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Visualizing Worldwide Prevalence of Age-Related Dual Sensory Loss

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Abstract

Objectives: This study aims to create a first visualization of global prevalence of age-related dual sensory loss (DSL), significantly affecting older people's quality of life. **Methods:** Data from World Health Organization (WHO) regions, particularly African, American, and European, were analyzed. The study focused on DSL onset and prevalence, using adjusted life expectancy for regional comparison. **Results:** There were notable regional variations in DSL onset and prevalence. The African region showed consistent data, thanks to standardized methods from the World Federation of the Deafblind. However, global patterns varied when adjusted for life expectancy, hinting at possible DSL prevalence stabilization at older ages. **Discussion:** The study identifies a lack of standardization in DSL prevalence research regarding definitions, methodologies, and reporting. It calls for more uniform and thorough research methods for accurate global DSL understanding. The research highlights the complexity and challenges in determining DSL prevalence worldwide.

Keywords

age-related dual sensory loss, global health visualization, epidemiology of dual sensory loss, World Health Organization regions analysis, standardization in prevalence studies

Introduction

Dual sensory loss (DSL), also referred to as deafblindness, combined/concurrent vision, and hearing impairment, is the loss of both hearing and vision, and can range from mild loss in hearing and vision to total deafness and blindness, or a variation in-between (Jaiswal et al., 2018; Wittich et al., 2013). DSL can be congenital, or individuals may be born with sensory loss in one modality then acquire a loss in the other modality, they can be born with no sensory loss but acquire both, or they can experience a later, age-related DSL (Minhas et al., 2022). The terms deafblindness may be more suited to the use for children and younger adults, as their needs might be different to those who have age-related dual sensory losses (Wittich et al., 2013). It is also the case that the prevalence of vision and hearing losses, both individually increase with age (Bright et al., 2023). Underlying mechanisms such as oxidative stress, microvascular changes, and chronic inflammation are common to both common conditions, but DSL may indicate a more advanced status of aging and a more severe degenerative process (Zhang et al., 2022). As the focus of this paper is age-related dual sensory loss, the term DSL shall be used throughout.

People with DSL experience difficulties that exceed those of having a single sensory loss (Dammeyer, 2014; Möller, 2003). It is a complex phenomenon posing unique challenges and individuals with DSL may not be able to compensate for the loss of one sense with the other, making it difficult to perform daily activities (Veenman et al., 2023). DSL is associated with poor health outcomes, including functional disability, depression, and cognitive decline, and it can significantly impact ability to socialize, communicate with others, and live independently (Fisher et al., 2014; Guo et al., 2023; Kuo et al., 2021). Of particular concern is an increase in risk of mortality. For people over the age of 60 years, there is a reported 42% higher risk of mortality compared with those with no sensory loss, while those with a single sensory loss have a 25%–26% higher risk of mortality (Zhang et al., 2022). This greatly increased risk for people with DSL has been attributed to an increased risk of comorbidities, an increased risk of falls and accidental injury, in

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addition to difficulties accessing healthcare (Brennan & Bally, 2007; Guthrie et al., 2018; Skalska et al., 2013).

When data are collected for single sensory deficits alone, as is often the case, the needs of people experiencing DSL may not be acknowledged or planned for (Minhas et al., 2022). There is an absence of Professional Bodies, specifically qualified clinicians, or tailored rehabilitation services for people with this condition (Wittich et al., 2015; Wittich et al., 2017). As the DSL literature lacks standardized definitions of hearing and visual impairment to determine DSL, it is often unrecognized as a distinct disability (Schneider et al., 2011).

Some definitions have focused on the sensory modalities involved, while others have emphasized the functional consequences of the condition (Dammeyer, 2015; Heine & Browning, 2015). The absence of a standardized definition results in the prevalence of DSL being difficult to compare across studies and thus hampers obtaining consistent prevalence rates. Whilst the prevalence data varies, what is common across the studies is that the prevalence of DSL increases with age (Bright et al., 2023; Dammeyer, 2015; Schneider et al., 2011; Swenor et al., 2013; Wittich et al., 2013, 2017, World Federation of the Deafblind, 2018). It may affect a significant proportion of older adults and in an increasingly aging global population, is at best, a burgeoning public health matter (Heyl & Wahl, 2012). A recent overview of the variability in definitions, methods, and the resulting wide-ranging prevalence estimates, indicated that anywhere between 1.3% and 55.6% of older adults over the age of 65 are living with DSL (Bright et al., 2023).

This research presented a review of 153 unique, primary studies and included the definitions used, prevalence, and the impact of DSL on people's lives. Over 80% of the studies that measured prevalence of DSL reported on adults aged ≥ 40 years; however. age cut-offs ranged from adults over 40 years to adults over 80 years with numerous categories in-between. This review highlighted that the current evidence base is mainly derived from high-income countries and that impact of DSL can be considered in relation to psychosocial, participation, and physical health outcomes.

While some researchers are utilizing definitions and measures rooted in the medical model, such as visual acuity, visual field, and audiogram measurements (Wittich et al., 2012), others root their definitions in functional ability, such as presented in the Nordic definition of deafblindness (Nordens Välfärdscenter, 2018). The Nordic definition uses the term deafblindness and defines it as a combined vision and hearing impairment of such severity that it is hard for the impaired senses to compensate for each other. Thus, deafblindness is a distinct disability. There are arguments both for and against using more objective definitions compared to more subjective definitions. However, it is known that for older adults the audiogram is not a good predictor of speech understanding (Hoppe et al., 2022; Lee, 2015; Profant et al., 2019). In addition, a perceived need for measures of visual acuity, visual field, and audiogram measurements may be contributing to the position with the current evidence base being derived from high-income countries. In the recent review, even though most studies were from high-income countries, hearing and vision loss were most commonly measured via self- or proxy-report alone with DSL being defined as a combination of both sensory losses according to the definitions of each single impairment. When more objective data was reported there was variation in the visual acuity chart used, whether results from the better/worse or both eyes were considered and the visual acuity threshold. There were numerous definitions of hearing loss, with variation by decibel threshold used, frequencies included, and whether the results were from the better or worse ear (Bright et al., 2023). This lack of agreement globally on objective measures reduces the reliability and validity of the pooled data. Using a definition grounded in functional ability may be more accessible for clinicians globally and offer a guide to rehabilitation needs. It may also capture more accurately the impact of both conditions, which exceed the impact of either hearing or vision loss when considered separately. The aim of the present paper is to initiate the process of developing a worldwide model estimating the prevalence of age-related DSL. The studies that have been published providing data on the prevalence of age-related DSL use varying age categories but do provide a functional starting point (see Table 1 and (Minhas et al., 2022)). For ease of understanding and as an overview of available usable worldwide data, the information will be categorized into distinct regions as defined by the World Health Organization (WHO). Following this, measures of comparisons to eliminate age-related differences between countries and WHO regions and how to correct for sampling differences in the existing studies will be discussed. Finally, the adjusted available data will be highlighted and presented as a first approximation of a world- wide model of the prevalence of age-related dual sensory loss. The conditions that would make a high precision worldwide model of the prevalence of age-related DSL possible will be detailed. The aim of this modelling process is to initiate a discussion on establishing a framework that incorporates a consistent definition of deafblindness/DSL and maintains uniform distinctions between countries, along with guidelines for categorizing age groups.

Methods

Data Availability in Different WHO Regions

The World Health Organization separates the globe into 6 different regions. These are:

1. AFR = African Region
2. AMR = Region of the Americas
3. SEAR = South-East Asian Region
4. EUR = European Region

Table 1. Table showing the age groups of the existing data for age-related DSL in various countries, classified into the different WHO regions. WPR = West Pacific Region, AMR = Region of the Americas, EUR = European Region, AFR = African Region, SEAR = Southeast Asian Region, EMR = Eastern Mediterranean Region).

Country	Age categories	WHO Region
Ghana	5-17 18-39 40-59 60-74 75+	AFR
South Africa	5-17 18-39 40-59 60-74 75+	AFR
Tanzania	5-17 18-39 40-59 60-74 75+	AFR
Brazil	5-17 18-39 40-59 60-74 75+	AMR
Canada	45-85 m/f 70-75 80-85	AMR
	15+ 25-64 65-74 75+	AMR
Mexico	5-17 18-39 40-59 60-74 75+	AMR
United States	<70 >80	AMR
	75-79 85+	AMR
	18-44 45-64 65-79 80+	AMR
	5-17 18-39 40-59 60-74 75+	AMR
Uruguay	5-17 18-39 40-59 60-74 75+	AMR
Denmark	Children Adults	EUR
Iceland	65+	EUR
Ireland	5-17 18-39 40-59 60-74 75+	EUR
Netherlands	55+	EUR
United Kingdom	0-9 10-19 20-29 30-39 40-49 50-59 60-69 70-79 80-89 90+	EUR
Sudan	5-17 18-39 40-59 60-74 75+	EMR
India	45-59 60+	SEAR
Indonesia	5-17 18-39 40-59 60-74 75+	SEAR
Australia	55-60 80	WPR
Japan	65-69 80+	WPR
Vietnam	5-17 18-39 40-59 60-74 75+	WPR

5. EMR = Eastern Mediterranean Region
6. WPR = Western Pacific Region

These regions are graphically represented in Figure 1.

Age-related DSL data is available for 19 countries and one Confederation (European Union) (Minhas et al., 2022). The WHO consists of 194 member states (World Health Organization, 2023).

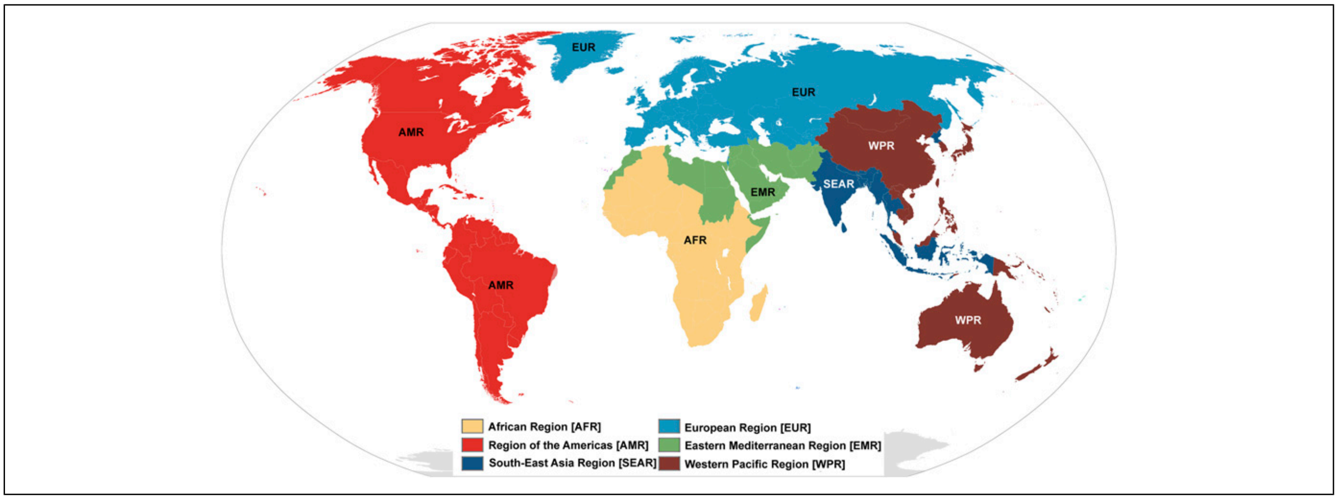

Figure 1. WHO regions. AFR = African Region, AMR = Region of the Americas, SEAR = South-East Asian Region, EUR = European Region, EMR = Eastern Mediterranean Region, WPR = Western Pacific Region.

If the EU 27 (European Deafblind Network, 2014) study, which was completed before the United Kingdom exited the European Union, is included, another 23 nations can be added to the total. In addition, individual national studies are available for Denmark, Ireland, the Netherlands, and the United Kingdom, which overlap partially with the EU 27 study. A total of 42 nations (19 and 23) have some form of data available, in addition to roughly 21% of WHO members states. Most of the published studies contain data from "Developed Countries."[1]

Of the individual countries (with the exception of the EU report) the number of countries with data on age-related DSL are from the following WHO regions: 3 countries from the West Pacific region (WPR); 5 countries from the America region (AMR); 5 countries from the WHO Europa region (EUR); 2 countries from the WHO South-East Asian region (SEAR); 3 countries from the WHO African region (AFR); and one country from the WHO Eastern Mediterranean region (EMR) (see Table 1).

Data Quality for an Age-Related Dual Sensory Loss Prevalence Model

The primary aim of this modelling exercise is to navigate the complexity presented by a wide array of data sets, each characterized by variable definitions of DSL and diverse age group categorizations. This variety mirrors the fragmented nature of DSL research globally, complicating the task of synthesizing a coherent picture from these disparate sources.

Particularly challenging is the handling of broad age categorizations such as "AGE+," which simplifies the prevalence to zero for all ages below a specified threshold. This method, seen in data from nations like Iceland and the Netherlands (Table 1), introduces significant imprecision into our understanding of DSL prevalence. Furthermore, the reliance on studies conducted in care homes or those lacking clear age categorizations adds another layer of complexity to the task at hand (Minhas et al., 2022).

The inconsistency in age categorizations across the available data sets (Table 1) obstructs direct comparisons across various regions and countries, complicating the global assessment of DSL prevalence. This issue is further exacerbated by the lack of a universally accepted definition for age-related DSL, resulting in each study reflecting the definition adopted within its country of origin (Table 2). Addressing these challenges is crucial for developing a model that accurately portrays the global prevalence of age-related DSL amidst the current disparate research landscape.

Study Selection

Our initial data pool was derived from the compilations of Minhas et al. (2022), which we expanded upon by seeking additional datasets quantifying the prevalence of age-related DSL. To ensure scientific rigor and relevance, we applied stringent inclusion and exclusion criteria, focusing on published datasets with clearly defined sample sizes.

Studies based in care homes were systematically excluded. This decision stemmed from the recognition that care home populations represent a subset of the broader community, one influenced by socio-economic factors and the varying capabilities of national health systems to support long-term care. Such factors introduce untraceable biases that could distort the prevalence rates of DSL in the general population.

The EU 27 study was deemed unsuitable due to its overlap with other national studies and the overly broad age categorizations employed, which did not offer the granularity required for our analysis, given the population size of the

European Union (overall, ≤ 64 years and ≥ 65 years (European Deafblind Network, 2014)).

Correcting for Individual Studies Sample Sizes

The studies under review exhibited a broad range of sample sizes. To facilitate a meaningful comparison across these studies, it was imperative to devise a weighting mechanism that accurately reflected the representativeness of the sample sizes relative to the populations of the respective countries. The rationale behind this approach is that a larger sample size from a country with a vast population may not necessarily offer a more accurate representation than a smaller sample size from a less populous country, particularly if the latter constitutes a higher proportion of its population.

Table 2. Range of ways dual sensory loss was assessed in selected studies. Age ranges can be found in Table 1.

Country or region	Measurement of deaf blindness, DSI, and DSL
Australia	Hearing thresholds were measured with the use of pure-tone audiometry. Visual acuity was measured with a log MAR chart while the subject wore distance glasses, if they owned a pair. DSI was defined as combined presenting visual acuity (better eye) < 20/40, and PTA 0. 5–4 kHz (better ear) > 25 dB HL. Incidence of DSI was considered by the use of two at-risk sub populations: (i) participants with no sensory impairment and (ii) with one type of sensory impairment at baseline
Brazil	Washington Group Questions for sight and hearing. Deaf blindness considered "a lot" of difficulty in both domains
Canada 1	Audiometry and visual acuity were measured
Canada 2	Disability Screening Questions established subjective assessment of disability and these verity classes at mild, moderate, severe, and very severe
Denmark	(1) Medical screening and tests of hearing and vision. (2) Functional evaluation of vision, hearing, and use of tactile modality including evaluation of the senses in social interaction and communication
Europe, 27 states/ region	Survey regarding the rights and opportunities of deaf blind people
Ghana	Does (the respondent) have any serious disability that limits his or her full participation in life activities (such as mobility, work, social life, etc.)?
Iceland	Participants were classified as having "moderate or greater" degree of impairment for vision only, hearing only, and both vision and hearing
India	Lasi Wave Self-Assessment and Helper supervised
Indonesia	Washington Group of Short questions for sight and hearing (response options: none, some, and total) Deaf blindness considered "total" difficulty in both domains
Ireland	Do you have any of the following long-lasting conditions or difficulties? Deafness or a serious hearing impairment (yes/no); Blindness or a serious visual impairment (yes/no)
Japan	Visual and hearing impairment measures using best-corrected visual acuity and pure-tone audiometric test
Mexico	Does (the respondent) have difficulty doing the following activities in his or daily life: (a) Seeing, even when using glasses (yes/no). (b) Hearing, even when using hearing aid (yes/no)?
Netherlands	The measurement methods included self-reports, clinical measurements, and observations
South Africa	Washington Group questions for sight and hearing. Deaf blindness considered "a lot" of difficulty in both domains
Sudan	Does (the respondent) have any difficulty in moving, seeing, hearing, speaking, or learning? (Mark all that apply) (a) difficulty hearing, (b) deaf, (c) difficulty seeing, and (d) blind
Tanzania	Washington Group Questions for sight and hearing. Deaf blindness considered "a lot" of difficulty in both domains
United Kingdom	Overall prevalence estimates (by gender and age) by pooling information across a number of surveys
Uruguay	Washington Group Questions for sight and hearing. Deaf blindness considered "a lot" of difficulty in both domains
United States 1	Objective assessments of hearing and vision in a nationally representative sample. Hearing impairment defined as having a speech-frequency pure-tone average of hearing thresholds at 0.5-, 1-, 2-, and 4 kHz tones of greater than 25 dB in the better-hearing ear; Visual impairment defined as having post-auto refraction visual acuity worse than 20/40 in the better seeing-eye
United States 2	Hearing screening in conjunction with measurements on a variety of vision tests including high-contrast acuity, low contrast acuity measured under a variety of lighting conditions, contrast sensitivity, stereopsis, and color vision
United States 3	Random health-oriented survey questionnaire on (1) Do you have any trouble seeing, even when wearing glasses or contact lenses? (2) Are you blind or unable to see at all? and (3) Which statement best describes your hearing (without a hearing aid): good, a little trouble, a lot of trouble, deaf? Participants responding yes to either of the first 2 questions were considered to be visually impaired. Participants reporting a little trouble, a lot of trouble, or that they were deaf were classified as hearing impaired
United States 4	Is the person deaf or does he or she have serious difficulty hearing? (yes/no) Is this person blind or does he or she have serious difficulty seeing even when wearing glasses? (yes/no)
Vietnam	Washington Group questions for sight and hearing. Deaf blindness considered "a lot" of difficulty in both domains

Table 3. Dual sensory loss (DSL) studies by country that include a clear sample size and distinct percentage values for different age ranges and were not specifically sampled in long-term care facilities (LTCFs) or in home care (HC). Australia (Schneider et al., 2012), Brazil (World Federation of the Deafblind, 2018), Canada 1 (Mick et al., 2020), Canada 2 (Jaiswal, 2019), Denmark (Dammeyer, 2010), Ghana (World Federation of the Deafblind, 2018), Iceland (Fisher et al., 2014), India (Bharati et al., 2022), Indonesia (World Federation of the Deafblind, 2018), Ireland (World Federation of the Deafblind, 2018), Mexico (World Federation of the Deafblind, 2018), South Africa (World Federation of the Deafblind, 2018), Sudan (World Federation of the Deafblind, 2018), Tanzania (World Federation of the Deafblind, 2018), United Kingdom (Dawes et al., 2014), United States 1 (Swenor et al., 2013), United States 2 (Schneck et al., 2011), United States 3 (Caban et al., 2005), United States 4 (World Federation of the Deafblind, 2018), Uruguay (World Federation of the Deafblind, 2018), and Vietnam (World Federation of the Deafblind, 2018).

Country	Weights
Australia	9.58325E-05
Brazil	0.055448976
Canada 1	0.001539633
Canada 2	0.002566054
Denmark	0.001945772
Ghana	0.095152539
Iceland	0.016197713
India	0.101552281
Indonesia	5.74479E-05
Ireland	0.115492258
Mexico	0.106581607
South Africa	0.088443316
Sudan	0.01479501
Tanzania	0.089535023
United Kingdom	0.002995822
United States 1	0.000165978
United States 2	1.71511E-06
United States 3	0.000722194
United States 4	0.011292777
Uruguay	0.117353309
Vietnam	0.178064743

To quantify this concept within the scope of our analysis, we introduced a weighting factor defined as the ratio of the study's sample size to the total population size of the corresponding country. This weighting factor serves as a metric to gauge the extent of the population sampled in each study and, by extension, the representativeness of the study's findings in the context of the national population.

The studies and their weights that were finally used in this paper are presented in Table 3 and Figure 2.

Correcting for Countries Health Differences

Life expectancy data for all countries involved in this study were collected, acknowledging that life expectancy varies significantly across different regions due to a myriad of factors influencing health outcomes (Freeman et al., 2020). It's recognized that an individual aged 60 in a country with a higher life expectancy might be in a markedly better state of health compared to their counterpart in a country with lower life expectancy. Consequently, the age range data from various studies were adjusted to reflect these disparities.

However, the application of life expectancy as a measure of health status is not without contention (Modig et al., 2020). Notably, life expectancy does not directly equate to physiological age or health condition, often represented by the concept of frailty (Fried et al., 2001; Rapp et al., 2022).

Frailty, which varies across populations, can be influenced by numerous factors, including socio-economic conditions and the effectiveness of a country's healthcare system (Biritwum et al., 2015; Harttgen et al., 2013). Various methodologies exist for assessing frailty and constructing frailty indices, though their utility in predicting health outcomes such as functional decline and mortality remains debated due to issues like high false positive rates (Pijpers et al., 2012).

Given these complexities and the absence of a universally accepted model for measuring frailty across countries, this study adopts a simplified assumption: frailty is linearly related to life expectancy. This assumption necessitates an adjustment in the age range data, particularly exaggerating the maximum age range in countries with notably low life expectancy. While this approach allows for some level of standardization across disparate datasets, it is acknowledged as a simplification and a potential area for future refinement.

Constructing the Model for Visualization

Acknowledging the significant variations in life expectancy across countries (Freeman et al., 2020), we employed a corrective methodology to harmonize age data from the studies under consideration. This entailed the use of a correcting factor, y, derived from the ratio of the maximum life expectancy observed globally to the individual life expectancy figures for each country, as reported by the World Bank (World Bank, 2022).

$$y = \frac{\max\,(all\ life\ expectancies)}{individual\ country\ values}$$

By applying this factor, we adjusted the age data in each study, scaling all values relative to the highest recorded life expectancy, which is that of Monaco (86.895 years). This adjustment served to standardize the age-related data across all studies, mitigating the impact of disparate life expectancies on our model.

The countries included in our DSL data span the entire spectrum of life expectancies recorded in the World Bank dataset (Figure 3), from the lowest to the highest, offering a comprehensive overview of the global situation.

To derive a weighted mean age for each year across all studies included in this analysis, we first adjusted the ages using the

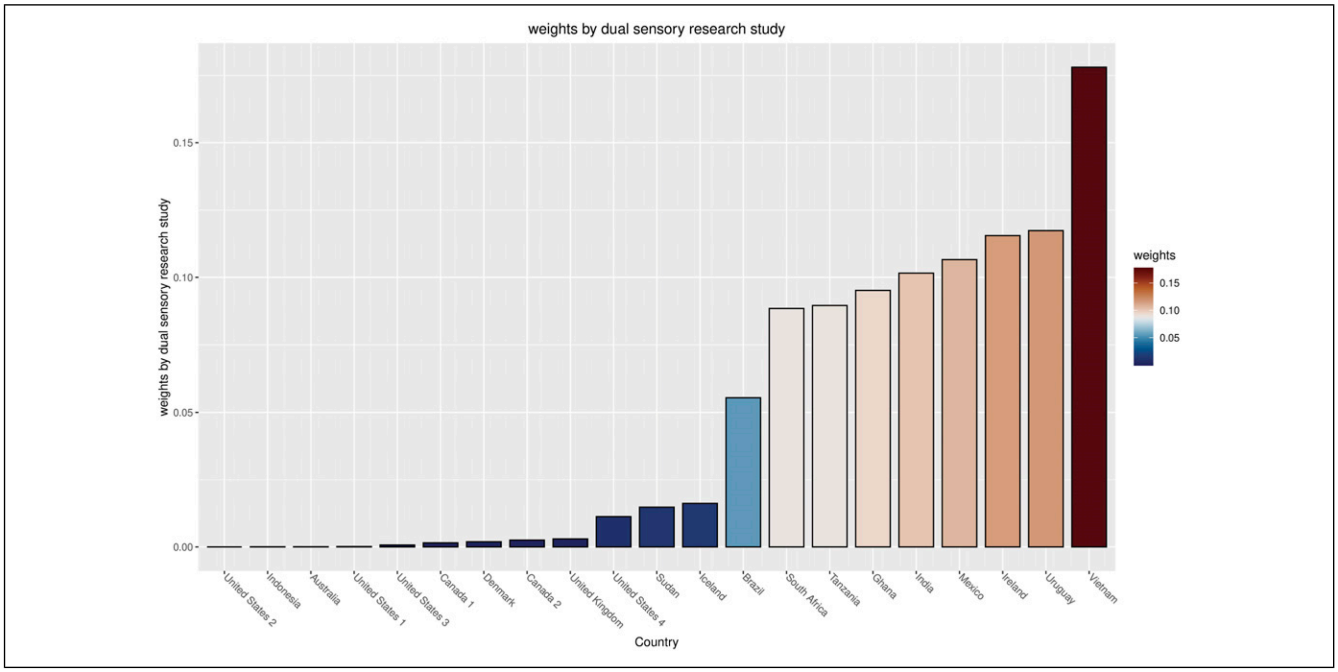

Figure 2. Weights by sample size divided through population size for the selected countries. Vietnam sampled the highest percentage of their population regarding age-related dual sensory loss (DSL) and USA study 2, Indonesia and Australia the smallest percentage.

method described above. We then computed the weighted average for each age, scaling the weights to unity based on the number of studies encompassing each age range, as data availability varied by country and age. The precision of the results was contingent on the number of data points available for each age.

The procedure is summarized as follows:

- Adjusting ages to scale according to the maximum life expectancy recorded globally.
- Calculating the weighted average for each age, considering the relative representation of each age in the studies.
- Estimating a worldwide visualization model for age-related DSL prevalence based on the harmonized and weighted data.

Results

The dataset for this study was primarily drawn from the African, American, and European WHO regions.

The African data, notably informed by the pivotal 2018 WFDB report (World Federation of the Deafblind, 2018), provides a foundational perspective on DSL within these regions, highlighting the variances in DSL prevalence and characteristics across diverse populations.

To ensure comparability across the collected datasets, we embarked on a comprehensive normalization of life expectancy figures at birth. This was essential due to the significant variations in life expectancy worldwide, which could potentially skew the analysis. The results of this normalization are detailed in Figures 4 and 5, showcasing the standardized prevalence rates of age-related DSL across the studied regions.

An intriguing pattern emerged from our analysis, indicating that age-related DSL tends to manifest more prominently at later life stages outside the European and American Zones, is known for their higher life expectancies. This trend was especially pronounced in the African Region. Assuming a uniform life expectancy across countries, DSL's emergence in these areas appears significantly delayed. This observation invites a re-evaluation of our understanding of DSL's onset across various socio-economic and geographic settings.

Additionally, our findings underscore a notable increase in age-related DSL prevalence within the West Pacific Region, predominantly influenced by data from Vietnam. In contrast, the East Mediterranean Region, with Sudan as its sole data contributor, presented a distinct prevalence landscape. The African Region displayed minimal variability, largely attributable to the consistent methodological approach of the WFDB report.

Upon calculating the weighted arithmetic mean for each year across all included studies, we were able to map the approximate relation between age and age-related DSL prevalence, as illustrated in Figure 6.

Our global analysis, visualized in the model shown in Figure 6, presents considerable variability in the prevalence of dual sensory loss (DSL) after adjusting for life expectancy,

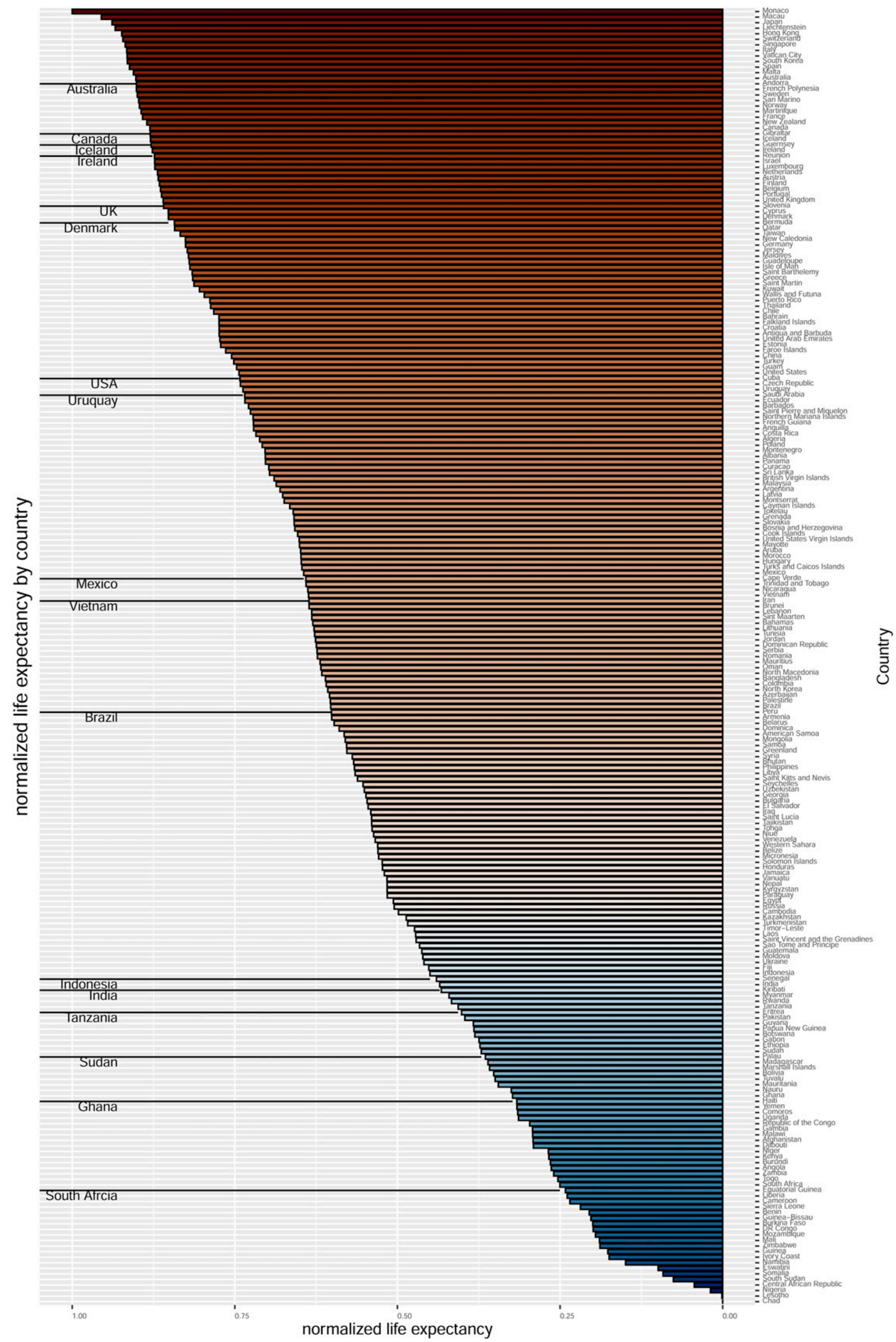

Figure 3. A bar plot indicating where the countries with data on dual sensory loss (DSL) in this study (lines) are in the range of normalized life expectancy at birth of all countries. Chad has the lowest life expectancy at birth and Monaco the highest life expectancy at birth.

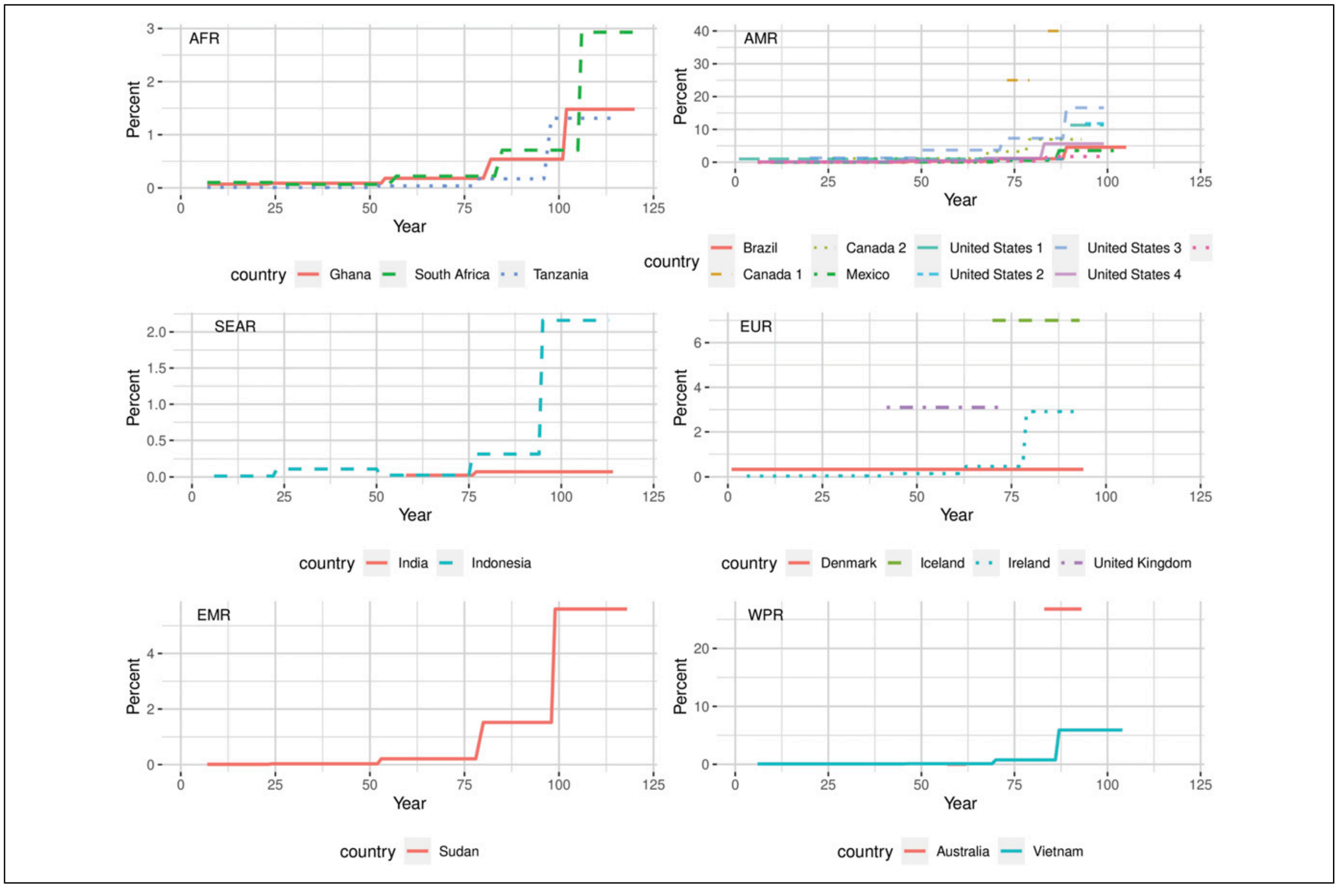

Figure 4. Age-related dual sensory loss (DSL) by countries in the assessed studies, grouped by WHO regions. AFR = African Region, AMR = Region of the Americas, SEAR = South-East Asian Region, EUR = European Region, EMR = Eastern Mediterranean Region, WPR = Western Pacific Region.

especially noticeable as we approach the centenarian age. The discernible pattern, where DSL prevalence rates seem to stabilize at advanced ages, might hint at an underlying dynamic worthy of further exploration. While our current methodology employed a general smoothed kernel approach to elucidate trends across the data, it raises intriguing questions about the potential applicability of more specialized models, such as the Stannard Model (Khamiz, 2005; Koesters et al., 2023; Kyurkchiev & Iliev, 2016), in future analyses.

The Stannard Model, belonging to the broader class of age-structured models, is particularly adept at investigating how specific conditions or characteristics distribute across varying age groups within a population. This model could offer valuable insights into the mechanisms driving the observed stabilization of DSL prevalence rates in older age groups. Its application might illuminate whether this stabilization is a natural epidemiological phenomenon, possibly reflecting a selection bias towards individuals with inherent resilience to DSL, or if other factors are at play.

Given the preliminary findings from our smoothed kernel analysis, there is a compelling case for incorporating age-structured models like the Stannard Model in subsequent research. Such an approach could enhance our understanding of the complex interplay between age and DSL prevalence, potentially revealing nuanced patterns that are not immediately apparent through more generalized analytical methods.

Discussion

The scarcity of prevalence studies for DSL is emphasized in this visualization exercise, which also presents proof of the variation in prevalence approximations. Table 1 demonstrates the diversity in age brackets, definitions of DSL, techniques for assessing sensory impairments, sample sizes, and age groups that contribute to this variation in prevalence data. The analyses and consistent reporting of prevalence estimates are restricted by this variation. The comparison of counts and estimates across the studies is complicated by diverse definitions and diverse assessment methods. Improving the consistency of definition, methodology, and reporting is necessary. Furthermore, the absence of acknowledgment of DSL in population-based epidemiological surveys results in

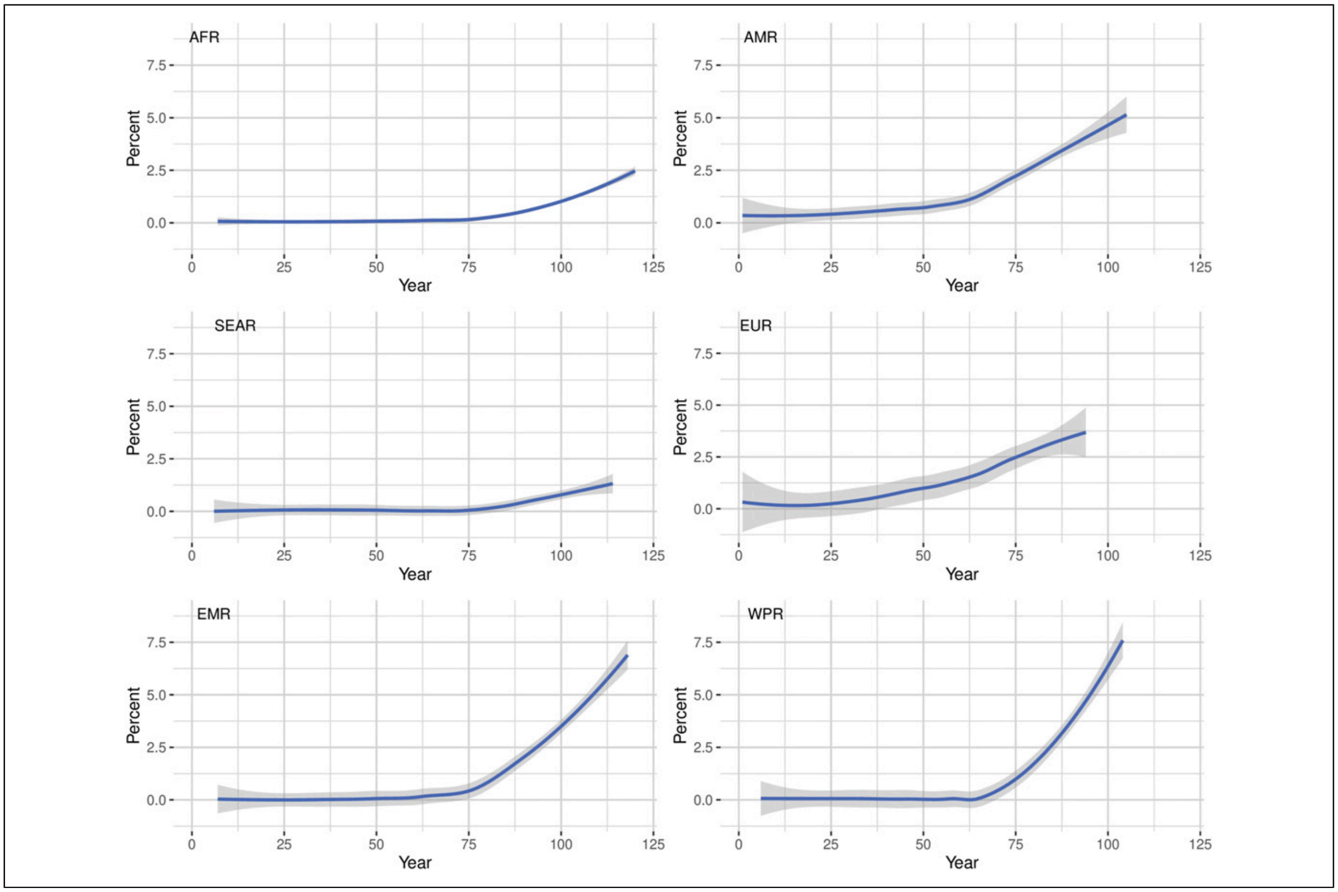

Figure 5. Loess smoothed age-related dual sensory loss (DSL) by countries in the assessed studies, grouped by WHO regions. AFR = African Region, AMR = Region of the Americas, SEAR = South-East Asian Region, EUR = European Region, EMR = Eastern Mediterranean Region, WPR = Western Pacific Region.

its concealment and underestimation, as previously emphasized by the 2018 global report of the World Federation of the Deafblind (World Federation of the Deafblind, 2018). For example, the data in the Global Burden of Disease study currently only provide information about vision and hearing difficulties separately, because the data are not linked within the data collection system (Cieza et al., 2020). Despite this modelling exercise highlighting the necessity for additional prevalence studies from several WHO regions (especially EMR and SEAR), forthcoming prevalence studies should also contemplate incorporating information from unique groups based on intersectionality. There are multiple forms of inequality or disadvantage that can be compounded to create obstacles that are particular to certain countries and demographics. This inclusion may assist in identifying factors that predict higher or lower prevalence rates for discrete populations.

Access to accurate prevalence data and the ability to predict prevalence into the future is essential for healthcare service provision planning. Functional definitions may be more useful when considering service provision, as frequently, there is residual hearing or vision, or both, which can be optimized for rehabilitation purposes (Dammeyer, 2014; Wittich et al., 2012). It is advisable that forthcoming research studies concerning individuals with DSL incorporate synchronized data collection tools, such as

a. standardized definitions of deafblindness or DSL;
b. gradations of visual and hearing impairments;
c. the level of sensory functioning in relation to access to information, communication, and mobility;
d. the age of onset of and age of functional limitations of deafblindness or DSL; and
e. language and communication ability and modality at the onset of deafblindness or DSL (Dalby et al., 2009; Dammeyer, 2014; Larsen & Damen, 2014; Saunders & Echt, 2007).

This degree of data granularity is essential for the generation of sound scientific evidence and allows for more effective cross-country comparisons. To alleviate the difficulty of making age-specific comparisons across countries over time, a standardized approach may be used among different study populations, and data collection methods.

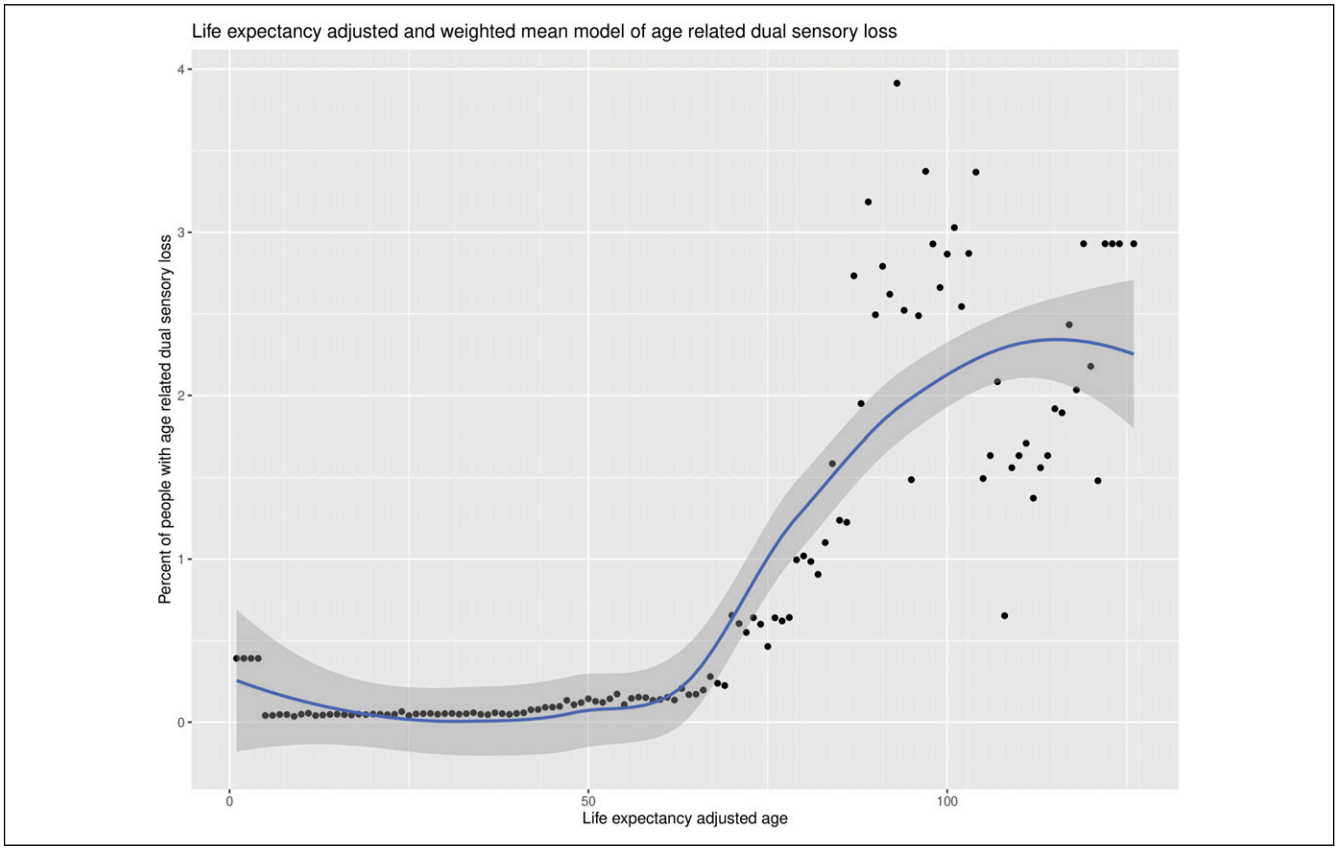

Figure 6. Weighted means (Percent) of life expectancy at birth adjusted age-related dual sensory loss (DSL) with a Loess smoothed trend analysis.

Ideally, the data could be made available in its raw form whereby individual ages would be linked to individual measures of vision and of hearing. This access would allow researchers conducting secondary analyses to maximize their use of the variability in the data without losing information by creating arbitrary categories. In cases where this process is not possible, the authors suggest utilizing the standard definitions of deafblindness/DSL used by the WFDB (2018) (World Federation of the Deafblind, 2018) global report and an age group classification according to the World Health Organization (WHO) (World Health Organization, 2023).

The utilization of standard age grouping and definition classifications will enhance data comparability and establish connections within the field of DSL at an international level, from diverse sources, over time, and with the same or distinct study samples (Department of International Economic & Social Affairs, 1982; World Federation of the Deafblind, 2018). In addition, adherence to standardized definitions and age grouping can aid in the effective coordination of data collection tools employed for census and national surveys, leading to the acquisition of valuable disability-related information for program development (Washington Group of Disability Statistics, 2017). Moreover, the adoption of the International Classification of Functioning, Disability and Health (ICF) as a standard framework for defining deafblindness/DSL is recommended by the World Report on Disability 2011 to ensure quality data collection on disability and facilitate cross-country data comparability. For this purpose, the development of ICF Core Sets for deafblindness is currently ongoing (Paramasivam et al., 2021). It is known that people with DSL have an increased risk of comorbidities, and increased difficulties accessing healthcare. The particular needs of people with DSL must be acknowledged and planned for (Minhas et al., 2022). The interRAI Community Health Assessment (CHA) (InterRAI, 2023), along with its Deafblind Supplement (CHA-Db) tool, has been scientifically developed to assess the strengths, preferences, and needs of individuals with DSL, as well as their severity levels, and could be beneficial for assessing individuals with DSL (Guthrie et al., 2011). However, the tool requires specific training for its administration, needs to be purchased, and the deafblind supplements cannot be administered independently of the CHA itself (Alfaro et al., 2019; Alfaro et al., 2020; Alfaro et al., 2021). In addition, the authors recognize the constraints of the CHA-Db supplement, as it is restricted to individuals who are 18 years or older, residing in the community or care facilities, except those receiving formal home care services. Despite this, the tool provides comprehensive evaluation data on the extent of impairment and status changes for individuals with deafblindness/DSL due to either congenital or acquired causes.

Globally, there is significant disparity in health provision and monitoring, with variations in disease prevalence,

access to healthcare, and social determinants of health. While life expectancy is commonly used as a measure of health status, it may not be the most accurate indicator of overall health, particularly among older adults. Frailty may provide a more nuanced understanding of health status. Frailty is associated with a higher risk of adverse health outcomes, such as disability, hospitalization, and mortality. However, there is no standardized definition of frailty, and it may be affected by cultural and social factors (Tan et al., 2020). Therefore, while life expectancy and frailty can provide useful insights into population health, they should only be considered in conjunction with other measures, such as disease prevalence, access to healthcare, and social determinants of health. Ultimately a standardized measure to gauge the health differences between countries unrelated to deafblindness/DSL must be agreed upon in order to achieve robust prevalence figures going forward. A world model of prevalence of age-related DSL is both necessary, achievable and is an area that warrants further research. This will be useful to country health policy planners, clinicians, industry partners, consumer groups and individuals in their efforts towards achieving the "United Nations Decade of Health Ageing" (World Health Organization, 2021) as well as the "Sustainable Development goals 2030" (United Nations Development Programme, 2024) and highlighting the urgent need for monitoring DSL and its rehabilitation.

Future studies focusing on this area could provide a more granular view of DSL epidemiology, especially in the context of aging populations. By considering models specifically designed to account for age-related variations, researchers could uncover new dimensions of DSL prevalence and its implications for public health planning and intervention strategies.

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Note

1. Although there is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system (Nations, 2003) it is a statistical convenience based on Gross National Product (Nations, 2017).

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