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ORIGINAL ARTICLE

Estimating depression-free life expectancy in the hearing-impaired population in Brazil*

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Individuals with hearing impairments are more vulnerable to depression. According to the 2010 Brazilian Demographic Census, around 10 million people have some degree of hearing impairment. Brazil also ranks highest in depression among middle-income countries. The prevalence of mental health conditions in the Brazilian hearing-impaired population remains an understudied topic. This study aims to quantify the impact of depression on the life expectancy of the Brazilian population with hearing impairment. We used data from the 2019 edition of the National Health Survey and from the 2010 Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE) Census to apply the Sullivan method (1971). Our results show that young women with severe hearing impairment are the population group that requires special attention due to the strong effect of depression on life expectancy. It is also possible that men have an underestimated prevalence of depression, which may obscure their years lived without depression. Targeted public policies are recommended to reduce communication barriers between patients, physicians, and other health professionals by promoting fluency in Brazilian Sign Language and knowledge of Deaf culture and their specific needs.

Keywords: Depression. Life expectancy. Hearing loss. Sign language. Persons with hearing impairments.

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Introduction

One in seven individuals worldwide has some form of disability, increasing their cost of living by 30% compared to those without disabilities (United Nations, 2016). These individuals face significant barriers in accessing healthcare, employment, and higher education due to environmental and societal obstacles. According to the United Nations Convention on the Rights of Persons with Disabilities (2006), individuals with disabilities are those with long-term physical, mental, intellectual, or sensory impairments that may limit their full and effective participation in society when interacting with various barriers.

Throughout its history, Brazil has maintained a significant population of people with disabilities. Historically, these individuals experienced invisibility and segregation, with their lives largely restricted to family environments or specialized care institutions. Over time, society recognized that disability needed to be properly addressed as a state concern, acknowledging that people with disabilities have the right to occupy the same spaces as others, which contributed to the modernization of Brazilian laws (Garcia; Vargas, 2014).

The most recent Brazilian population census revealed that approximately 45.6 million people had some form of disability, representing 23.9% of the Brazilian population. Additionally, about 63.4% of people aged 60 or older reported having at least one type of disability (IBGE, 2018). In Brazil, the prevalence of hearing loss progressively increases from age 60 for both sexes, with women showing a higher expectation of remaining free from hearing loss compared to men (Belo *et al.*, 2023).

Since the 2010 census, following local regulations, the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE) has collected and measured disability data using the International Classification of Functioning, Disability and Health (ICF) framework. This approach aligns with the World Health Organization's (WHO) 2001 recommendations viewing disability as the result of interactions between functional limitations, body structures, and social and environmental barriers, as established by the United Nations Convention on the Rights of People with Disabilities (CRPD) in 2006 (IBGE, 2018).

In 2001, the Washington Group on Disability Statistics (WG) was established as a United Nations Statistical Commission City Group to promote and coordinate international cooperation in generating disability statistics for censuses and national surveys. Their criterion identifies a person as disabled if they respond "Yes, a lot of difficulty" or "Cannot do it at all" to any disability-related questions. Using this threshold to assess disability prevalence in the 2010 Brazilian census, researchers estimated that 12,748,663 people, or 6.7% of the total Brazilian population, had disabilities (IBGE, 2018).

The 2010 census, without applying the Washington Group threshold, showed a visual disability prevalence of 18.8% and hearing disability of 5.1% (IBGE, 2018). When applying the threshold, these rates decreased to 3.4% and 1.1%, respectively. The 2019 National Health Survey (Pesquisa Nacional de Saúde – PNS) indicated that 17.3 million people aged 2 years or older (8.4% of the total population) reported having at least one form of disability,

with approximately 8.5 million elderly individuals (24.8% of the elderly population) in this category. Among the population aged 2 years or older, 1.1% (2.3 million people) reported hearing impairment. Notably, among those aged 5-40 years with hearing impairment, only 22.4% knew Brazilian Sign Language (Libras).

Regardless of classification criteria, Brazil faces the challenge of addressing the needs of a large population with disabilities who encounter barriers to full inclusion in healthcare, education, and general well-being to ensure a better quality of life.

Among various disabilities, hearing impairment stands as particularly impactful, directly affecting speech development, language acquisition, and cognitive abilities in children, thereby influencing academic progress and subsequent occupational capabilities. Across all age groups and both sexes, hearing loss creates significant challenges in interpersonal communication and social interaction, often leading to isolation and stigmatization (Mackenzie; Smith, 2009). Primary causes of hearing impairment include congenital factors, early childhood issues, chronic middle ear infections, noise-induced hearing loss, age-related hearing decline, and ototoxic medications affecting the inner ear (WHO, 2024).

The hearing impaired population faces increased risk of depression due to social isolation, loneliness, anxiety, and reduced self-esteem stemming from communication difficulties and social interaction challenges (Černelič Bizjak, 2009; Fellinger; Holzinger; Pollard, 2012; Ishine; Okumiya; Matsubayashi, 2007; Kvam; Loeb; Tambs, 2007; Palmer *et al.*, 2013; WHO, 2024). This population typically bears a heavier burden in communication processes, often relying on strategies like lip reading, which typically achieves only 35% to 40% comprehension (Lieu *et al.*, 2007).

Mental health disorders significantly impact population health outcomes, leading to reduced life expectancy and higher mortality rates among affected individuals (Abdin *et al.*, 2020; Chang *et al.*, 2011; Erlangsen *et al.*, 2017; Pan *et al.*, 2020; Plana-Ripoll *et al.*, 2020). Depression has emerged as a significant mental health concern in contemporary society (Baxter *et al.*, 2014; Bhugra; Mastrogianni, 2004). Globally, the estimated prevalence of depression is 5.0% in adults and 5.7% among the elderly, with women more affected than men (WHO, 2021). A study across 18 countries found an overall depression prevalence of 11.1%, with Brazil reporting the highest rate among middle-income countries at 18.4% (Bromet *et al.*, 2011). According to the Ministry of Health (2022), Brazil currently leads Latin American countries in depression rates. However, it is estimated that 79% to 93% of individuals with depression in low-and middle-income countries do not receive care (Esponda *et al.*, 2020).

The relationship between depression and hearing loss remains understudied globally, though evidence suggests an association between hearing loss and a higher prevalence of depression, particularly among elderly women (Li *et al.*, 2014; Cosh *et al.*, 2018). In Brazil, Schmidt's 2018 study, using data from the 2013 National Health Survey of respondents aged 18-59 years, found a 26% higher prevalence of depression among those reporting hearing impairment. The EpiFloripa Idoso 2017/19 study revealed prevalences of 26.0%

for self-reported negative perception of hearing ability and 21.8% for depression. Analysis showed that elderly individuals reporting negative perception of their hearing ability were 96% more likely to report depression compared to those with positive perceptions (Paiva *et al.*, 2023). Most studies have focused primarily on elderly populations.

Given Brazil's aging population and increasing life expectancy, examining the health conditions of the hearing-impaired population is crucial. This is particularly pressing in developing countries where services and facilities for the hearing impaired are limited, trained professionals are scarce, and awareness about the challenges associated to hearing loss remains insufficient. Additionally, the historical invisibility of this population has resulted in limited understanding of their specific needs.

Health life expectancy has become a crucial indicator, combining mortality and morbidity into a single metric reflecting the average years a person is expected to live with a given health condition. This measure serves as a valuable tool for guiding public policy and population health planning (Jagger *et al.*, 2001).

While some studies have examined the impact of depression on life expectancy in the Brazilian population, including among the elderly (Andrade *et al.*, 2016) and across race and sex differentials (Alves; Pereira, 2018), research on these effects on the hearing-impaired population remains lacking. The prevalence of mental health conditions in the Brazilian deaf population, especially among those depending primarily on Brazilian Sign Language (Libras) for communication, represents an important yet understudied area. This paper specifically examines the association between the degree of hearing impairment and the use of Libras, recognizing that higher levels of hearing impairment correlate with an increased likelihood of sign language dependence for communication.

Given this context, this study aims to quantify the impact of depression on life expectancy among Brazil's hearing-impaired population, using the latest available data from the 2019 National Health Survey and the 2010 Brazilian Demographic Census.

Methodology

Data sources

The primary data source for this analysis is the 2019 National Health Survey (Pesquisa Nacional de Saúde – PNS), conducted by the Brazilian Ministry of Health (Ministério da Saúde, MS), along with Life Tables from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE) from 2010. The PNS is a comprehensive nationwide household survey conducted every six years, collecting data on food habits, lifestyle, healthcare access, anthropometric measurements such as body mass index, among others.

The PNS employs a complex survey design characterized by probabilistic sampling procedures, which enables researchers to make design-based inferences about characteristics of interest and generalize findings to the broader unsampled population (Lumley, 2010).

Complex surveys face various constraints, including time limitations, budget restrictions, non-response issues, and potential miscommunication between question intent and respondent interpretation. As Lumley (2010, p. 3) notes, "the world is imperfect in many ways, and the necessary properties are present only as approximations in real surveys."

By analyzing complex survey data while accounting for its sampling design and associated statistical methods, researchers can draw valid conclusions that generalize to the unsampled target population. While various frequentist statistical methods are available for survey data analysis (including ordinary least squares regressions, generalized linear models, hypothesis tests, confidence intervals, and survival analysis), this study focuses specifically on estimating population totals using the Horvitz-Thompson estimator within the survey sampling design by means framework.

Like other large-scale complex surveys, the PNS relies on respondent self-assessment, with sampled participants representing the population through probabilistic selection. The collected data undergoes post-stratification and weighting according to key demographic variables to ensure alignment between respondent and overall population profiles, though this approach may involve potential biases in self-reported information. The PNS sampling procedure consists of three stages: (1) random selection of primary sampling units (PSUs) from census tracts with equal probability; (2) random selection of a fixed number of households within each PSU and (3) random selection of one individual aged 15 or older within each sampled household to complete questionnaires for all household members. For this study, we downloaded and processed the raw microdata, implementing the survey design using the following variables: UPA_PNS (primary sampling unit), V0024 (strata) and weights (V0028, V00281, V00282, and V00283). This design implementation enabled us to derive weighted post-stratified estimates of depression prevalence by sex, age group, and hearing impairment level using the Horvitz-Thompson estimator.

We used abbreviated life tables from the 2010 Brazilian Population Census (IBGE), which provided life table functions including l_x and ${}_nL_x$ variables by sex and quinquennial age groups, enabling life expectancy calculations across different variable levels.

Our analysis assumes that the hearing-impaired subpopulation follows the same mortality patterns, as the overall population, reflected in the abbreviated life tables grouped by sex and quinquennial ages. This assumption was necessary since Brazil lacks officially available life tables disaggregated by hearing impairment levels.

While the Brazilian national statistics bureau annually provides single age and abridged life tables based on population projections (as required by law), we chose to use the life table from the most recent census years. This was due to its greater robustness and basis in formal population counting processes, thereby avoiding the substantial variation present in projections.

While the original census abbreviated life tables extended to 90+ years, we modified them to end at 80+ years due to limited case enumeration in the national health survey for advanced ages. Similarly, all comparisons by sex and hearing impairment in this study

cover ages 15 to 80+, corresponding to the minimum age of sampled individuals in the National Health Survey.

Both data sources rely on self-reported assessments of hearing ability rather than clinical evaluations by healthcare professionals, an approach that follows international best practices established by the Washington Group on Disability Statistics Short Set of Questions (WG-SS), which Brazil has incorporated into its censuses and household surveys since 2010 (Washington Group on Disability Statistics, 2020). Both the National Health Survey and Census classify hearing impairment into four categories: no difficulty hearing (not impaired); Some difficulty hearing (mildly impaired); Great difficulty hearing (heavily impaired) and Complete inability to hear (fully impaired).

We conducted our analyses using the survey library in GNU R software version 4.4.0. All analyses can be reproduced using scripts made freely available at https://github.com/hafermoraes/Deaf_DFLE.

Variables

This study analyzed depression prevalence using four key variables from the self-reported data: hearing impairment level, depression diagnosis (confirmed by a physician or mental health professional), respondent age (grouped in 5-year intervals), and respondent sex. Table 1 provides detailed descriptions of these variables.

TABLE 1
Variables used in this study. Additional variables that determined weights, post-stratification, and survey design include UPA_PNS, V0024, V0028, V00281, V00282, and V00283

Variable	Code in microdata	Wording
Sex	C006	Sex of household respondent
Age	C008	Age of household respondent in years
Diagnosed with depression	Q092	Has any physician or mental health professional (psychiatrist or psychologist) ever given you a depression diagnosis? Levels (answer options): • Yes • No
Hearing impairment	G057 and G058 combined	(G057) Do you have any permanent hearing impairment even when using hearing aid devices? (G058) Do you have any permanent hearing impairment? Levels (answer options): • No, no impairment whatsoever • Yes, mild impairment • Yes, heavy impairment • Yes, full impairment
Knowledge of the Brazilian Sign Language (Libras)	G05801	Do you know how to use the Brazilian Sign Language (Libras)? Levels (answer options): • Yes • No

Source: National Health Survey (IBGE, 2019).

Statistical analysis

We calculated depression-free life expectancy using Sullivan's method (1971), which applies age-, sex-, and hearing impairment-specific prevalence rates to person-years lived across different age categories. These calculations used period life tables (Jagger *et al.*, 2001) from the 2010 Brazilian Census, expressed as:

$$DFLE_x = \frac{\sum_{k=x}^{\omega} [1 - {}_n\pi_k] \times {}_nL_k}{l_x}$$

where $DFLE_x$ represents the average number of years an individual will live without depression starting at exact age x until terminal age ω. The equation incorporates ${}_n\pi_x$ (depression prevalence in age group x to $x + n$ from the PNS), l_n (number of survivors at age x), and ${}_nL_x$ (person-years lived between ages x and $x + n$).

Depression prevalence (${}_n\pi_x$) was determined using physician-diagnosed depression (variable Q029, Table 1). We calculated the percentage of individuals diagnosed with depression within each combination of sex (variable C006), quinquennial age groups (variable C008), and hearing impairment level (variables G057 and G058). This methodological approach aligns with similar studies in the field (Bramajo, 2022; Belo *et al.*, 2023).

To account for statistical uncertainty, we calculated 95% confidence intervals for both depression prevalence and depression-free life expectancy following the methodology outlined by Jagger *et al.* (2014).

Our analysis focuses on the broader hearing-impaired population rather than specifically on the Deaf community who primarily communicate through Brazilian Sign Language (Libras) and identify with Deaf culture, including its distinct language, identity, and values. This decision was made because the small size of the Deaf population would result in statistically unstable rates, particularly at younger and advanced ages. Consequently, this study examines hearing impairment levels stratified by sex and quinquennial age groups between 15 and 80+ years.

Results

Analysis of depression prevalence among Libras users revealed notably lower rates among those with heavy and full hearing impairment, averaging approximately four times lower ([12.2% + 15.7%]/2 / [3.0% + 3.8%]/2 ≈ 4.09) than other hearing impairment levels. This pattern emerges particularly where traditional interventions such as hearing devices or cochlear implants may prove less effective, and Libras serves as the primary communication method (Table 2). We observed a positive link between depression prevalence and hearing impairment severity, except in the fully hearing-impaired group.

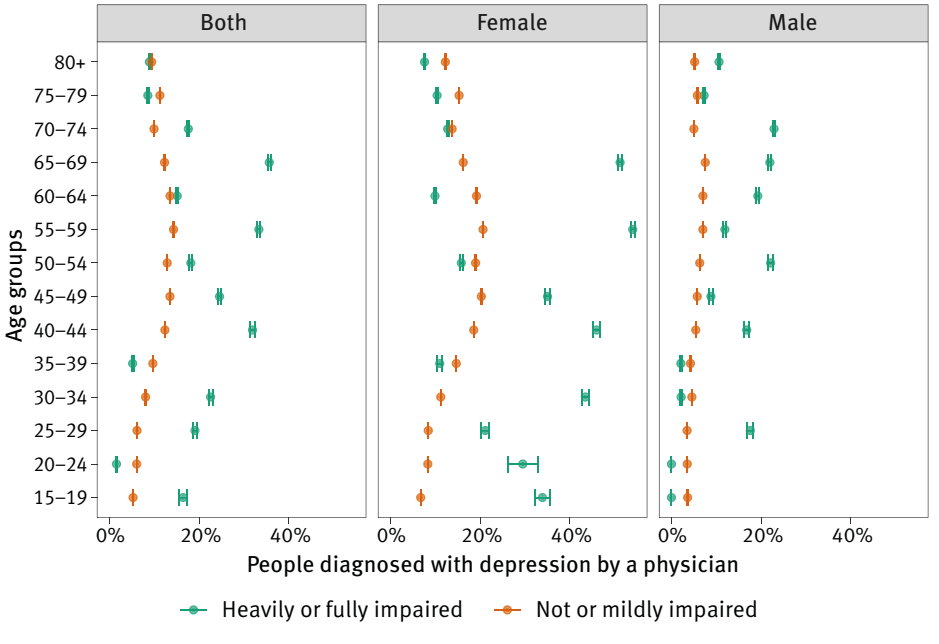
TABLE 2
Libras users and prevalence of depression among respondents aged 5 to 40 years
Brazil – 2019

Level of impairment	Libras users (%)	Diagnosed with depression (%)	Libras users diagnosed with depression (%)
Not hearing impaired	2.8	7.6 (7.6358, 7.6358)	12.2 (12.227, 12.227)
Mildly hearing impaired	5.6	7.9 (7.9034, 7.9035)	15.7 (15.7074, 15.7097)
Heavily hearing impaired	12.9	14.9 (14.9428, 14.9433)	3.0 (2.9855, 2.9868)
Fully hearing impaired	61.3	5.5 (5.5059, 5.5068)	3.8 (3.8482, 3.849)

Source: Own calculations made on prepared data from National Health Survey (IBGE, 2019).
Note: The choice of the age group for Table 2 – between 5 and 40 years – adheres to the convention adopted by IBGE in its official report regarding the 2019 Edition of the National Health Survey, allowing for an improvement in official statistics on Libras users by impairment level, facilitated by the inclusion of depression prevalence in that population stratum. Values in parentheses represent the 95% confidence interval for the prevalence of depression.

Figure 1 illustrates depression prevalence patterns across sex and age groups for different levels of hearing impairment. Women consistently showed higher depression prevalence, approximately twice that of men across categories. Age-related patterns differed markedly between sexes: women exhibited increased prevalence with age and greater variability between ages 15-69, whereas men showed relatively stable prevalence across age groups with lower variability.

FIGURE 1
Prevalence of depression by sex and age group across grouped levels of hearing impairment, with 95% confidence intervals
Brazil – 2019



Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

Life expectancy analysis revealed that individuals with heavy or full hearing impairment experienced shorter life expectancy compared to those with no or mild impairment, regardless of sex or age. Women's depression-free life expectancy was particularly affected due to higher depression prevalence (Table 3).

Among women with heavy or full hearing impairment, depression-free life expectancy at birth averaged 60 years out of an expected 77.38 years, representing 2.88 times longer lived with depression compared to men. This disparity decreased with age, showing 1.30 times longer duration in the 60s and 1.14 times in the 80s. At ages 20 and 40, women in this group lived with depression 2.58 and 2.01 times longer than men, respectively.

In the population with no or mild hearing impairment, women consistently lived approximately three times longer with depression than men across all age groups (Table 3). At birth, women lived 9.06 years with depression *versus* men's 2.86 years (3.17 times longer). In their 20s, women experienced 8.94 years *versus* men's 2.78 years (3.21 times longer). This pattern continued through the 40s (6.96 *versus* 2.14 years, 3.26 times longer), 60s (3.45 *versus* 1.17 years, 2.95 times longer), and 80s (1.11 *versus* 0.36 years, 3 times longer).

Men with heavy or full hearing impairment showed progressively longer periods living with depression compared to those with no or mild impairment. At birth, they lived 2.11 times longer with depression (6.04 years *versus* 2.86 years). This difference increased through their 20s (2.25 times longer, 6.25 *versus* 2.78 years), 40s (2.58 times longer, 5.51 *versus* 2.14 years), and 60s (2.73 times longer, 3.20 *versus* 1.17 years), before decreasing in their 80s (1.77 times longer, 0.64 *versus* 0.36 years).

TABLE 3
Comparison by sex, age, and grouped level of hearing impairment of life expectancy and depression-free life expectancy, with 95% confidence intervals
Brazil – 2019

Sex	Age	Life expectancy	Depression-free life expectancy	
			Not or mildly impaired	Heavily or fully impaired
Both	0	73.76	67.76 (67.7596, 67.7682)	62.84 (62.7683, 62.9092)
	20	55.78	49.87 (49.8641, 49.8726)	45.36 (45.3037, 45.412)
	40	37.64	33.01 (33.0069, 33.0145)	29.26 (29.2151, 29.2973)
	60	21.06	18.68 (18.6764, 18.6829)	17.39 (17.3692, 17.4101)
	80	8.61	7.82 (7.8137,7.8204)	7.88 (7.8667, 7.8835)

(continue)

(continued)

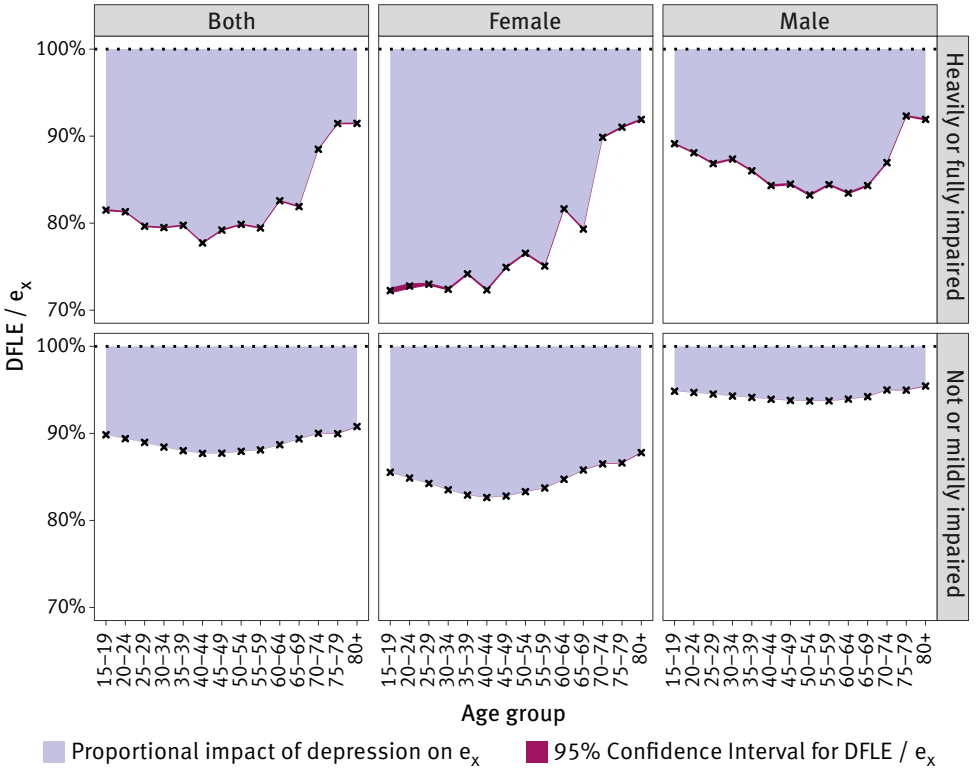
Sex	Age	Life expectancy	Depression-free life expectancy	
			Not or mildly impaired	Heavily or fully impaired
Female	0	77.38	68.32 (68.3108, 68.3252)	60.00 (59.7985, 60.2046)
	20	59.12	50.18 (50.1703, 50.1845)	43.02 (42.8369, 43.2131)
	40	40.06	33.10 (33.097, 33.1097)	28.97 (28.915, 29.0343)
	60	22.61	19.16 (19.1506, 19.1612)	18.46 (18.4282, 18.4877)
	80	9.07	7.96 (7.9575, 7.9678)	8.34 (8.3255, 8.349)
Male	0	70.21	67.35 (67.3442, 67.3528)	64.17 (64.1158, 64.231)
	20	52.46	49.68 (49.6754, 49.6837)	46.21 (46.1523, 46.2716)
	40	35.12	32.98 (32.9803, 32.9878)	29.61 (29.563, 29.6638)
	60	19.34	18.17 (18.1649, 18.1714)	16.14 (16.1139, 16.1673)
	80	7.97	7.61 (7.6033, 7.6099)	7.33 (7.316, 7.3374)

Source: Own calculations based on prepared data from the National Health Survey and the Population Census (IBGE, 2019; 2010).
Note: Values in parentheses represent the 95% confidence interval for Depression-Free Life Expectancy.

Figure 2 highlights distinct patterns in depression-free life expectancy between sexes. Men with no or mild hearing impairment maintained relatively constant depression-free life expectancy (approximately 95% of population level), while those with heavy or full impairment showed a general declining trend, except between ages 70-89. This pattern suggests progressive decline in life expectancy with age in this population group.

Women's patterns differed markedly from men's. Those with no or mild hearing impairment displayed a U-shaped curve, with minimum depression-free life expectancy between ages 40-49. Conversely, women with heavy and full hearing impairment showed continuous improvement in life expectancy starting around age 40, demonstrating an upward trend.

FIGURE 2
Proportional impact of depression on life expectancy by sex and grouped levels of hearing impairment and its 95% confidence interval
Brazil – 2019



Source: Own calculations based on data prepared from the National Health Survey and Population Census (IBGE, 2019; 2010).

Discussion

Our study demonstrates that depression disproportionately affects young women, with hearing impairment severity generally correlating with reduced life expectancy for both sexes, except for women above 70 years (as shown by solid and dotted lines in Figure 2). The diminishing impact of depression on life expectancy at advanced ages, particularly among women, suggests possible adaptation to long-standing mental health conditions as part of daily life. However, it's important to note that depression in males may be underreported and underidentified.

These findings align with previous Brazilian studies that identified a higher depression burden among women compared to men (Alves; Arruda, 2017; Stopa *et al.*, 2015). Specifically among the hearing impaired, our results corroborate earlier research indicating a higher prevalence of depression in women (Li *et al.*, 2014). While extensive literature examines determinant factors in women's higher depression prevalence, complete

understanding remains elusive (Kessler, 2003). Current research points to multiple contributing factors, including biological sex differences, race, culture, diet, education, and various socioeconomic elements (Albert, 2015).

The gender gap in depression warrants attention regarding socio-cultural and economic influences on psychopathology (Kuehner, 2017). Mental healthcare for Brazilian men is characterized by neglect and limited visibility of mental suffering, suggesting a silent crisis (Silva; Melo, 2021). Male attitudes toward mental vulnerabilities, including low self-care levels and limited health care adherence, contribute to gender-based depression differentials (Couto *et al.*, 2010). Research by Fields and Cochran (2011) highlights potential under-identification and undertreatment of male depression.

Our findings reveal a positive association between depression prevalence and hearing impairment severity, except in cases of complete hearing loss. The self-reported nature of depression diagnoses, based on professional medical assessment, requires careful consideration. Depression diagnosis typically involves detailed clinical interviews and mental status examinations (Goldman *et al.*, 1999), necessitating active patient-professional communication. Communication barriers specific to hearing impairment may lead to depression under-diagnosis when health professionals lack appropriate training for this patient group.

The scarcity of studies in this field partly stems from limited reliable data on Brazilian Sign Language users in large sample surveys and evolving approaches to deafness assessment in household surveys. Current methodologies have shifted from disability-focused questioning to evaluating hearing ability, even with external aids.

Previous Brazilian censuses did not inquire about Brazilian Sign Language knowledge or usage. While the 2019 National Health Survey pioneered questioning about Brazilian Sign Language use, caution is needed when assuming all Libras users are deaf or that it represents their exclusive communication method.

This study faces some limitations, including temporal disparities between the 2010 Census and 2019 National Health Survey, and differences in geographical coverage, sampling sizes, and survey designs. Our choice to use 2010 census data represents a strategic decision to avoid potential biases from 2019 life table estimates based on projections rather than formal population counts. Additionally, self-reported hearing impairment and depression data carry inherent biases, though these measures are widely accepted in global population health research. The absence of comprehensive Brazilian Sign Language usage data in population censuses necessitated indirect estimation of depression-free life expectancy for the Brazilian Deaf population with severe communication barriers. Furthermore, evolving methodologies for disability statistics in Brazilian censuses and surveys present analytical challenges; however, such limitations should not deter applied research.

Brazil's 2009 adoption of the UN Convention on the Rights of Persons with Disabilities (United Nations, 2006) established the foundation for Brazilian disability inclusion law.

The convention mandates equal access to healthcare and quality (Article 25a) and requires healthcare professionals to provide equivalent care quality while recognizing the rights, dignity, autonomy, and needs of persons with disabilities (Article 25d).

By highlighting barriers to mental healthcare access for Deaf and hearing impaired individuals, our study emphasizes the need for expanded disability data collection, particularly regarding sign language use in large-scale surveys and censuses. This aligns with Article 31 of the UN Convention concerning statistics and data collection for policy implementation. Comprehensive data on sign language users is crucial for ensuring equal rights across education, health, employment, and other aspects of life.

Accurate demographic data on sign language users would enable proper healthcare workforce planning through government-university-professional collaboration, establishing mandatory minimums for professionals trained in serving Deaf and hearing impaired populations. This could form the basis for sustainable health policies addressing the rights of minority population and mitigating life expectancy losses from inadequate depression treatment due to communication barriers.

Progress in this direction includes the 2012 establishment of Brazil's public health system network for individuals with disability (Rede de Cuidados da Pessoa com Deficiência, Portaria SUS 793/2012). Further benefits await expanded disaggregated data availability and specific policies ensuring adequate sign language-fluent healthcare professionals.

Brazil currently has opportunities to improve both healthcare access for hearing-impaired populations and related statistical data collection. Professional sign language fluency among healthcare providers could effectively reduce the communication burden for Deaf populations. Germany's Klinikum am Europakanal in Erlangen provides a model, with psychiatric and psychotherapy professionals fluent in German Sign Language and familiar with Deaf culture.

Statistical improvements could include conducting complex surveys like the National Health Survey in sign language, following the example of the United States with the Health Information National Trends Survey in American Sign Language, which examines health-related information and communication usage (Kushalnagar *et al.*, 2017).

Targeted public policies are recommended to reduce communication barriers between patients, physicians, and other health professionals by promoting fluency in Brazilian Sign Language and knowledge of Deaf culture and their specific needs.

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Resumo

Estimativa da esperança de vida livre de depressão na população com deficiência auditiva no Brasil

A população surda é mais vulnerável à depressão. De acordo com o Censo Demográfico de 2010, cerca de 10 milhões de pessoas no Brasil apresentam algum grau de deficiência auditiva. O Brasil também lidera o *ranking* de depressão entre os países de renda média. A prevalência de doenças mentais na população surda brasileira ainda é um tema pouco explorado. Este estudo tem como objetivo quantificar o impacto da depressão na expectativa de vida da população brasileira com deficiência auditiva. Utilizamos dados da edição de 2019 da Pesquisa Nacional de Saúde e do último Censo Demográfico disponível (edição de 2010 do IBGE) para aplicar o método de Sullivan (1971). Os resultados mostram que mulheres jovens com deficiência auditiva grave são o grupo populacional que demanda atenção especial, devido ao forte efeito da depressão na expectativa de vida. Também é possível que a prevalência de depressão em homens esteja subestimada, o que pode mascarar o número de anos vividos sem depressão. Recomenda-se a implementação de políticas públicas direcionadas para reduzir as barreiras de comunicação entre pacientes, médicos e outros profissionais de saúde, por meio da fluência na língua brasileira de sinais e do conhecimento da cultura surda e de suas necessidades específicas.

Palavras-chave: Depressão. Esperança de vida. Perda auditiva. Língua de sinais. Pessoas com deficiência auditiva.

Resumen

Estimación de la esperanza de vida libre de depresión en la población con discapacidad auditiva de Brasil

La población sorda es más vulnerable a la depresión. Según el Censo Demográfico Brasileño de 2010, alrededor de diez millones de personas presentan algún grado de discapacidad auditiva, además de que Brasil lidera el ránking de depresión entre los países de renta media. A pesar de ello, la prevalencia de enfermedades mentales en la población sorda brasileña sigue siendo un tema poco investigado. Este estudio tiene como objetivo cuantificar el impacto de la depresión en la esperanza de vida de la población brasileña con discapacidad auditiva, para lo que se utilizaron datos de la edición 2019 de la Encuesta Nacional de Salud y del último Censo de Población de Brasil disponible (edición 2010 del IBGE) para aplicar el método de Sullivan. Los resultados muestran que las mujeres jóvenes con discapacidad auditiva severa son el grupo poblacional que requiere especial atención debido al fuerte efecto de la depresión en su esperanza de vida. También es posible que la prevalencia de depresión en los hombres esté subestimada, lo que podría ocultar el número de que viven sin depresión. Se recomienda la implementación de políticas públicas específicas para reducir las barreras de comunicación entre pacientes, médicos y otros profesionales de la salud mediante el dominio de la lengua de signos brasileña y el conocimiento de la cultura sorda y sus necesidades específicas.

Palabras clave: Depresión. Esperanza de vida. Pérdida auditiva. Lengua de signos. Personas con deficiencia auditiva.

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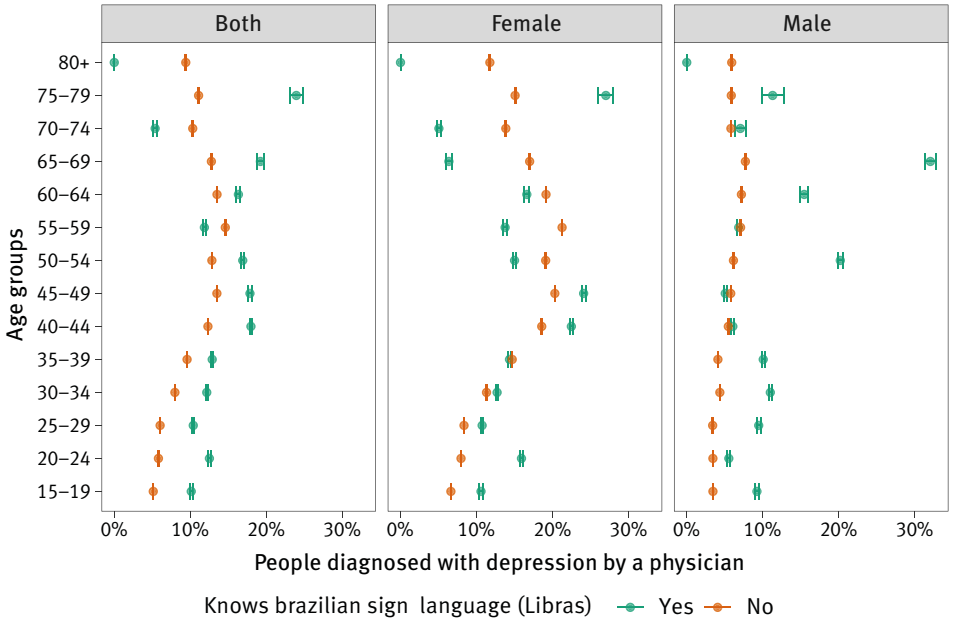
Supplementary material

FIGURE 1
Depression prevalence and its 95% confidence interval by 5-year age group, sex, and Brazilian Sign Language knowledge
Brazil – 2019



Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

TABLE 1
Depression free life expectancy and its 95% confidence intervals for heavily or fully impaired persons of both sexes combined
Brazil – 2019

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
<1	73.76	0.0000	62.84	0.0360	0.85	62.77	62.91
1-4	74.02	0.0000	62.91	0.0366	0.85	62.84	62.98
5-9	70.22	0.0000	59.07	0.0367	0.84	59.00	59.15
10-14	65.32	0.0000	54.16	0.0367	0.83	54.09	54.23
15-19	60.43	0.1643	49.25	0.0368	0.82	49.18	49.32
20-24	55.78	0.0158	45.36	0.0276	0.81	45.30	45.41
25-29	51.24	0.1909	40.81	0.0273	0.80	40.76	40.86
30-34	46.69	0.2257	37.12	0.0238	0.79	37.07	37.16
35-39	42.14	0.0519	33.61	0.0214	0.80	33.56	33.65
40-44	37.64	0.3193	29.26	0.0210	0.78	29.22	29.30

(continue)

(continued)

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
45-49	33.23	0.2458	26.32	0.0177	0.79	26.28	26.35
50-54	28.98	0.1816	23.14	0.0149	0.80	23.11	23.17
55-59	24.92	0.3334	19.80	0.0128	0.79	19.77	19.82
60-64	21.06	0.1514	17.39	0.0104	0.83	17.37	17.41
65-69	17.42	0.3566	14.27	0.0091	0.82	14.25	14.29
70-74	14.09	0.1761	12.47	0.0063	0.88	12.46	12.48
75-79	11.14	0.0857	10.19	0.0049	0.91	10.18	10.20
80-84	8.61	0.0937	7.88	0.0043	0.91	7.87	7.88
85-89	6.55	0.0386	6.04	0.0038	0.92	6.03	6.05
90+	5.04	0.1342	4.37	0.0055	0.87	4.35	4.38

Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

TABLE 2
Depression free life expectancy and its 95% confidence intervals for not or mildly impaired persons of both sexes combined
Brazil – 2019

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
<1	73.76	0.0000	67.76	0.0022	0.92	67.76	67.77
1-4	74.02	0.0000	67.92	0.0022	0.92	67.91	67.92
5-9	70.22	0.0000	64.10	0.0022	0.91	64.09	64.10
10-14	65.32	0.0000	59.19	0.0022	0.91	59.19	59.19
15-19	60.43	0.0529	54.29	0.0022	0.90	54.29	54.30
20-24	55.78	0.0608	49.87	0.0021	0.89	49.86	49.87
25-29	51.24	0.0616	45.59	0.0021	0.89	45.58	45.59
30-34	46.69	0.0807	41.29	0.0020	0.88	41.28	41.29
35-39	42.14	0.0970	37.09	0.0020	0.88	37.09	37.09
40-44	37.64	0.1238	33.01	0.0019	0.88	33.01	33.01
45-49	33.23	0.1351	29.15	0.0019	0.88	29.15	29.16
50-54	28.98	0.1289	25.48	0.0018	0.88	25.48	25.49
55-59	24.92	0.1430	21.95	0.0017	0.88	21.95	21.96
60-64	21.06	0.1352	18.68	0.0017	0.89	18.68	18.68
65-69	17.42	0.1230	15.57	0.0016	0.89	15.57	15.57
70-74	14.09	0.0995	12.68	0.0016	0.90	12.68	12.69
75-79	11.14	0.1127	10.02	0.0016	0.90	10.02	10.03
80-84	8.61	0.1056	7.82	0.0017	0.91	7.81	7.82
85-89	6.55	0.0647	6.03	0.0020	0.92	6.02	6.03
90+	5.04	0.1016	4.53	0.0029	0.90	4.52	4.54

Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

TABLE 3
Depression free life expectancy and its 95% confidence intervals for heavily or fully impaired women Brazil – 2019

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
<1	77.38	0.0000	60.00	0.1036	0.78	59.80	60.20
1-4	77.57	0.0000	59.92	0.1052	0.77	59.72	60.13
5-9	73.77	0.0000	56.07	0.1055	0.76	55.87	56.28
10-14	68.86	0.0000	51.14	0.1056	0.74	50.94	51.35
15-19	63.96	0.3390	46.21	0.1057	0.72	46.01	46.42
20-24	59.12	0.2951	43.02	0.0960	0.73	42.84	43.21
25-29	54.30	0.2116	39.63	0.0435	0.73	39.55	39.72
30-34	49.50	0.4348	35.84	0.0376	0.72	35.77	35.91
35-39	44.76	0.1099	33.20	0.0329	0.74	33.13	33.26
40-44	40.06	0.4597	28.97	0.0304	0.72	28.91	29.03
45-49	35.47	0.3503	26.57	0.0252	0.75	26.52	26.62
50-54	31.02	0.1581	23.74	0.0211	0.77	23.70	23.78
55-59	26.73	0.5403	20.07	0.0190	0.75	20.03	20.10
60-64	22.61	0.0994	18.46	0.0152	0.82	18.43	18.49
65-69	18.71	0.5122	14.84	0.0138	0.79	14.81	14.87
70-74	15.11	0.1275	13.58	0.0091	0.90	13.56	13.60
75-79	11.88	0.1041	10.81	0.0079	0.91	10.80	10.83
80-84	9.07	0.1120	8.34	0.0060	0.92	8.33	8.35
85-89	6.80	0.0570	6.44	0.0046	0.95	6.43	6.45
90+	5.12	0.0472	4.88	0.0049	0.95	4.87	4.89

Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

TABLE 4
Depression free life expectancy and its 95% confidence intervals for not or mildly impaired women Brazil – 2019

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
<1	77.38	0.0000	68.32	0.0037	0.88	68.31	68.33
1-4	77.57	0.0000	68.37	0.0037	0.88	68.36	68.38
5-9	73.77	0.0000	64.54	0.0037	0.87	64.53	64.55
10-14	68.86	0.0000	59.62	0.0037	0.87	59.61	59.63
15-19	63.96	0.0676	54.70	0.0038	0.86	54.70	54.71
20-24	59.12	0.0834	50.18	0.0036	0.85	50.17	50.18
25-29	54.30	0.0844	45.75	0.0035	0.84	45.74	45.75

(continue)

(continued)

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
30-34	49.50	0.1123	41.34	0.0034	0.84	41.34	41.35
35-39	44.76	0.1469	37.11	0.0034	0.83	37.11	37.12
40-44	40.06	0.1858	33.10	0.0033	0.83	33.10	33.11
45-49	35.47	0.2027	29.37	0.0031	0.83	29.36	29.38
50-54	31.02	0.1899	25.84	0.0030	0.83	25.84	25.85
55-59	26.73	0.2066	22.38	0.0028	0.84	22.37	22.39
60-64	22.61	0.1920	19.16	0.0027	0.85	19.15	19.16
65-69	18.71	0.1624	16.05	0.0026	0.86	16.05	16.06
70-74	15.11	0.1376	13.07	0.0026	0.86	13.06	13.07
75-79	11.88	0.1531	10.29	0.0026	0.87	10.28	10.29
80-84	9.07	0.1340	7.96	0.0026	0.88	7.96	7.97
85-89	6.80	0.0898	6.04	0.0029	0.89	6.03	6.04
90+	5.12	0.1404	4.40	0.0041	0.86	4.39	4.41

Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

TABLE 5
Depression free life expectancy and its 95% confidence intervals for heavily or fully impaired men
Brazil – 2019

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
<1	70.21	0.0000	64.17	0.0294	0.91	64.12	64.23
1-4	70.51	0.0000	64.37	0.0299	0.91	64.31	64.42
5-9	66.71	0.0000	60.55	0.0300	0.91	60.49	60.61
10-14	61.82	0.0000	55.65	0.0301	0.90	55.59	55.70
15-19	56.95	0.0000	50.76	0.0301	0.89	50.70	50.82
20-24	52.46	0.0000	46.21	0.0304	0.88	46.15	46.27
25-29	48.17	0.1758	41.83	0.0309	0.87	41.77	41.89
30-34	43.82	0.0216	38.28	0.0258	0.87	38.23	38.33
35-39	39.46	0.0209	33.94	0.0256	0.86	33.89	33.99
40-44	35.12	0.1678	29.61	0.0257	0.84	29.56	29.66
45-49	30.89	0.0880	26.10	0.0224	0.84	26.05	26.14
50-54	26.81	0.2212	22.32	0.0205	0.83	22.27	22.36
55-59	22.96	0.1192	19.38	0.0150	0.84	19.36	19.41
60-64	19.34	0.1926	16.14	0.0136	0.83	16.11	16.17

(continue)

(continued)

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
65-69	15.95	0.2195	13.45	0.0113	0.84	13.43	13.47
70-74	12.87	0.2288	11.19	0.0088	0.87	11.17	11.21
75-79	10.19	0.0727	9.41	0.0059	0.92	9.39	9.42
80-84	7.97	0.0685	7.33	0.0055	0.92	7.32	7.34
85-89	6.16	0.0093	5.59	0.0049	0.91	5.58	5.60
90+	4.90	0.2213	3.81	0.0092	0.78	3.80	3.83

Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).

TABLE 6
Depression free life expectancy and its 95% confidence intervals for not or mildly impaired men
Brazil – 2019

Age group $(x, x+n)$	Total life expectancy e_x	Proportion of age group with depression ${}_n\pi_x$	Depression free life expectancy $\sqrt{S^2(DFLE_x)}$	Standard error of DFLE S^2DFLE_x	Proportion of remaining life spent depression-free $\%DFLE$	Lower confidence interval for DFLE	Upper confidence interval for DFLE
<1	70.21	0.0000	67.35	0.0022	0.96	67.34	67.35
1-4	70.51	0.0000	67.60	0.0022	0.96	67.59	67.60
5-9	66.71	0.0000	63.79	0.0022	0.96	63.79	63.80
10-14	61.82	0.0000	58.90	0.0023	0.95	58.89	58.90
15-19	56.95	0.0361	54.02	0.0023	0.95	54.01	54.02
20-24	52.46	0.0352	49.68	0.0021	0.95	49.68	49.68
25-29	48.17	0.0348	45.53	0.0021	0.95	45.52	45.53
30-34	43.82	0.0455	41.32	0.0020	0.94	41.32	41.32
35-39	39.46	0.0424	37.15	0.0020	0.94	37.14	37.15
40-44	35.12	0.0541	32.98	0.0019	0.94	32.98	32.99
45-49	30.89	0.0575	28.97	0.0019	0.94	28.97	28.98
50-54	26.81	0.0630	25.13	0.0018	0.94	25.13	25.13
55-59	22.96	0.0701	21.52	0.0017	0.94	21.52	21.53
60-64	19.34	0.0703	18.17	0.0017	0.94	18.16	18.17
65-69	15.95	0.0754	15.03	0.0016	0.94	15.03	15.03
70-74	12.87	0.0500	12.23	0.0016	0.95	12.22	12.23
75-79	10.19	0.0576	9.68	0.0016	0.95	9.67	9.68
80-84	7.97	0.0675	7.61	0.0017	0.95	7.60	7.61
85-89	6.16	0.0203	6.03	0.0017	0.98	6.03	6.03
90+	4.90	0.0243	4.78	0.0025	0.98	4.78	4.78

Source: Own calculations based on prepared data from the National Health Survey (IBGE, 2019).