Global Burden of Childhood Epilepsy, Intellectual Disability, and Sensory Impairments

Bolajoko O. Olusanya, FRCPCH, PhD, Scott M. Wright, MD, M.K.C. Nair, MD, DSc, Nem-Yun Boo, FRCPCH, Ricardo Halpern, MD, PhD, Hannah Kuper, ScD, Amina A. Abubakar, PhD, Nihad A. Almasri, PhD, Jalal Arabloo, PhD, Narendra K. Arora, MD, Sophia Backhaus, MA, Helen E. Olsen, MA, Jacob O. Olusanya, MBA, Ashok Pandey, MPH, Maureen E. Samms-Vaughan, MD, PhD, Chiara Servili, MD, PhD, Amira Shaheen, PhD, Tracey Smythe, PhD, Donald Wertlieb, PhD, Andrew N. Williams, FRCPCH, PhD, Charles R.J. Newton, FRCPCH, Adrian C. Davis, PhD, FFPH, OBE, Nicholas J. Kassebaum, MD, on behalf of the Global Research on Developmental Disabilities Collaborators (GRDDC)

BACKGROUND: Estimates of children and adolescents with disabilities worldwide are needed to inform global intervention under the disability-inclusive provisions of the Sustainable Development Goals. We sought to update the most widely reported estimate of 93 million children <15 years with disabilities from the Global Burden of Disease Study 2004.

METHODS: We analyzed Global Burden of Disease Study 2017 data on the prevalence of childhood epilepsy, intellectual disability, and vision or hearing loss and on years lived with disability (YLD) derived from systematic reviews, health surveys, hospital and claims databases, cohort studies, and disease-specific registries. Point estimates of the prevalence and YLD and the 95% uncertainty intervals (UIs) around the estimates were assessed.

RESULTS: Globally, 291.2 million (11.2%) of the 2.6 billion children and adolescents (95% UI: 249.9–335.4 million) were estimated to have 1 of the 4 specified disabilities in 2017. The prevalence of these disabilities increased with age from 6.1% among children aged <1 year to 13.9% among adolescents aged 15 to 19 years. A total of 275.2 million (94.5%) lived in low- and middle-income countries, predominantly in South Asia and sub-Saharan Africa. The top 10 countries accounted for 62.3% of all children and adolescents with disabilities. These disabilities accounted for 28.9 million YLD or 19.9% of the overall 145.3 million (95% UI: 106.9–189.7) YLD from all causes among children and adolescents.

CONCLUSIONS: The number of children and adolescents with these 4 disabilities is far higher than the 2004 estimate, increases from infancy to adolescence, and accounts for a substantial proportion of all-cause YLD.
The United Nations’ Sustainable Development Goals (SDGs) mandate programs that will ensure inclusive and equitable quality education and promote lifelong learning opportunities for all children and adolescents, including those with disabilities.1 The majority of children with disabilities live in low- and middle-income countries (LMICs)2,3 and are less likely to go to school, or if they do attend school, they are more likely to leave school before completing primary or secondary education, resulting in considerable barriers to work and gainful employment.4–6 They are frequently marginalized in society and are disproportionately vulnerable to neglect, abuse, poverty, and violence.4 Thus, children and adolescents with disabilities are prone to be left behind under the SDGs era without timely and appropriate intervention from early childhood.4,5

Limited global data exist on children and adolescents with disabilities because of insufficient investment in collecting comparable data on different disabilities.6,7 The global prevalence estimates that are most frequently cited by multilateral agencies, such as the World Health Organization (WHO),3,7 the United Nations Children’s Fund,2 the United Nations Educational, Scientific and Cultural Organization,6 the Office of the United Nations High Commissioner for Refugees,8 the World Bank Group,5 and, more recently, the US Agency for International Development,9 were first published in 2008 on the basis of the WHO’s Global Burden of Disease Study (GBD) 2004.10 The GBD estimated that in 2004, at least 93 million children and adolescents (0–15 years) worldwide (5.1% of the global total) lived with a moderate-to-severe disability, and 13 million (0.7%) had a severe disability.10 These estimates were generated from 4 specific impairments that were modeled as sequelae of specific health disorders: epilepsy, intellectual disability, hearing loss, and vision loss. However, the reported estimates excluded children and adolescents with mild impairments and were based on limited data sources. Additionally, the proportion of preschool-aged children with disabilities, who may be the most likely to benefit from early childhood intervention services, was not reported.

Updated and improved estimates of children and adolescents with disabilities are needed to better quantify the disease burden and the resources required to address the needs and rights of these children as mandated by the SDGs,1,11 the Convention on the Rights of the Child,12 the Convention on the Rights of Persons with Disabilities,13 and the subsisting resolution of the World Health Assembly on Disability14 and in line with the International Classification of Functioning, Disability, and Health (ICF).15 Such data are also needed to monitor progress under the SDG era. We, therefore, set out to report the prevalence of childhood epilepsy, intellectual disability, vision loss, or hearing loss among children and adolescents (<20 years) and the associated years lived with disability (YLD) on the basis of data from the GBD 201716,17 to complement and update our earlier report for children <5 years of age from the GBD 2016.18

**METHODS**

The GBD provides estimates of non-fatal outcomes for “impairments” (used interchangeably with “disabilities” in the current article), as part of the annual comprehensive assessment of incidence, prevalence, and YLD for several health conditions across 195 countries and territories. Impairments are defined as sequelae of multiple causes for which better data are available to estimate the overall occurrence than for each underlying cause. Four such impairments are developmental intellectual disability, epilepsy, hearing loss, and vision loss. Case definitions and diagnostic criteria for these impairments were based on International Classification of Diseases, Ninth Revision (ICD-9) and International Classification of Diseases, 10th Revision (ICD-10) codes, complemented with relevant guidelines such as the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition19 and the Guidelines for Epidemiologic Studies on Epilepsy.20 A detailed description of the GBD conceptual framework for epilepsy is reported elsewhere.21 Disorders of intellectual development in the ICD-9 and ICD-10 codes are termed as “developmental intellectual disability” or simply “intellectual disability” in this article and were grouped into 5 bands on the basis of IQ scores: borderline, mild, moderate, severe, and profound intellectual disability. Hearing and visual impairments were similarly classified into bands of severity corresponding to frequency response and visual acuity cutoffs, respectively. These 4 disabilities were selected for comparability with the GBD 2004 estimates for childhood disabilities.

The detailed methodologic techniques used for estimating the burden of each impairment have been reported previously16–18 and are presented in the Supplemental Information. In brief, the estimation for each condition started with the compilation of all available data inputs from systematic reviews of the literature, hospital and claims databases, health surveys, case notification systems, cohort studies, and multinational survey data. All input data for GBD 2017 are available at the Global Health Data Exchange (http://ghdx.healthdata.org/gbd-2017/data-input-sources). A total of 1675 sources were analyzed for data on the prevalence of intellectual disability (57), hearing loss (355),
| Region and Subregion                     | Prevalence Cases per 100 000 | YLD Cases per 100 000 | Rate per 100 000 |
|-----------------------------------------|------------------------------|----------------------|-----------------|
| **High-income North America**           |                              |                      |                 |
| Prevalence                              | 131 803 (107 432–159 389)    | 199 970 (157 616–240 003) | 216 420 (188 746–265 722) |
| Rate per 100 000                         | 767 (625–927)                | 890 (701–1 065)      | 920 (717–1 129) |
| **Western Europe**                       |                              |                      |                 |
| Prevalence                              | 126 468 (100 007–156 598)    | 188 957 (144 255–237 155) | 196 355 (151 269–242 173) |
| Rate per 100 000                         | 712 (585–882)                | 803 (615–1 008)      | 845 (651–1 042) |
| **North Africa and the Middle East**     |                              |                      |                 |
| Prevalence                              | 48 964 (34 429–67 257)       | 70 905 (49 056–98 578) | 72 145 (49 298–98 731) |
| Rate per 100 000                         | 276 (194–379)                | 301 (209–419)        | 310 (212–425)   |
| **Central Europe, Eastern Europe, and Central Asia** |                              |                      |                 |
| Prevalence                              | 189 861 (156 308–226 756)    | 275 179 (221 331–356 004) | 256 698 (207 905–311 453) |
| Rate per 100 000                         | 837 (689–1 000)              | 1001 (803–1 222)     | 1066 (864–1 063) |
| **Latin America and the Caribbean**      |                              |                      |                 |
| Prevalence                              | 449 650 (370 510–548 055)    | 575 028 (459 495–713 720) | 609 379 (483 554–749 148) |
| Rate per 100 000                         | 368 (266–476)                | 423 (314–558)        | 449 (327–600)   |
| **Southeast Asia, East Asia, and Oceania** |                              |                      |                 |
| Prevalence                              | 737 521 (605 450–893 982)    | 945 540              | 958 185         |
| Rate per 100 000                         | 664 (545–804)                | 701 (573–863)        | 703 (567–888)   |
| **Sub-Saharan Africa**                   |                              |                      |                 |
| Prevalence                              | 1 154 387 (982 510–1 402 582) | 1 216 086–2 023 679) | 1 248 656–2 048 161) |
| Rate per 100 000                         | 388 (273–519)                | 425 (304–586)        | 434 (316–593)   |
| **North Africa and the Middle East**     |                              |                      |                 |
| Prevalence                              | 529 020 (425 795–647 712)    | 605 404 (471 749–644 750) | 515 935 (406 382–628 706) |
| Rate per 100 000                         | 1 025 (825–1 255)            | 980 (771–1 207)      | 888 (718–1 111) |
| **Global**                              |                              |                      |                 |
| Prevalence                              | 4 704 742                    | 5 051 176            | 5 825 559       |
| Rate per 100 000                         | 4 588 (3 577–6 111)          | 423 (313–583)        | 397 (289–527)   |
| **No. (95% UI)**                         |                              |                      |                 |
| 1–4 y                                   |                              |                      |                 |
| 5–9 y                                   |                              |                      |                 |
| 10–14 y                                 |                              |                      |                 |
| 15–19 y                                 |                              |                      |                 |
| <20 y                                   |                              |                      |                 |
| High-income North America | No. (95% UI) |
|---------------------------|--------------|
| Prevalence                | 312,301 (242,878–382,044) |
| Cases per 100,000         | 1317 (1096–1558) |
| YLD                       | 56,625 (42,735–71,313) |
| Rate per 100,000          | 329 (249–415) |

| Western Europe            | 306,760 (244,393–366,154) |
| Prevalence                | 407,635 (323,805–486,663) |
| Cases per 100,000         | 1727 (1376–2062) |
| YLD                       | 58,630 (44,214–76,755) |
| Rate per 100,000          | 331 (249–432) |

| Central Europe, Eastern Europe, and Central Asia | 464,555 (372,176–551,948) |
| Prevalence                   | 566,007 (456,083–671,043) |
| Cases per 100,000            | 2048 (1641–2434) |
| YLD                          | 96,975 (74,084–123,808) |
| Rate per 100,000             | 428 (327–546) |

| Latin America and the Caribbean | 672,585 (546,288–790,809) |
| Prevalence                     | 793,565 (640,531–936,587) |
| Cases per 100,000              | 1654 (1343–1944) |
| YLD                            | 192,502 (141,828–249,593) |
| Rate per 100,000               | 401 (301–505) |

| Southeast Asia, East Asia, and Oceania | 1,999,600 (1,551,605–2,417,553) |
| Prevalence                          | 7,711,280 (6,203,711–8,114,461) |
| Cases per 100,000                   | 1,673,315 (1,322,991–1,906,676) |
| YLD                                 | 186,842 (138,637–245,525) |
| Rate per 100,000                    | 376 (254–459) |

| South Asia                        | 8,814,255 (6,626,639–10,976,227) |
| Prevalence                         | 10,915,694 (8,235,801–13,631,549) |
| Cases per 100,000                  | 2,388,846 (1,858,076–2,909,589) |
| YLD                                | 1,047,333 (1,837,960–2,863,620) |
| Rate per 100,000                   | 2,342,392 (2,152,186–2,533,713) |

| Sub-Saharan Africa                | 19,501,296 (2.817,070–33,875,016) |
| Prevalence                         | 24,810,982 (18,588,401–31,156,570) |
| Cases per 100,000                  | 2,843,521 (2,150,008–3,491,657) |
| YLD                                | 3,212,894 (2,485,326–3,855,238) |
| Rate per 100,000                   | 12,578,275 (9,852,736–15,399,332) |
TABLE 2 Continued

| No. (95% UI) | 1–4 y | 5–9 y | 10–14 y | 15–19 y | <20 y |
|-------------|-------|-------|---------|---------|-------|
| YLD         | 537 270 (403 404–681 216) | 502 903 (371 463–654 997) | 427 855 (318 385–583 515) | 344 876 (257 747–450 141) | 1 978 503 (1 492 394–2 545 605) |
| Rate per 100 000 | 417 (313–528) | 341 (252–444) | 328 (244–432) | 312 (233–407) | 358 (270–461) |

North Africa and the Middle East

| Prevalence | 2 085 975 (1 607 222–2 584 440) | 2 407 074 (1 843 229–2 988 253) | 2 134 977 (1 635 729–2 648 884) | 1 888 277 (1 448 419–2 345 875) | 9 063 331 (6 947 456–11 240 448) |
| Cases per 100 000 | 4062 (3115–5028) | 3896 (2984–4834) | 3773 (2891–4681) | 3596 (2759–4468) | 3853 (2954–4779) |
| YLD | 247 026 (186 292–312 698) | 277 132 (211 358–354 743) | 244 547 (186 614–310 299) | 214 982 (164 447–274 406) | 1 049 302 (801 194–1 335 594) |
| Rate per 100 000 | 479 (361–606) | 449 (342–574) | 432 (330–548) | 409 (313–523) | 446 (341–568) |

Global

| Prevalence | 18 008 445 (13 908 115–22 144 957) | 21 463 907 (16 582 653–26 576 300) | 20 163 862 (15 573 910–24 783 030) | 19 007 495 (14 683 193–23 427 643) | 83 209 866 (64 444 586–102 067 901) |
| Cases per 100 000 | 3518 (2563–4080) | 3246 (2508–3989) | 3169 (2448–3985) | 3083 (2382–3800) | 3207 (2484–3834) |
| YLD | 2 349 727 (1 817 711–2 849 999) | 2 754 614 (2 118 761–3 468 366) | 2 603 898 (2 016 601–3 243 552) | 2 437 342 (1 889 411–3 031 441) | 10 753 989 (8 286 280–13 378 933) |
| Rate per 100 000 | 433 (335–543) | 417 (320–524) | 408 (317–510) | 395 (306–492) | 414 (319–516) |

epilepsy (455), and vision loss (808). Efforts were made to (1) optimize the comparability of data derived from various sources by using different methods, (2) find a consistent set of estimates across prevalence data, and (3) generate estimates for locations with sparse or no data by using available information from other locations combined with covariates. Prevalence estimates were produced by using DisMod-MR 2.1, a statistical modeling technique developed for the GBD project (Supplemental Fig 5). This is a Bayesian meta-regression tool that synthesizes epidemiological data for fatal and non-fatal health outcomes from disparate settings and sources, adjusting for different case definitions, diagnostic criteria, or sampling methods, to generate internally consistent estimates by geographical location, year, age group, and sex. The validity of DisMod has been widely reported.

YLD, defined as the years of life lived with a condition in a less than ideal health state, are designed to provide a comparable measure of disease burden across diverse health conditions and impairments rather than a measure of functional status, as described in ICP. To calculate YLD for the 4 disabilities, the estimated prevalence of each disability was multiplied by an assigned disability weight. Disability weights are the population assessment of magnitude of health loss from specific health outcomes measured on a scale from 0 to 1, in which 0 equals a state of perfect health and 1 equals death. The disability weights were estimated from multicountry population-based surveys, as described in detail elsewhere.

The global estimates of the prevalence and YLD for the 4 disabilities in children and adolescents were disaggregated by age group (children: <1, 1–4, 5–9 years; adolescents: 10–14 and 15–19 years), sex, and geographical regions (high-income North America, Western Europe, Central and Eastern Europe and Central Asia, Latin America and the Caribbean, Southeast and East Asia and Oceania, South Asia, Sub-Saharan Africa, North Africa and the Middle East). The selected locations are not geopolitical units, but groupings of countries created by GBD for analytical purposes. All computations in the GBD were conducted 1000 times to propagate uncertainty around the estimates for prevalence and YLD. At every step in the modeling process, the distributions were assessed for the sampling error of data inputs, the uncertainty of data corrections for measurement errors, the uncertainty in coefficients from model fit, and the uncertainty of severity distributions and disability weights. The corresponding uncertainty intervals (UIs) for prevalence and YLD estimates of the 4 disabilities were defined at the 2.5th and 97.5th value of 1000 draws. As with all GBD articles, the substantive data that formed the basis of this analysis adhered to the Guidelines for Accurate and Transparent Health Estimates Reporting, which include recommendations on the documentation of data sources.
| Region |
|--------------------------------|
| **High-income North America** |
| Prevalence | 258,142 (225,327–295,461) |
| Cases per 100,000 | 1502 (1311–1719) |
| YLD | 12,408 (8680–17,110) |
| Rate per 100,000 | 72 (50–100) |
| **Western Europe** |
| Prevalence | 226,464 (198,409–259,596) |
| Cases per 100,000 | 1275 (1117–1462) |
| YLD | 9,166 (6304–12,735) |
| Rate per 100,000 | 52 (35–72) |
| **Central Europe, Eastern Europe, and Central Asia** |
| Prevalence | 446,534 (393,229–505,136) |
| Cases per 100,000 | 1969 (1734–2227) |
| YLD | 19,754 (13,847–27,355) |
| Rate per 100,000 | 87 (61–121) |
| **Latin America and the Caribbean** |
| Prevalence | 843,578 (744,767–954,872) |
| Cases per 100,000 | 2074 (1831–2348) |
| YLD | 36,917 (29,862–51,437) |
| Rate per 100,000 | 91 (84–126) |
| **Southeast Asia, East Asia, and Oceania** |
| Prevalence | 2,937,855 | 5,847,100 | 6,652,840 | 9,517,169 | 25,253,888 |
| Cases per 100,000 | 2,645 (2574–2922) | 4,333 (3844–4867) | 4,878 (4377–5460) | 6,887 (6178–7575) | 4574 (4231–4935) |
| YLD | 147,715 (103,706–203,433) | 258,411 (179,943–352,506) | 295,134 (205,206–407,958) | 346,117 (242,624–475,054) | 1,070,558 (750,476–1,466,477) |
| Rate per 100,000 | 133 (93–183) | 192 (133–261) | 216 (151–298) | 249 (174–341) | 194 (156–266) |
| **South Asia** |
| Prevalence | 3,931,287 | 7,908,429 | 8,847,058 | 12,035,855 | 33,081,529 |
| Cases per 100,000 | 2,786 (2258–3058) | 4,415 (3940–4923) | 4,975 (4485–5519) | 6,763 (6141–7485) | 4684 (4336–5021) |
| YLD | 209,056 (146,539–286,880) | 359,968 (252,910–485,911) | 399,390 (275,291–552,742) | 457,025 (321,410–630,307) | 1,455,912 (1,025,230–1,979,015) |
| Rate per 100,000 | 148 (104–203) | 201 (141–271) | 225 (155–311) | 257 (181–354) | 205 (144–279) |
| **Sub-Saharan Africa** |
| Prevalence | 3,684,805 | 6,576,843 | 6,563,670 | 7,182,174 | 24,215,356 |
| Cases per 100,000 | 3,352,275–4,064,331 | 5,912,292–7,295,890 | 5,763,444–7,037,152 | 6,581,941–7,868,098 | 22,583,511–25,985,485 |
and adolescents was Globally, the population of children
and adolescents was estimated to be 1.32 billion in 2017, of whom 291.2 million (95% UI: 249.9–335.4), or 11.2% (95% UI: 10.0–12.5), were estimated to have 1 of the 4 disabilities examined (Tables 1–4). Approximately 152.3 million (52.3%) were male, although the sex pattern varied across the disabilities. The prevalence of these disabilities increased with age, from 6.1% among all the ∼138 million children aged <1 year to 13.9% among the roughly 616 million adolescents aged 15 to 19 years. A total of 16 million (95% UI: 13.4–18.9 [5.5%]) lived in high-income countries, and 275.2 million (95% UI: 236.4–316.5 [94.5%]) lived in LMIC. Of all the children and adolescents with disabilities, 8.4 million (2.9%) were aged <1 year, 47.9 million (16.4%) were aged 1 to 4 years, 73.5 million (25.2%) were aged 5 to 9 years, 75.9 million (26.1%) were aged 10 to 14 years, and 85.6 million (29.4%) were aged 15 to 19 years. Thus, a total of 205.6 million (70.6%) were aged 5 to 9 years, 75.9 million (25.2%) were aged 4 years, 73.5 million (25.2%) were aged 1 to 4 years, 73.5 million (25.2%) were aged 5 to 9 years, 75.9 million (26.1%) were aged 10 to 14 years, and 85.6 million (29.4%) were aged 15 to 19 years. These 4 disabilities accounted for 12.5), were estimated to have 1 of all the 4 disabilities examined (Tables 1–4). Approximately 152.3 million (52.3%) were male, although the sex pattern varied across the disabilities. The prevalence of these disabilities increased with age, from 6.1% among all the ∼138 million children aged <1 year to 13.9% among the roughly 616 million adolescents aged 15 to 19 years. A total of 16 million (95% UI: 13.4–18.9 [5.5%]) lived in high-income countries, and 275.2 million (95% UI: 236.4–316.5 [94.5%]) lived in LMIC. Of all the children and adolescents with disabilities, 8.4 million (2.9%) were aged <1 year, 47.9 million (16.4%) were aged 1 to

RESULTS

Globally, the population of children and adolescents was ∼2.6 billion in 2017, of whom 291.2 million (95% UI: 249.9–335.4), or 11.2% (95% UI: 10.0–12.5), were estimated to have 1 of the 4 disabilities examined (Tables 1–4). Approximately 152.3 million (52.3%) were male, although the sex pattern varied across the disabilities. The prevalence of these disabilities increased with age, from 6.1% among all the ∼138 million children aged <1 year to 13.9% among the roughly 616 million adolescents aged 15 to 19 years. A total of 16 million (95% UI: 13.4–18.9 [5.5%]) lived in high-income countries, and 275.2 million (95% UI: 236.4–316.5 [94.5%]) lived in LMIC. Of all the children and adolescents with disabilities, 8.4 million (2.9%) were aged <1 year, 47.9 million (16.4%) were aged 1 to

### TABLE 3

| Age group | No. (95% UI) |
|-----------|-------------|
| 1–4 y     | 2686 (2560–3152) |
| 5–9 y     | 4460 (4009–4947) |
| 10–14 y   | 4877 (4417–5393) |
| 15–19 y   | 6495 (5953–7113) |
| <20 y     | 4387 (4052–4708) |

estimation methods, statistical analysis, and statistical code. RESULTS

Globally, the population of children and adolescents was ∼2.6 billion in 2017, of whom 291.2 million (95% UI: 249.9–335.4), or 11.2% (95% UI: 10.0–12.5), were estimated to have 1 of the 4 disabilities examined (Tables 1–4). Approximately 152.3 million (52.3%) were male, although the sex pattern varied across the disabilities. The prevalence of these disabilities increased with age, from 6.1% among all the ∼138 million children aged <1 year to 13.9% among the roughly 616 million adolescents aged 15 to 19 years. A total of 16 million (95% UI: 13.4–18.9 [5.5%]) lived in high-income countries, and 275.2 million (95% UI: 236.4–316.5 [94.5%]) lived in LMIC. Of all the children and adolescents with disabilities, 8.4 million (2.9%) were aged <1 year, 47.9 million (16.4%) were aged 1 to

4 years, 73.5 million (25.2%) were aged 5 to 9 years, 75.9 million (26.1%) were aged 10 to 14 years, and 85.6 million (29.4%) were aged 15 to 19 years. Thus, a total of 205.6 million (70.6%) were <15 years of age. These 4 disabilities accounted for 28.9 million YLD (or 19.9%) of the overall 145.3 million (95% UI: 106.9–189.7) YLD among children and adolescents from all causes of fatal and non-fatal outcomes included in the GBD 2017.

The prevalence of hearing loss rose from 0.9% among children aged <1 year to 5.9% (95% UI: 5.4%–6.5%) among adolescents aged 15 to 19 years (Fig 1). Vision loss rose from 1.1% among children aged <1 year to 3.9% (95% UI: 3.4%–4.6%) among adolescents aged 15 to 19 years. The prevalence of intellectual disability and epilepsy remained largely constant at ∼3% and 0.9%, respectively, in all age groups. Among all children and adolescents, the disability-specific prevalence was 0.9% (95% UI: 0.8%–1.1%) for epilepsy, 3.2% (95% UI: 2.5%–3.9%) for intellectual disability, 3.1% (95% UI: 2.7%–3.6%) for vision loss, and 4.0% (95% UI: 3.7%–4.3%) for hearing loss. However, epilepsy and intellectual disability were associated with the highest YLD in all age groups, which were significantly higher than sensory disabilities.

South Asia accounted for the highest prevalence of intellectual disability (6.0% [95% UI: 4.5%–7.5%]), hearing loss (4.7% [95% UI: 4.3%–5.0%]), and vision loss (3.7% [95% UI: 3.2%–4.2%]), whereas Latin America and the Caribbean recorded the highest prevalence of epilepsy (1.2% [95% UI: 1.0%–1.5%]), as shown in Fig 2. Epilepsy was least prevalent in Southeast and East Asia and Oceania (0.7% [95% UI: 0.6%–0.8%]), and intellectual disability was least prevalent in Latin America and the Caribbean (1.6% [95% UI: 1.3%–1.9%]), whereas vision loss
Table 4: Global and Regional Age-Specific Prevalence of and YLD for Vision Loss in 2017

| Region                        | Subregion                        | 1–4 y | 5–9 y | 10–14 y | 15–19 y | <20 y |
|-------------------------------|----------------------------------|-------|-------|---------|---------|-------|
| High-income North America    | Prevalence                       | 152,625 | 290,067 | 325,847 | 332,019 | 1,114,609 |
|                              | Cases per 100,000                | 888 (887–1,090) | 1,290 (963–1,683) | 1,385 (1,042–1,841) | 1,409 (1,107–1,764) | 1,224 (881–1,501) |
|                              | YLD                               | 682,574 (449,980) | 12,472 (794,618–1,813) | 13,922 (910,909–20,643) | 14,080 (9,443–20,526) | 48,069 (31,567–70,763) |
|                              | Rate per 100,000                  | 40 (26–57) | 56 (35–84) | 59 (39–88) | 60 (40–87) | 53 (35–78) |
| Western Europe                | Prevalence                       | 276,387 | 517,470 | 525,529 | 518,419 | 1,865,897 |
|                              | Cases per 100,000                | 1,956 (1,119–2,111) | 2,200 (1,503–3,088) | 2,261 (1,542–3,271) | 2,211 (1,585–3,031) | 20,200 (15,24–26,64) |
|                              | YLD                               | 12,670 (8,363–18,679) | 22,999 (14,561–35,761) | 23,903 (15,661–36,263) | 24,246 (16,157–35,060) | 85,277 (56,719–126,152) |
|                              | Rate per 100,000                  | 71 (47–105) | 98 (62–152) | 103 (67–156) | 103 (69–149) | 92 (61–137) |
| Central Europe, Eastern Europe, and Central Asia | Prevalence | 56,728 | 94,642 | 86,984 | 84,675 | 3,263,489 |
|                              | Cases per 100,000                | 2,490 (1,941–3,100) | 3,424 (2,609–4,450) | 3,605 (2,812–4,624) | 3,709 (3,014–4,553) | 3,206 (2,633–3,886) |
|                              | YLD                               | 23,331 (15,339–33,908) | 37,060 (23,671–57,112) | 33,650 (22,175–50,785) | 32,090 (21,729–46,689) | 129,096 (86,179–190,154) |
|                              | Rate per 100,000                  | 103 (68–150) | 135 (86–208) | 140 (92–211) | 141 (95–204) | 126 (84–186) |
| Latin America and the Caribbean | Prevalence | 74,115 | 1,382,342 | 1,772,148 | 2,134,390 | 6,060,394 |
|                              | Cases per 100,000                | 1,820 (1,495–2,192) | 2,795 (2,305–3,410) | 3,495 (2,961–4,218) | 4,273 (3,735–4,814) | 3,037 (2,633–3,886) |
|                              | YLD                               | 35,105 (24,358–49,102) | 56,438 (38,220–82,876) | 65,224 (43,422–93,124) | 71,839 (49,073–102,16) | 231,800 (161,066–330,075) |
|                              | Rate per 100,000                  | 86 (60–121) | 114 (77–188) | 128 (88–189) | 144 (98–205) | 116 (81–163) |
| Southeast Asia, East Asia, and Oceania | Prevalence | 2,249,931 | 3,832,438 | 4,413,990 | 4,703,742 | 15,585,040 |
|                              | Cases per 100,000                | 2,024 (1,627–2,442) | 2,914 (2,306–3,644) | 3,236 (2,644–4,012) | 3,378 (2,887–3,964) | 2,823 (2,397–3,509) |
|                              | YLD                               | 109,196 (78,200–153,579) | 166,445 (111,487–245,196) | 176,644 (121,421–254,986) | 181,132 (128,902–254,871) | 653,115 (455,879–924,467) |
|                              | Rate per 100,000                  | 98 (69–138) | 123 (83–182) | 130 (89–187) | 130 (91–183) | 118 (83–167) |
| South Asia                    | Prevalence                       | 3,774,616 | 6,439,687 | 7,183,140 | 8,143,890 | 26,038,313 |
|                              | Cases per 100,000                | 2,675 (2,181–3,195) | 3,595 (2,832–4,389) | 4,039 (3,441–4,820) | 4,577 (4,032–5,201) | 3,671 (3,205–4,213) |
|                              | YLD                               | 165,533 | 245,087 (163,525–364,04) | 249,088 (168,740–368,544) | 261,408 (181,428–376,079) | 948,988 |
|                              | Rate per 100,000                  | 117 (80–167) | 137 (91–203) | 140 (95–207) | 147 (102–211) | 134 (91–193) |
| Sub-Saharan Africa            | Prevalence                       | 2,684,821 | 4,543,637 | 4,907,105 | 4,973,232 | 17,405,909 |
|                              | Cases per 100,000                | 2,192,343 (3–177,167) | 3,814,398 (5–446,542) | 4,263,876 (5–738,216) | 4,439,948 (5–952,714) | 15,387,972–19,716,012 |
|                              | YLD                               | 129,586 (91,767–177,285) | 178,202 (122,892–257,198) | 172,247 (119,122–245,839) | 161,966 (113,190–226,755) | 667,326 (471,988–937,436) |
(1.2% [95% UI: 1.0%–1.5%]) and hearing loss (2.2% [95% UI: 2.1%–2.4%]) were least prevalent in high-income North America. South Asia (0.6% [95% UI: 0.4%–0.7%]) and Latin America and the Caribbean (0.5% [95% UI: 0.4%–0.7%]) were associated with the highest YLD rates for intellectual disability and epilepsy, respectively. South Asia (107.8 million or 37.5%) and sub-Saharan Africa (59.8 million or 20.5%) accounted for more than half of all children and adolescents with disabilities (Fig 3). High-income North America (5.6 million or 1.9%) and Western Europe (6.2 million or 2.1%) accounted for the lowest population of children and adolescents with disabilities.

Globally, mild intellectual disability (IQ scores of 50–69) was the most prevalent disability, and mild vision loss was the least prevalent disability among the 4 types of disability (Fig 3). Within regions, mild hearing loss was the most common disability in all regions except Central and Eastern Europe and Central Asia and Southeast and East Asia and Oceania. Mild vision loss was the least prevalent disability in all regions.

Severe epilepsy and severe intellectual disability were the 2 most common disabilities with the highest YLD globally and in all regions. The burden of epilepsy was more concentrated in Mexico, Colombia, and Venezuela in Latin America and was more concentrated in Gabon, the Republic of the Congo, and Angola in sub-Saharan Africa (Fig 4). Intellectual disability had the highest prevalence in India (South Asia), Afghanistan, and Yemen (Middle East). Hearing loss was most prevalent in Madagascar (sub-Saharan Africa) and Myanmar (Southeast Asia), whereas vision loss was more widespread and had the highest prevalence in South Sudan, the Central African Republic (sub-Saharan Africa), and Papua New Guinea (Oceania).

The top 10 countries accounted for 52.8% of all children and adolescents with epilepsy, 68.0% of children and adolescents with intellectual disability, 62.0% of children and adolescents with hearing loss, and 59.4% of children and adolescents with vision loss (Supplemental Fig 6). The top 10 countries accounted for 62.3% of all children and adolescents with these disabilities. These countries also accounted for at least 53.5% of the YLD associated with these conditions. India and China had the highest population of children and adolescents with any disability, with their associated YLD. The United States was the only high-income country among the top 10 countries for any disability. However, in terms of the highest prevalence and YLD rates per population, countries with the highest prevalence were Gabon for epilepsy, India for intellectual disability, Madagascar for hearing loss, and Israel for vision loss. The underlying causes or risk factors and their ICD-9 and ICD-10 codes that formed the basis of the reported estimates for all disabilities in the GBD 2017, as well as their contributions to the aggregate estimate for each disability, are summarized in Supplemental Fig 7.

**DISCUSSION**

Our primary aim was to update the global estimate of children and adolescents with disabilities previously attributed to the GBD 2004 and still widely reported in the literature.\(^2\)\(^{–}\)\(^9\) Although, in our study,
we did not capture the full spectrum of all possible childhood disabilities, our analysis reveals that the number of children and adolescents with disabilities is at least 291 million globally and that the prevalence increases with age. Among children and adolescents 15 years, the estimate of children and adolescents with these 4 disabilities is more than twice the 2004 estimate of 93 million. The substantially higher estimate can be attributed to several factors besides the modest impact of the ~6.6% and 4.1% rise in the global population of children and adolescents <15 and <20 years, respectively, between 2004 and 2017.25 Firstly, the number and variety of data sources used in generating estimates have increased substantially since 2004. Secondly, the modeling techniques have improved significantly on the basis of expert contributions from an increasing number of institutional and individual collaborators from 146 countries.26 Thirdly, consistent with the classification recommended by the ICF, the GBD 2017 estimates include disabilities of varying degrees of severity from slight or mild to profound for each disability. Lastly, there is now an internationally agreed on framework for evaluating estimates of health from statistical modeling, which has been strictly followed by the GBD since 2015.24

The GBD modeling efforts are meant to bridge a critical gap in the epidemiology of developmental disorders resulting from several conceptual and operational challenges in measuring disabilities in children and adolescents.27,28 As with most health conditions, the dearth of population-based data for specific disabilities, especially in LMIC, has compelled a growing reliance on the statistical estimation of health outcomes as an interim step to guide health policy and intervention. The implicit philosophy underpinning these efforts is that the absence of conventional epidemiological data is not evidence of the absence of a health condition. Thus, GBD is an essential, independent, and up-to-date source of alternative data for policy-makers and decision-makers in global health, especially for countries with poor or no data.2,3

However, it is helpful to evaluate the plausibility of the GBD estimates in the absence of comparable global estimates from other reputable sources. The global estimate of 0.9% (95% UI: 0.8%–1.1%) for epilepsy among all children and adolescents appears plausible on the basis of evidence in the literature, suggesting a global prevalence of between 0.5% and 1%.29,30 In addition, the estimate of 1.0% (95% UI: 0.8%–1.3%) for sub-Saharan Africa is consistent with the 0.9% reported in the most comprehensive systematic review on epilepsy to date from this region.31 The GBD estimate for intellectual disability of 3.2% (95% UI: 3.2%–3.4%) is greater than the 2.3% (95% UI: 2.2%–2.4%) estimate from the most recent comprehensive review of epidemiologic studies conducted in LMIC.32,33

![FIGURE 1](https://www.aappublications.org/news/2021/05/19/fig1.png)

**FIGURE 1**
Global age-specific prevalence of and YLD for childhood epilepsy, intellectual disability, hearing loss and vision loss in 2017.
2.5%–3.9%) was higher than the estimate of 1.8% reported in 1 meta-analysis of population-based studies, possibly because of the inclusion of children and adolescents with comorbid autism spectrum disorder and cerebral palsy secondary to neonatal encephalopathy in the GBD.32,33 South Asia substantially contributed to the reported global estimates for intellectual disability, and the age-specific GBD estimates for this region are supported by a recent robust population-based study from India in which a prevalence of 5.2% was reported.34 Sensory disabilities are perhaps the most researched childhood disabilities worldwide. Several studies in school-aged children support the reported estimates for vision loss and hearing loss, with most suggesting that the GBD estimates were conservative.35–38 For example, in 1 systematic review of childhood hearing loss, a prevalence of between 0.8% and 46.7% was reported across 26 well-conducted studies from different regions,36 whereas 2 population-based studies from Canada and the United States revealed estimates of between 4.5% and 7.9%, compared with a GBD estimate of 2.2% for North America. More crucially, these findings underscore the need to develop local capacity toward early identification and timely on-going support for children and adolescents with any disability and their families, especially in high-burden LMIC. The unique challenges faced by children with disabilities as they transition into adolescence also need to be recognized and addressed.39

This study has several limitations worth emphasizing. Most importantly, our main finding must be regarded as a conservative estimate of children with disabilities in general because this study was restricted to 4 conditions. The inclusion of conditions such as cerebral palsy without comorbid intellectual disability would have increased the reported estimates in our article. Additionally, the GBD 2017 has methodologic limitations that have been extensively described in previous publications in accordance with the Guidelines for Accurate and Transparent Health Estimates Reporting.16–18 For example, the 95% CIs around estimates for regions with sparse data are still wide. Most of the uncertainty in the YLD estimates results from the current limitations in the determination of disability weights that may be minimized in the future by removing some of the ambiguities in lay descriptions and increasing the volume of survey data. In addition, despite the continuous efforts toward improving the GBD methodology, concerns remain on estimating the prevalence of disabilities solely as sequelae of health conditions.2,3,40 Furthermore, the estimates do not fully reflect the complex and dynamic relationship between health conditions and contextual personal or environmental factors.
factors, as envisaged under the ICF, and so provide a limited picture of disability.\textsuperscript{15} Finally, it was difficult to completely and precisely account for children with multiple disabilities and across multiple developmental domains. These considerations reveal the need for complementary nationally representative disability data, such as those published periodically by the United Nations Children’s Fund and the WHO, that can be used as additional data inputs for the GBD. Although estimates of disabilities from both statistical modeling and household surveys are not definitive, they reflect current knowledge and the best available evidence to inform policies and interventions.

CONCLUSIONS

In the most recent GBD, it is shown that the number of children and adolescents with disabilities globally far exceeds the estimate in 2004. The burden of disability is substantial from early childhood and corroborates our earlier report on the need to address the quality of life of many beneficiaries of the child survival programs during the era of the Millennium Development Goals (2000–2015).\textsuperscript{18} The risk likely to be faced by the affected children and adolescents of not realizing their full potential, especially in LMIC, as envisaged under the SDGs era, is real and disturbing. Regardless of the inherent limitations of modeled estimates, the findings from our analysis are plausible and insightful. These findings shed light on the high and growing health needs among child survivors that warrant significant investments and should be a wake-up call to public health leaders and advocates globally. A committed global leadership will ensure that these and other vulnerable children and adolescents are truly not left behind in accordance with the obligations under the Convention on the Rights of the Child and the Convention on the Rights of Persons with Disabilities.

ACKNOWLEDGMENTS

We thank Christopher J.L. Murray, Theo Vos, and Mohsen Naghavi of the Institute for Health Metrics and Evaluation for their overall guidance of the substantive GBD study that formed the basis of this analysis.

FIGURE 3

Regional ranking of childhood epilepsy, intellectual disability, hearing loss, and vision loss by severity among children and adolescents based on estimates of prevalence and YLD in 2017. Colors correspond to the ranking of disability by severity, with dark red indicating the most common disability and dark green indicating the least common disability for the location indicated. The numbers inside each box indicate the ranking.

| Prevalence | (Global) | North America | Western Europe | Central, Eastern Europe, and Central Asia | Latin America and the Caribbean | Eastern Asia, South Asia, and Oceania | South Asia | Sub-Saharan Africa | North Africa and the Middle East |
|------------|---------|---------------|----------------|------------------------------------------|---------------------------------|----------------------------------------|----------|-----------------|-------------------------------|
| Treated epilepsy | 12 | 5 | 5 | 9 | 9 | 12 | 14 | 17 | 10 |
| Moderate epilepsy | 8 | 7 | 10 | 8 | 5 | 9 | 9 | 8 | 5 |
| Severe epilepsy | 8 | 8 | 8 | 5 | 8 | 7 | 7 | 6 | 4 |
| Moderate intellectual disability | 10 | 11 | 12 | 11 | 10 | 9 | 8 | 7 | 6 |
| Mild intellectual disability | 8 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 3 |
| Moderate intellectual disability | 5 | 10 | 7 | 4 | 6 | 3 | 6 | 11 | 7 |
| Severe intellectual disability | 9 | 6 | 6 | 7 | 6 | 8 | 6 | 8 | 6 |
| Profound intellectual disability | 17 | 17 | 17 | 17 | 14 | 13 | 16 | 12 | 14 |
| Mild hearing loss | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Moderate hearing loss | 4 | 4 | 4 | 5 | 8 | 7 | 4 | 5 | 6 |
| Severe hearing loss | 7 | 6 | 9 | 10 | 11 | 11 | 10 | 9 | 11 |
| Profound hearing loss | 13 | 13 | 13 | 13 | 15 | 14 | 12 | 13 | 12 |
| Complete hearing loss | 16 | 16 | 15 | 16 | 16 | 16 | 17 | 16 | 16 |
| Mild vision loss | 16 | 17 | 17 | 17 | 17 | 17 | 18 | 17 | 18 |
| Moderate vision loss | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Severe vision loss | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Blindness | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 |

YLD

| Severe hearing loss | 10 | 14 | 13 | 13 | 13 | 13 | 10 | 12 | 13 |
| Moderate hearing loss | 12 | 14 | 13 | 15 | 14 | 15 | 12 | 13 | 15 |
| Severe hearing loss | 10 | 16 | 15 | 15 | 15 | 15 | 14 | 15 | 16 |
| Profound hearing loss | 9 | 9 | 10 | 10 | 11 | 11 | 9 | 10 | 12 |
| Complete hearing loss | 16 | 15 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Mild vision loss | 16 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Moderate vision loss | 6 | 7 | 5 | 5 | 5 | 5 | 6 | 6 | 6 |
| Severe vision loss | 14 | 15 | 11 | 12 | 14 | 14 | 15 | 16 | 17 |
| Blindness | 8 | 10 | 9 | 9 | 8 | 8 | 13 | 7 | 10 |

ABBREVIATIONS

GBD: Global Burden of Disease Study
ICD-9: International Classification of Disease, Ninth Revision
ICD-10: International Classification of Disease, 10th Revision
ICF: International Classification of Functioning, Disability, and Health
LMIC: low- and middle-income countries
SDG: sustainable development goal
UI: uncertainty interval
WHO: World Health Organization
YLD: years lived with disability
FIGURE 4
Global distribution of childhood epilepsy, intellectual disability, hearing loss and vision loss in 2017. A. Epilepsy, both sexes, <20 years, 2017, prevalent cases per 100,000. B. Developmental intellectual disability, both sexes, <20 years, 2017, prevalent cases per 100,000. C. Hearing loss, both sexes, <20 years, 2017, prevalent cases per 100,000. D. Blindness and vision impairment, both sexes, <20 years, 2017, prevalent cases per 100,000.
FIGURE 4
Continued.
Progressions: Developmental and Behavioral Pediatrics, San Francisco, California; Center for Healthy Development, Seattle, Washington; Ear Institute, University College London, London, United Kingdom; Division of Child and Adolescent Psychiatry, Department of Psychiatry and Mental Health, University of Cape Town, Cape Town, South Africa; Department of Emergency Medicine, CHI St. Vincent, Little Rock, Arkansas; Fed is Best Foundation, Little Rock, Arkansas; Department of Pharmacology and Toxicology, Maragheh University of Medical Sciences, Maragheh, Iran; Institute of Translational Medicine, University of Liverpool, Liverpool, United Kingdom; Department of Psychology, Institute of Psychiatry, Psychology and Neuroscience, King’s College London, London, United Kingdom; Department of Epidemiology, Emory University Rollins School of Public Health, Atlanta, Georgia; Department of Paediatrics and Child Health, University of the Witwatersrand, Johannesburg, Johannesburg, South Africa; Department of Paediatrics and Child Health, Makerere University College of Health Sciences, Kampala, Uganda; Translational Health Research Institute, School of Medicine, Western Sydney University, Campbelltown Campus, Penrith, New South Wales, Australia; Bill and Melinda Gates Foundation, Seattle, Washington; Nepal Health Research Council, Kathmandu, Nepal; Department of Child and Adolescent Health, The University of the West Indies, Mona Campus, Kingston, Jamaica; Department of Mental Health and Substance Use, World Health Organization, Geneva, Switzerland; Division of Public Health, Faculty of Medicine and Health Sciences, An-Najah National University, Nablus, Palestine; Eliot-Pearson Department of Child Development, Tufts University, Medford, Massachusetts; Virtual Academic Unit, Northampton General Hospital, Northampton, United Kingdom; and Institute for Health Metrics and Evaluation, University of Washington, Seattle, Washington

Dr.s B.O. Olusanya and Davis conceptualized and designed the study, drafted the initial manuscript, revised the manuscript, and provided overall coordination of all authors’ inputs; Drs Abubakar, Almasri, Arabloo, Arora, Berman, Breinbauer, de Vries, del Castillo-Hegyi, Effekhari, Kakooza-Mwesige, Halpern, Hoekstra, Kancherla, Mulaudi, Nair, Ogbo, Samms-Vaughan, Servili, Shaheen, Smythe, Wartlieb, Williams, and Wright, Profs Boo and Pandey, Ms Backhaus, Ms Carr, Ms Gladstone, Ms Olsen, and Mr J.O. Olusanya provided critical feedback on the methods and results, provided additional data, and critically reviewed the first draft and subsequent revisions for important intellectual content; Dr Kassebaum applied the analytical methods to produce estimates and reviewed and revised the manuscript for important intellectual content; Profs Kuper and Newton provided critical feedback on the methods and results and critically reviewed the final draft for important intellectual content; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Dr Abubakar’s current affiliation is Institute for Human Development, Aga Khan University, Nairobi, Kenya.

DOI: https://doi.org/10.1542/peds.2019-2623

Accepted for publication Apr 8, 2020

Address correspondence to Bolajoko O. Olusanya, FRCPCH, PhD, Center for Healthy Start Initiative, 286A Corporation Dr, Dolphin Estate, Ikoyi, Lagos, Nigeria.

E-mail: bolajoko.oulosanya@uclmail.net

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2020 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: Dr Kassebaum reports personal fees and nonfinancial support from Vifor Pharma Group outside the submitted work; the other authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding was received by any of the authors for this work. The substantive data that formed the basis of this article and the open access charge were funded by the Bill & Melinda Gates Foundation. This article is licensed under the Creative Commons Attribution 4.0 International License. The named authors alone are responsible for the views expressed in this publication.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

REFERENCES

1. United Nations. Sustainable Development Goals. New York, NY: United Nations; 2015. Available at: www.un.org/sustainabledevelopment/sustainable-development-goals/. Accessed July 30, 2019

2. United Nations Children’s Fund. The State of the World’s Children 2013: Children With Disabilities. New York, NY: United Nations Children’s Fund; 2013. Available at: https://www.unicef.org/sowc2013/files/SWCR2013_ENG_lo_res_24_Apr_2013.pdf. Accessed July 30, 2019

3. World Health Organization; The World Bank. World Report on Disability. Geneva, Switzerland: World Health Organization; 2011. Available at: www.who.int/disabilities/world_report/2011/report.pdf. Accessed July 30, 2019

4. United Nations Educational, Scientific and Cultural Organization. Education and disability. Available at: http://uis.unesco.org/sites/default/files/documents/fs40-education-and-disability-2017-en.pdf. Accessed July 30, 2019

5. Male C, Wodon Q. The Price of Exclusion: Disability and Education: Disability Gaps in Educational Attainment and Literacy. Washington, DC: The World Bank; 2017. Available at: http://documents.worldbank.org/curated/en/39628151988894028/pdf/121762-replacement-PUBLIC-WorldBank-GapsInEdAttainmentLiteracy-Brief-v6.pdf. Accessed July 30, 2019

6. United Nations Educational, Scientific and Cultural Organization. GEM report summary on disabilities and education. Available at: https://en.unesco.org/gem-report/sites/gem-report/files/GAW2014-Facts-Figures-gmr_0.pdf.pdf. Accessed July 30, 2019

7. World Health Organization. WHO Global Disability Action Plan 2014–2021: Better Health for All People With Disability. Geneva, Switzerland: World Health Organization; 2015. Available at: https://www.who.int/disabilities/actionplan/en/. Accessed July 30, 2019

8. United Nations High Commission for Human Rights. 93 million children with
disabilities ‘among the most likely to be left behind’: UN rights chief. Available at: https://news.un.org/en/story/2019/03/1034011. Accessed July 30, 2019

9. US Agency for International Development. Advancing protection and care for children in adversity: a US Government strategy for international assistance (2019–2023). Available at: https://www.usaid.gov/documents/1880/advancing-protection-and-care-for-children-adversity. Accessed July 30, 2019

10. World Health Organization. The Global Burden of Disease: 2004 Update. Geneva, Switzerland: World Health Organization; 2008. Available at: www.who.int/iris/handle/10665/43942. Accessed July 30, 2019

11. Olusanya BO, Krishnamurthy V, Wertlieb D. RE: global initiatives for early childhood development should be disability inclusive. Pediatrics. 2018; 141(3): e20174055

12. United Nations Convention on the Rights of the Child. 1989. UNCRD 1990. Available at: https://www.unicef.org.uk/what-we-do/un-convention-child-rights/. Accessed July 30, 2019

13. Convention on the Rights of Persons with Disabilities (CRPD) 2006. CRPD 2006. Available at: https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf. Accessed July 30, 2019

14. World Health Organization. Disability. In: 68th World Health Assembly; May 20–27, 2013; Geneva, Switzerland

15. World Health Organization. International Classification of Functioning, Disability and Health. Geneva, Switzerland: World Health Organization; 2001

16. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national burden of disease, injuries, and risk factors in child and adolescent health, 1990 to 2017: findings from the Global Burden of Diseases, Injuries, and Risk Factors 2017 Study. JAMA Pediatr. 2019;173(6):e180337

17. Reiner RC Jr., Olsen HE, Ikeda CT, et al; GBD 2017 Child and Adolescent Health Collaborators. Diseases, injuries, and risk factors in child and adolescent health, 1990 to 2017: findings from the Global Burden of Diseases, Injuries, and Risk Factors 2017 Study. JAMA Pediatr. 2019;173(6):e180337

18. Global Research on Developmental Disabilities Collaborators. Developmental disabilities among children younger than 5 years in 195 countries and territories, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016 [published correction appears in Lancet Glob Health. 2018;6(12):e1287]. Lancet Glob Health. 2018;6(10): e1100–e1121

19. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR), 4th ed, Text Revision. Washington, DC: American Psychiatric Association; 2000

20. Thurman DJ, Beghi E, Begley CE, et al; ILAE Commission on Epidemiology. Standards for epidemiologic studies and surveillance of epilepsy. Epilepsia. 2011;52(suppl 7):2–26

21. GBD 2016 Epilepsy Collaborators. Global, regional, and national burden of epilepsy, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016 [published correction appears in Lancet Neurol. 2019;18(5):e4]. Lancet Neurol. 2019; 18(4):357–375

22. Flaxman AD, Vos T, Murray CJL, eds. An Integrative Meta-regression Framework for Descriptive Epidemiology, 1st ed. Seattle, WA: University of Washington Press; 2015

23. Salomon JA, Haagsma JA, Davis A, et al. Disability weights for the Global Burden of Disease 2013 study. Lancet Glob Health. 2015;3(11):e712–e723

24. Stevens GA, Alkema L, Black RE, et al; GATHER Working Group. Guidelines for accurate and transparent health estimates reporting: the GATHER statement [published correction appears in PLoS Med. 2016;13(8): e1002116]. PLoS Med. 2016;13(6): e1002056

25. United Nations Population Division. United Nations World Population Prospects 1950–2100 - 2010 Revision. New York, NY: United Nations; 2011

26. Murray CJL, Lopez AD. Measuring global health: motivation and evolution of the Global Burden of Disease Study. Lancet. 1997;390(10100):1460–1464

27. Loeb M, Mont D, Cappa C, De Palma E, Madans J, Crialesi R. The development and testing of a module on child functioning for identifying children with disabilities on surveys: I. background. Disabil Health J. 2018;11(4):495–501

28. Gladstone M, Abubakar A, Idr0 R, Langfitt J, Newton CR. Measuring neurodevelopment in low-resource settings. Lancet Child Adolesc Health. 2017;1(4):258–259

29. Aaberg KM, Gunnes N, Bakken IJ, et al. Incidence and prevalence of childhood epilepsy: a nationwide cohort study. Pediatrics. 2017;135(5):e20165908

30. Camfield P, Camfield C. Incidence, prevalence and aetiology of seizures and epilepsy in children. Epileptic Disord. 2015;17(2):117–123

31. Ba-Diop A, Marin B, Druet-Cabanac M, Ngoungou EB, Newton CR, Preux PM. Epidemiology, causes, and treatment of epilepsy in sub-Saharan Africa. Lancet Neurol. 2014;13(10):1029–1044

32. Maulik PK, Masonchens MN, Mathers CD, Dua T, Saxena S. Prevalence of intellectual disability: a meta-analysis of population-based studies [published correction appears in Res Dev Disabil. 2013;34(2):729]. Res Dev Disabil. 2011; 32(2):419–436

33. McKenzie K, Milton M, Smith G, et al. Systematic review of the prevalence and incidence of intellectual disabilities: current trends and issues. Curr Dev Disord Rep. 2016;3:104–115

34. Arora NK, Nair M, Smith G, et al. Systematic review of alternate screening methods. Cogent Med 2017;4(1):1371103

35. Nunes ADDS, Silva CRL, Balen SA, Souza DLB, Barbosa IR. Prevalence of hearing impairment and associated factors in school-aged children and adolescents: a systematic review. Braz J Otorhinolaryngol. 2019;85(2):244–253
37. Feder KP, Michaud D, McNamee J, Fitzpatrick E, Ramage-Morin P, Beauregard Y. Prevalence of hearing loss among a representative sample of Canadian children and adolescents, 3 to 19 years of age. *Ear Hear*. 2017;38(1):7–20

38. Hoffman HJ, Dobie RA, Losonczy KG, Themann CL, Flamme GA. Kids nowadays hear better than we did: declining prevalence of hearing loss in US youth, 1966-2010. *Laryngoscope*. 2019;129(8):1922–1939

39. National Academies of Sciences Engineering and Medicine; Health and Medicine Division; Board on Health Care Services; Committee on Improving Health Outcomes for Children with Disabilities. In: Byers E, Valliere FR, Houtrow AJ, eds. *Opportunities for Improving Programs and Services for Children With Disabilities*. Washington, DC: National Academies Press; 2018

40. Graham N, Schultz L, Mitra S, Mont D. Disability in Middle Childhood and Adolescence. In: Bundy DAP, Silva N, Horton S, Jamison DT, Patton GC, eds. *Child and Adolescent Health and Development*, 3rd ed. Washington, DC: The International Bank for Reconstruction and Development/The World Bank; 2017:221–237
Global Burden of Childhood Epilepsy, Intellectual Disability, and Sensory Impairments

Bolajoko O. Olusanya, Scott M. Wright, M.K.C. Nair, Nem-Yun Boo, Ricardo Halpern, Hannah Kuper, Amina A. Abubakar, Nihad A. Almasri, Jalal Arabloo, Narendra K. Arora, Sophia Backhaus, Brad D. Berman, Cecilia Breinbauer, Gwen Carr, Petrus J. de Vries, Christie del Castillo-Hegyi, Aziz Eftekhari, Melissa J. Gladstone, Rosa A. Hoekstra, Vijaya Kancherla, Mphelekedzeni C. Mulaudzi, Angelina Kakooza-Mwesige, Felix A. Ogbo, Helen E. Olsen, Jacob O. Olusanya, Ashok Pandey, Maureen E. Samms-Vaughan, Chiara Servili, Amira Shaheen, Tracey Smythe, Donald Wertlieb, Andrew N. Williams, Charles R.J. Newton, Adrian C. Davis, Nicholas J. Kassebaum and on behalf of the Global Research on Developmental Disabilities Collaborators (GRDDC)

Pediatrics 2020;146; DOI: 10.1542/peds.2019-2623 originally published online June 17, 2020;

Updated Information & Services including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/146/1/e20192623

References This article cites 21 articles, 2 of which you can access for free at: http://pediatrics.aappublications.org/content/146/1/e20192623#BIBL

Subspecialty Collections This article, along with others on similar topics, appears in the following collection(s):

Children With Special Health Care Needs http://www.aappublications.org/cgi/collection/disabilities_sub

International Child Health http://www.aappublications.org/cgi/collection/international_child_health_sub

Permissions & Licensing Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml

Reprints Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml
Global Burden of Childhood Epilepsy, Intellectual Disability, and Sensory Impairments

Bolajoko O. Olusanya, Scott M. Wright, M.K.C. Nair, Nem-Yun Boo, Ricardo Halpern, Hannah Kuper, Amina A. Abubakar, Nihad A. Almasri, Jalal Arabloo, Narendra K. Arora, Sophia Backhaus, Brad D. Berman, Cecilia Breinbauer, Gwen Carr, Petrus J. de Vries, Christie del Castillo-Hegyi, Aziz Eftekhari, Melissa J. Gladstone, Rosa A. Hoekstra, Vijaya Kancherla, Mphelekedzeni C. Mulaudzi, Angelina Kakooza-Mwesige, Felix A. Ogbo, Helen E. Olsen, Jacob O. Olusanya, Ashok Pandey, Maureen E. Samms-Vaughan, Chiara Servili, Amira Shaheen, Tracey Smythe, Donald Wertlieb, Andrew N. Williams, Charles R.J. Newton, Adrian C. Davis, Nicholas J. Kassebaum and on behalf of the Global Research on Developmental Disabilities Collaborators (GRDDC)

Pediatrics 2020;146;
DOI: 10.1542/peds.2019-2623 originally published online June 17, 2020;

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/146/1/e20192623

Data Supplement at:
http://pediatrics.aappublications.org/content/suppl/2020/06/16/peds.2019-2623.DCSupplemental