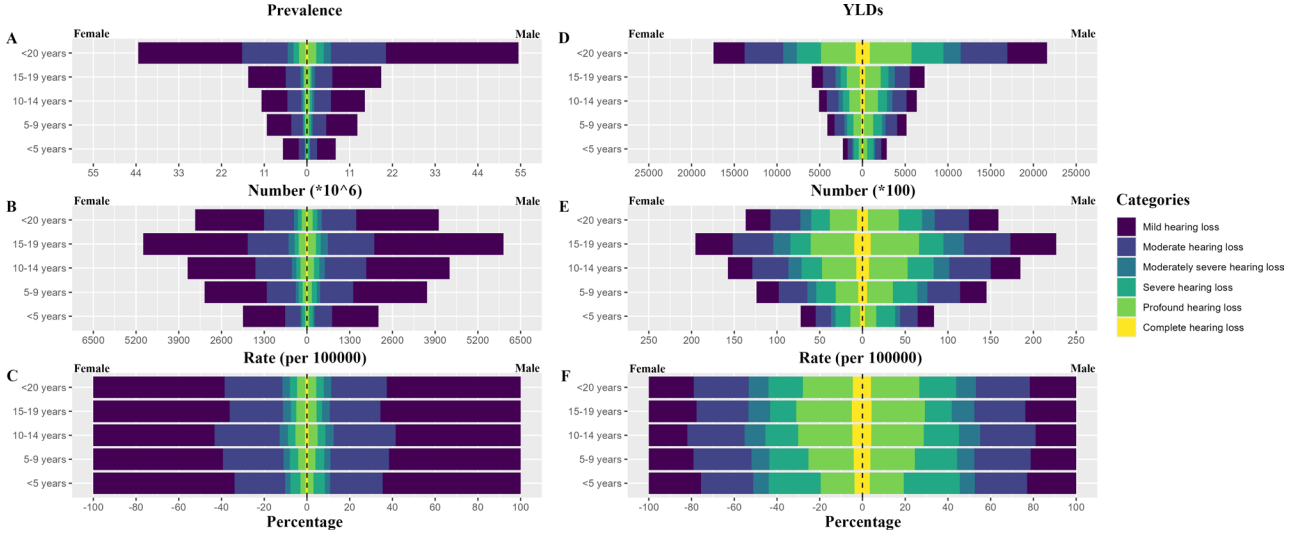

Fig. 3 Prevalence and YLDs for different categories of hearing loss in children and adolescents under the age of 20 globally in 2021. YLDs, years lived with disability

results of this study are consistent with WHO estimates that 60% of childhood hearing loss is due to preventable causes such as ear infections and vaccine-preventable diseases [31]. This study revealed that congenital hearing loss is most common in children under 5 years of age. The Joint Committee on Infant Hearing issued position statements in 2000 and 2007 to establish guidelines for early hearing detection and intervention to reduce the burden of hearing loss from congenital birth defects [32, 33]. A previous study analyzed in detail the burden of congenital hearing loss in children under the age of five for nearly three decades and revealed that the burden caused by congenital hearing loss is decreasing [34]. Age-related and other hearing losses are common in all age groups of children and adolescents, especially in the 15–19 years age group. Age-related and other hearing loss is the leading cause of YLDs globally, with the burden of age-related and other hearing loss increasing with age [2]. Previous studies have indicated that many adolescents may be at increased risk of noise-induced hearing loss due to unsafe use of personal hearing devices, and attendance at concerts in homes, schools, and entertainment venues [35, 36]. Providing the necessary guidance and effective education to adolescents will help to raise awareness and increase knowledge to improve bad habits and protect hearing [37]. A sufficient understanding of the etiology of the burden of hearing loss is the basis for the development of targeted public policies to reduce the burden of disease among children and adolescents.

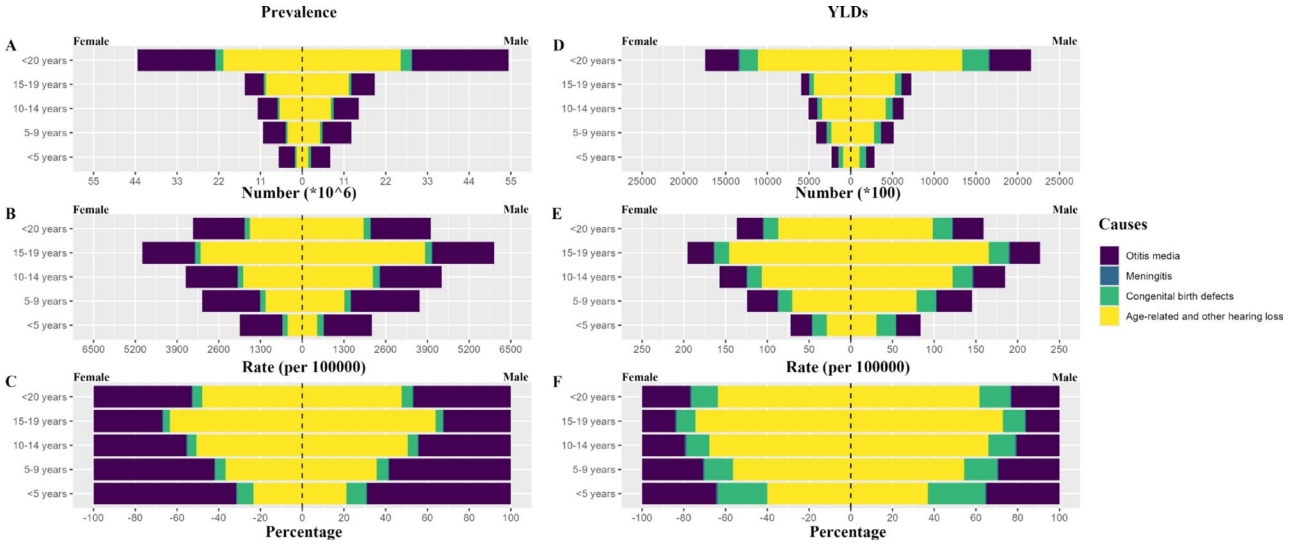

Fig. 4 Prevalence and YLDs attributable to different causes of hearing loss in children and adolescents under the age of 20 globally in 2021. YLDs, years lived with disability

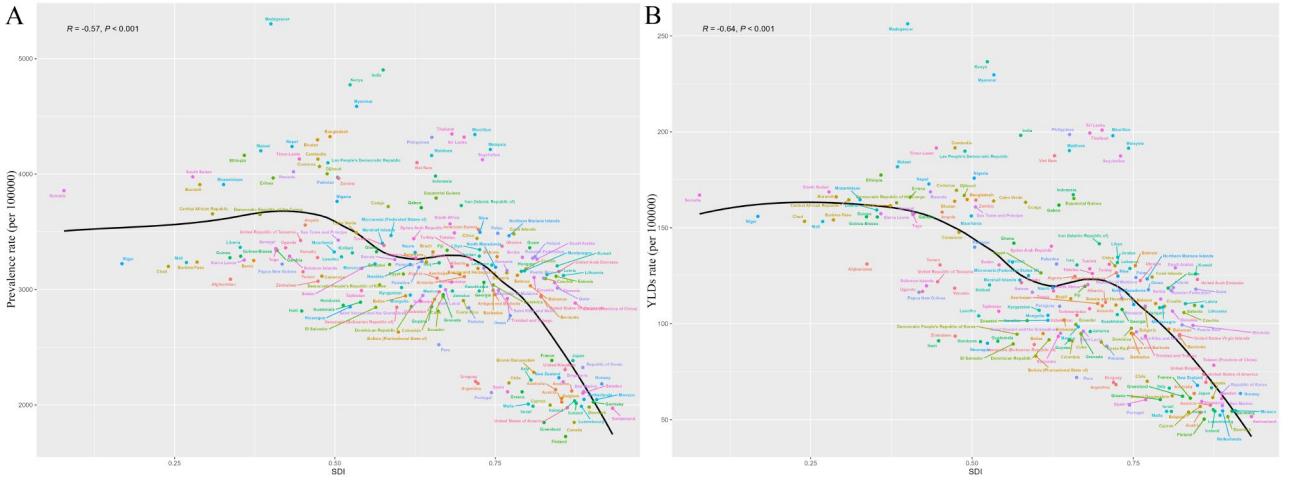

Fig. 5 Burden of hearing loss in children and adolescents under the age of 20 in 204 countries and territories by SDI in 2021. (**A**) Prevalence rate (per 100,000) in 204 countries and territories; (**B**) YLDs rate (per 100,000) in 204 countries and territories. YLDs, years lived with disability

In 2021, the prevalence rates of hearing loss among children and adolescents in low-middle-SDI and low-SDI regions were 4128.59 per 100,000 and 3855.12 per 100,000, respectively, which are much greater than the global level of 3711.35 per 100,000. In addition, there may be a lower detection rate of hearing loss in low-SDI countries or regions compared to low-middle-SDI countries or regions, which may contribute to the lower prevalence of hearing loss in low-SDI regions. The results of the Pearson correlation analyses showed that hearing loss burden was negatively correlated with the SDI. Countries or regions with lower SDI typically face more scarce healthcare resources, and in these regions, there is a tendency to divert limited healthcare resources to life-threatening illnesses, and screening and treatment for hearing loss are often limited [38, 39]. In countries and regions with lower SDI, adequate health care financing, sufficient otologists and audiologists, and well-developed public health systems and hearing health care services would be beneficial in reducing the burden of hearing loss [40–42]. However, these remain significant challenges. In addition, previous studies have shown that malnutrition is a potential risk factor for hearing loss [43]. Economic growth in some regions may improve the diets of residents, thereby reducing the incidence of hearing loss [44, 45]. International health institutions and policymakers should develop targeted guidance for poor regions, which is important for reducing the global burden of hearing loss among children and adolescents and is key to achieving sustainable development goals.

This study performed a comprehensive assessment of the burden of hearing loss in children and adolescents.

The results of this study will improve the understanding and knowledge of hearing loss in children and adolescents, provide a targeted basis for public health policy and intervention development. However, there are also some limitations to this study. First, there are differences in economic levels, medical levels, and public health systems across countries, which may result in different data collection methods, techniques, and tools in different countries or regions, affecting the quality of the data. Second, for countries with relatively large land areas, such as China, improved and more detailed provincial data would be beneficial for further epidemiologic research. Third, due to the limitations of the GBD data, the burden of hearing loss attributable to other causes, such as the use of ototoxic drugs, noise, and trauma, was not estimated in detail.

Conclusions

In summary, the global burden of hearing loss among children and adolescents continues to increase, and hearing loss is currently a public health issue. Moreover, the burden is worse in lower SDI regions. Policymakers should pay attention to this issue and take targeted measures to prevent further harm.

Abbreviations

GBD	Global Burden of Disease
YLDs	years lived with disability
SDI	sociodemographic index
UI	uncertainty interval
EAPC	estimated annual percentage change
CI	confidence interval

Supplementary Information

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Supplementary Material 1

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Not applicable.

Author contributions

ZFG and WQJ wrote the manuscript. ZFG, MQY, and PS assisted in the statistical analyses and data visualization. JLZ, FHB, XNZ, YW, and ZG read the manuscript and revised it. ZG and LLS supervised the study as the corresponding authors. All authors approved the final manuscript.

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Data availability

The data for this study are available through the Global Health Data Exchange query tool (https://vizhub.healthdata.org/gbd-results/).

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Nanyang Maternal and Child Health Care Hospital, Nanyang Central Hospital, Nanyang 473005, China
[2]College of Public Health, Zhengzhou University, Zhengzhou 450001, China
[3]Research Department, Nanyang Central Hospital, Nanyang 473005, China

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