

Trends in prevalence and burden of autism spectrum disorder in Chile from 1990 to 2021

Tendencias en la prevalencia y carga del trastorno del espectro autista en Chile desde 1990 a 2021

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What do we know about the subject matter of this study?

The prevalence of autism spectrum disorder (ASD) has increased in several countries. In Chile, there are few studies on the prevalence and burden of ASD, and no studies have addressed the temporal evolution of these indicators.

What does this study contribute to what is already known?

This study estimates the prevalence (1.06%) and Years Lived with Disability (196 per 100,000) of ASD in Chile in 2021, stratified by sex and age, and analyzes trends from 1990 to 2021. The indicators are higher in males and in children/adolescents compared to females and adults. Although crude prevalence appears stable, the increase in prevalent cases among adults indicates a growing burden of ASD in Chile.

Abstract

The autism spectrum disorder (ASD) prevalence has increased in many countries. However, studies on ASD health indicators in Chile are limited. **Objective:** To estimate ASD prevalence and years lived with disability (YLDs) in Chile in 2021, stratified by sex and age, and to analyze trends from 1990 to 2021. **Material and Method:** A secondary analysis of the data from Global Burden of Disease Study 2021 was performed. Non-linear trends were evaluated by estimating the average annual percentage change (AAPC). **Results:** In 2021, the crude prevalence and YLDs rate of ASD in Chile were 1.06% (95% CI 0.88-1.25) and 196 (95% CI 135-280) per 100,000 people, respectively. The prevalence was 2.2 times higher in males (1.47%; 95% CI 1.23-1.76) than in females (0.65%; 95% CI 0.54-0.78). Annual cases and YLDs in adults increased by approximately 75% from 1990 to 2021, while annual cases and YLDs in children and adolescents remained stable. Trend analysis revealed a slight annual increase in overall prevalence and in prevalence among children and adolescents (AAPC 0.03% and 0.05%, respectively) and an annual decrease in prevalence among females (AAPC -0.11%). Trends in YLDs rates were closely related to prevalence. No other significant

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changes were observed. **Conclusions:** ASD prevalence in Chile in 2021 was higher in males than in females, with no significant age-related differences. Although overall and age-specific prevalence rates appear to be stable, the increase in total adult cases indicates a growing ASD burden in Chile. Further research is needed to identify underlying factors and address potential barriers to diagnosis and access to care.

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental condition that manifests from early childhood and involves significant difficulties in social and emotional adjustment¹. This often results in challenges to full participation in essential daily activities, such as play, schooling, work, and self-care. The intensity of these difficulties can vary across the lifespan, being most noticeable at times of increased social demand, such as at the start of schooling and during adolescence and early adulthood¹. As individuals with ASD gain social experience, they may develop masking strategies that allow them to temporarily adapt to their environment, without modifying autistic symptoms or underlying difficulties^{1,2}.

The Global Burden of Disease, Injuries, and Risk Factors Study 2021 (GBD 2021) provided a detailed description of health indicators for 371 diseases and conditions in 204 countries and territories between 1990 and 2021, in order to enable a comparative assessment of global health status³. The results of this study show that, globally in 2021, the age-standardized prevalence and rate of Years Lived with Disability (YLD) of ASD were 0.79% (95% CI: 0.66–0.93) and 148 per 100,000 population (95% CI: 100–208), respectively⁴. Both indicators have experienced a slight increase of approximately 2% between 1990 and 2021. However, the presence of significant variations in these metrics, associated with sociodemographic differences, highlights the need to analyze data disaggregated by region to accurately interpret trends in condition-specific health indicators^{4,5}.

In Chile, the growing interest of the population and the scientific community in this diagnosis, driven, among other factors, by increased visibility and awareness of the condition, advances in etiological research, and a rising prevalence around the world^{6,7}, has promoted improvements in early detection mechanisms at the primary healthcare level, as well as the development and implementation of inclusive educational strategies and adjustments in the legal framework, aimed at ensuring the social inclusion of people with ASD throughout their lives^{8–11}. A previous study estimated the prevalence of ASD in the Chilean child and adolescent population at 1.95% (95% CI: 0.81–

4.63)¹². However, due to methodological limitations and an exclusive focus on pediatric groups, these results cannot be generalized to a national level¹². To date, no studies have been published that address the temporal evolution of the prevalence and burden of ASD in Chile. The objective of this study was to analyze the GBD 2021 data to describe the estimated prevalence and YLD rate of ASD in Chile during 2021, stratified by sex and age, and to analyze its trends between 1990 and 2021.

Methodology

Data Source

The data for this ecological time series study were extracted from the GBD 2021 database, which is publicly available on the Institute for Health Metrics and Evaluation (IHME) website, accessible at <https://www.healthdata.org/research-analysis/gbd>¹³. This source compiles detailed information on mortality, population size, and causes of death and disability in Chile, obtained from reliable sources, including records from entities such as the World Health Organization (WHO), the United Nations (UN), the Ministry of Health of Chile (MINSAL), and the National Statistics Institute of Chile (INE)¹⁴. It also incorporates morbidity data, national health surveys, and prevalence studies publicly available on the Global Health Data Exchange (GHDx) website, accessible at https://ghdx.healthdata.org/ihme_data.

The GBD 2021 team collected information on the incidence and prevalence of ASD through a systematic review of PubMed, Embase, and PsycINFO databases, including gray literature from reliable sources. This review covered studies published up to April 2021, based on the diagnosis of ASD established by different editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM, III to 5-TR) and the International Classification of Diseases (ICD-9 and ICD-11). Studies that did not use probability sampling techniques or that were limited to the analysis of specific subgroups were excluded, following the same criteria as in the 2019 report⁵. After the initial review, articles were peer-reviewed to ensure the inclusion of all relevant information needed to calculate the health indicators.

Details of the data collection process and the statistical models used to estimate the indicators are available on the IHME website.

Measurements

This study extracted and analyzed information on the prevalence and YLDs of ASD in the Chilean population. The data collected include absolute values, rates per 100,000 inhabitants, relative differences between prevalences (comparing 2021 with 1990), and their corresponding 95% CI, stratified by sex, year, and age group.

The GBD 2021 team estimated the annual prevalence of ASD using the prevalent cases of the previous year as the numerator, and the total population estimated by sex and age group from the INE data for the same year as the denominator¹⁴. In the estimation of the annual prevalence, the lifetime prevalence of ASD was also incorporated.

It should be noted that the GBD 2021 results do not include Years of Life Lost (YLLs) for neurodevelopmental disorders, therefore, the Disability-Adjusted Life Years (DALYs) reported reflect only the impact of ASD on quality of life, through YLDs, i.e. its non-fatal burden. YLDs were calculated by multiplying the number of prevalent cases in the previous year by the disability burden associated with ASD and the average duration of each case, until remission or death, so trends in YLD rates of ASD are closely related to their prevalence⁴.

Data analysis

Initially, the GBD 2021 study team evaluated and adjusted the data obtained from the systematic review to reduce the risk of bias in the studies. Subsequently, it estimated health indicators and their 95% CIs by sex, age, region, and year, using modeling strategies tailored to each disease or condition through Bayesian meta-regression methods^{3,15}.

In this study, absolute frequencies were used to characterize prevalent cases and YLDs of ASD by year. Crude and age-standardized annual rates were described, as well as those specific to sex and age group, expressed as percentages for prevalence and per 100,000 population for the rate of YLDs. To determine the proportion of ASD cases by sex, the sex ratio was calculated by dividing the annual sex-specific (male/female) prevalences, both in total and by age range.

For the trend analysis of the prevalence and rate of YLDs, the data were grouped by age into two main groups: (1) children and adolescents under 20 years of age; and (2) adults 20 years of age and older. In addition,

trends of indicators were analyzed in secondary age groups in five-year intervals, from birth to 69 years and above.

The temporal evolution of the prevalence and rate of YLDs of ASD was analyzed using two methods. First, the net variability for the period 1990–2021 was quantified by calculating the relative percentage difference (RPD) between the values of the indicators for the first and last year using the formula: $RPD = [(Indicator_{2021} - Indicator_{1990}) / Indicator_{1990}] \times 100$. Subsequently, the magnitude and direction of the annual trends were evaluated using the mean annual percent change (APC), a non-parametric method that does not require assumptions about the distribution of the data or the presence of autocorrelation and that allows capturing the annual variability of the indicators. The APC was calculated using the following formula: $APC = (1/n) \times \sum [(Indicator_t - Indicator_{t-1}) / Indicator_{t-1}] \times 100$, where n is the number of years in the time series, $Indicator_t$ is the prevalence, YLD rate, or sex ratio in year t , and $Indicator_{t-1}$ is the prevalence, YLD rate, or sex ratio in the year before t . The 95% CI for APC was calculated as: $95\% CI = APC \pm 1.96 \times (s / \sqrt{n})$, where s is the standard deviation of APC.

Significance was set at 5%. All analyses were performed using the R programming language (version 4.4.1), through the RStudio interface.

Results

In 2021, 198,898 (95% CI: 165,530–234,571) prevalent cases and 36,926 (95% CI: 25,392–52,667) YLDs (years) attributable to ASD were reported in Chile. The prevalence of ASD was higher in children under 5 years of age, decreasing progressively with age. In all age groups, prevalence was two to three times higher in males than in females (Figure 1A). The sex difference was more pronounced in adults aged 70 years and older. The rate of YLDs in children and adolescents was 20% higher than that reported in adults and showed a similar distribution to the prevalence by sex and age group (Figure 2A).

Table 1 shows the number of prevalent cases and YLDs, the prevalence, and the rate of YLDs—both total and by age group—for ASD in Chile in 2021, stratified by sex, including the sex ratio for each rate. In addition, Table 1 presents the RPD and APC of the indicators between 1990 and 2021. The crude prevalence showed an average annual reduction of 0.03% (95% CI: –0.05 to –0.01). This downward trend was significant in females (APC: –0.11; 95% CI: –0.13 to –0.09), but not in males (APC: 0.07; 95% CI: –0.02 to 0.03) (Figure 1B). Sex-specific trend analysis showed a significant sustained yearly increase in the sex ratio of

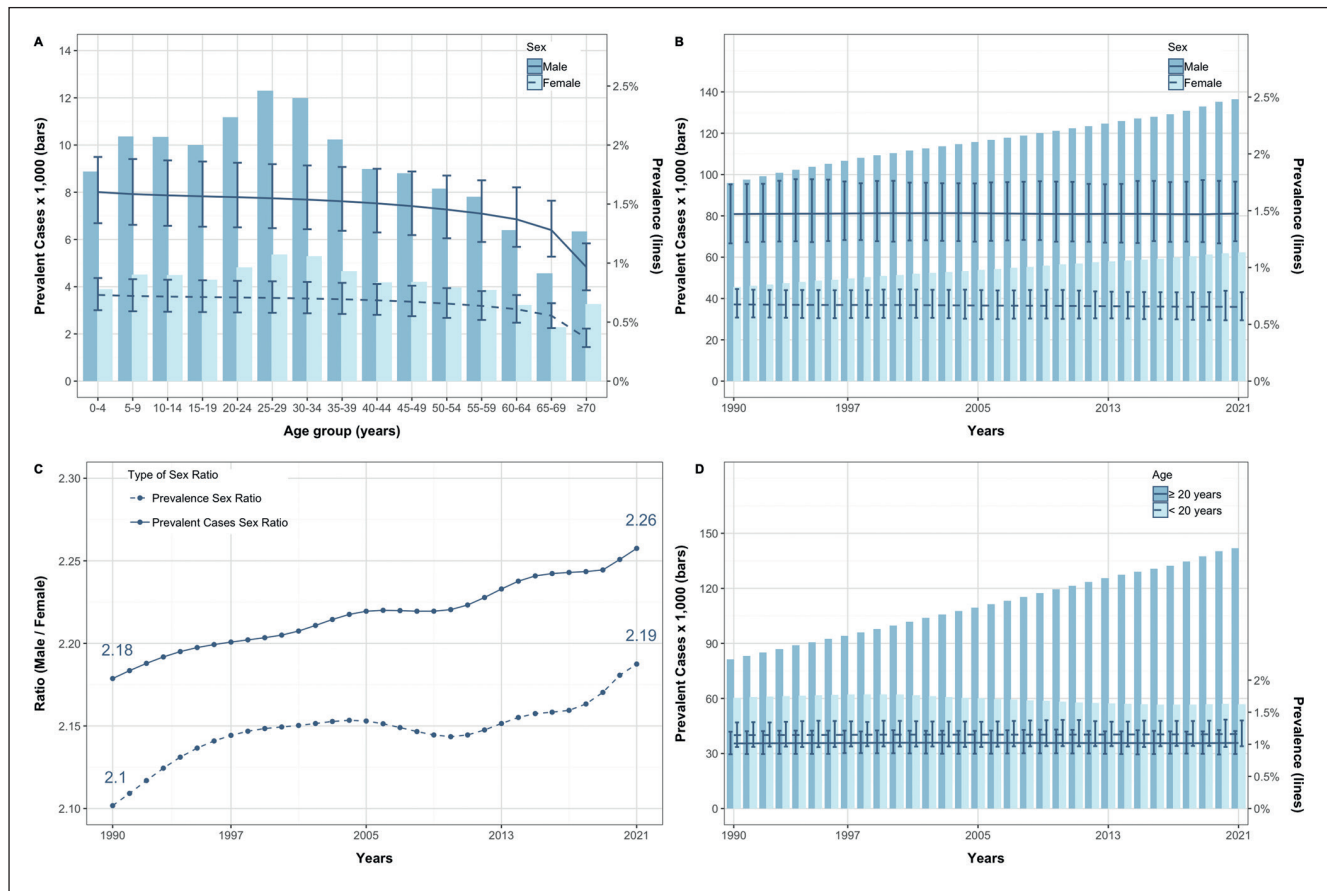


Figure 1. Distribution of Autism Spectrum Disorder (ASD) Prevalence in Chile. **A.** Age- and sex-specific prevalence of ASD in Chile in 2021. **B.** Sex-specific prevalence of ASD in Chile from 1990 to 2021. **C.** Sex ratio of ASD in Chile from 1990 to 2021. **D.** Age-specific prevalence of ASD (< 20 years and ≥ 20 years) in Chile from 1990 to 2021. In panels A, B, and D, vertical error bars represent the 95% confidence interval for annual prevalence.

prevalence (APC: 0.11; 95% CI: 0.08 to 0.14) and in the sex ratio of prevalent cases (APC: 0.13; 95% CI: 0.07 to 0.18) (Figure 1C).

Although the specific prevalence of ASD in the main age groups did not show considerable changes (only a slight, statistically significant increase in children/adolescents) between 1990 and 2021 (Table 1), the total number of prevalent cases increased by 40% during that period. This increase is attributed to the steady rise in the number of registered adult cases over the time studied (Figure 1D), whereas the number of prevalent cases in children under 20 years of age remained stable. The APC was positive in all age groups, with an increase in magnitude with advancing age (Table 2).

The distribution of the absolute number and rate of YLDs was closely related to the distribution of prevalence (Figure 2). The APC of the YLD rate was not significant in the pediatric population but was positive in some adult age ranges (Table 2).

Discussion

This study provides a detailed analysis of trends in ASD prevalence and disease burden in Chile between 1990 and 2021, stratified by age group and sex, using reliable data extracted from the GBD 2021 database¹³.

In 2021, the prevalence of ASD in Chile, estimated at 1.06% (crude) and 1.08% (age-standardized), exceeded both the global prevalences estimated by GBD 2021 (0.66% and 0.69%, respectively) and those reported in a previous meta-analysis (crude prevalence of ASD ranging from 0.4% to 1%) that included data from more than 30 million participants from 74 international studies^{4,16}.

The analysis shows an annual decrease of 0.03% in the crude prevalence of ASD in Chile during the period studied. This decreasing trend does not reflect a reduction in the absolute number of ASD cases but is due to demographic changes in the country, particularly the proportional decrease in children and

Table 1. Prevalence and Years Lived with Disability of Autism Spectrum Disorder in Chile, 1990–2021

	N, per 1,000 (95% CI)		Prevalence (%) and YLD rate per 100,000 population (95% CI)					SR
	2021	RPD	2021	RPD	APC	Male	Female	
Crude								
Prevalence	199 (166 a 235)	40% (31 a 53)	1.06% (0.88 a 1.25)	-0.80% (-7.5 a 8.1)	-0.03% (-0.05 a -0.01)	1.47% (1.23 a 1.76)	0.65% (0.54 a 0.78)	2.26
YLDs	37 (25 a 53)	39% (28 a 51)	196 (135 a 280)	-1.9% (-9.6 a 6.7)	-0.06% (-0.10 a -0.03)	275 (191 a 385)	120 (81 a 172)	2.29
Age-standardized								
Prevalence	NA	NA	1.08% (0.90 a 1.28)	3.5% (-3.4 a 13)	0.11% (0.09 a 0.13)	1.49% (1.25 a 1.78)	0.67% (0.55 a 0.81)	2.22
YLDs	NA	NA	203 (140 a 289)	3.4% (-4.4 a 12)	0.11% (0.08 a 0.14)	281 (195 a 393)	125 (85 a 179)	2.25
Age group: 0–19 years								
Prevalence	57 (47 a 67)	-5.8% (-12 a 2.6)	1.16% (0.97 a 1.37)	1.5% (-5.2 a 11)	0.05% (0.03 a 0.07)	1.58% (1.32 a 1.88)	0.72% (0.59 a 0.86)	2.19
YLDs	11 (7 a 16)	-5.9% (-14 a 3.5)	224 (153 a 318)	1.5% (-7 a 12)	0.05% (0.01 a 0.09)	305 (212 a 430)	138 (92 a 198)	2.21
Age group: ≥ 20 years								
Prevalence	142 (118 a 168)	75% (63 a 90)	1.02% (0.85 a 1.21)	0.62% (-6.2 a 9.5)	0.02% (-0.01 a 0.05)	1.43% (1.20 a 1.71)	0.63% (0.52 a 0.76)	2.27
YLDs	26 (18 a 37)	73% (59 a 90)	187 (128 a 265)	-0.12% (-8.6 a 9.5)	-0.01% (-0.04 a 0.04)	264 (182 a 369)	114 (78 a 162)	2.32

YLDs: Years Lived with Disability; N: Prevalent cases (in thousands); 95% CI: 95% confidence interval; RPD: Relative percentage difference between indicators in 2021 and 1990; APC: Average annual percent change; NA: Not applicable; SR: Sex ratio of indicators (male/female). Data source: Global Burden of Disease Collaborative Network, results of the Global Burden of Disease Study 2021 (GBD 2021). Institute for Health Metrics and Evaluation (IHME), 2024. Accessed on 03/02/2024 from <https://vizhub.healthdata.org/gbd-results/>¹³.

adolescents and the aging of the population¹⁴. When standardizing prevalence by age, and eliminating the effect of these demographic changes, an annual increase of 0.11% is observed in the total population. Analysis by five-year age groups reveals an upward trend in age-specific prevalence across all groups, increasing progressively with age. In particular, among children and adolescents, an annual increase is observed that fluctuates between 0.03% and 0.08%. Although the number of prevalent cases in individuals under 20 years of age remained stable, cases in people aged 20 years and older increased by 75% between 1990 and 2021, reinforcing the need to allocate resources and develop strategies for the comprehensive care of adults with ASD¹⁷.

Our findings reveal a sex ratio of 2.19 for ASD in Chile in 2021, with no significant differences by among individuals under 70 years of age. This ratio is slightly higher than the overall ratio reported by GBD 2021 (2.13)⁴, but notably lower than that observed in pre-

vious studies conducted in the United States and the United Kingdom (3.44 and 3.77, respectively)^{6,18}. In contrast to the increase in prevalence and incidence of ASD in females described by a cohort study conducted in England and Northern Ireland between 1998 and 2018 that included over 19 million patients⁶, the GBD 2021 data for Chile indicate a slight but significant decrease in prevalence among females. This observed discrepancy could be related to a gap in the diagnosis of ASD in Chilean women that may persist throughout life, either due to a lack of awareness of sex-related clinical differences among health professionals¹⁹, or to real differences in the distribution of risk factors by sex²⁰, which could result in a lower incidence of ASD in women.

Finally, a higher burden of YLDs attributable to ASD was observed in Chile compared to the rest of the world and in comparison with other neurodevelopmental disorders globally⁴, reflecting the significant influence of ASD on quality of life when the condition

Table 2. Average Annual Percent Change in the Prevalence and Years Lived with Disability (YLDs) of Autism Spectrum Disorder in Chile, 1990–2021

	Prevalence APC (95% CI)	YLD Rate APC (95% CI)
Crude		
Both sexes	-0.03 (-0.05 a -0.01)	-0.06 (-0.10 a -0.03)
Male	0.07 (-0.02 a 0.03)	-0.03 (-0.07 a 0.01)
Female	-0.11 (-0.13 a -0.09)	-0.15 (-0.20 a -0.11)
Age-standardized		
Both sexes	0.11 (0.09 a 0.13)	0.11 (0.08 a 0.14)
Male	0.11 (0.09 a 0.14)	0.12 (0.08 a 0.15)
Female	0.03 (0.02 a 0.06)	0.03 (-0.02 a 0.08)
Major age group		
Pediatric (0–19 years)	0.05 (0.03 a 0.08)	0.05 (0.01 a 0.09)
Adults (≥ 20 years)	0.02 (-0.01 a 0.05)	-0.01 (-0.04 a 0.04)
Age group (years)		
0-4	0.03 (0.01 a 0.04)	0.02 (-0.02 a 0.06)
5-9	0.05 (0.03 a 0.06)	0.06 (-0.05 a 0.17)
10-14	0.05 (0.04 a 0.08)	0.05 (-0.03 a 0.12)
15-19	0.08 (0.05 a 0.10)	0.08 (-0.01 a 0.18)
20-24	0.10 (0.07 a 0.13)	0.10 (0.02 a 0.18)
25-29	0.11 (0.08 a 0.14)	0.12 (-0.01 a 0.26)
30-34	0.11 (0.08 a 0.15)	0.12 (0.02 a 0.22)
35-39	0.11 (0.08 a 0.14)	0.11 (-0.02 a 0.24)
40-44	0.10 (0.08 a 0.13)	0.11 (0.01 a 0.21)
45-49	0.11 (0.08 a 0.14)	0.11 (-0.02 a 0.24)
50-54	0.14 (0.10 a 0.17)	0.15 (0.07 a 0.24)
55-59	0.16 (0.12 a 0.21)	0.15 (0.06 a 0.23)
60-64	0.19 (0.16 a 0.23)	0.20 (0.10 a 0.30)
65-69	0.29 (0.25 a 0.33)	0.28 (0.18 a 0.39)
≥ 70	0.44 (0.37 a 0.51)	0.41 (0.31 a 0.52)

YLDs: Years Lived with Disability; APC: Average annual percent change, representing the magnitude and direction of average yearly variability in prevalence and YLD rates. Data source: Global Burden of Disease Collaborative Network, results of the Global Burden of Disease Study 2021 (GBD 2021). Institute for Health Metrics and Evaluation (IHME), 2024. Accessed on 03/02/2024 from <https://vizhub.healthdata.org/gbd-results/>¹³.

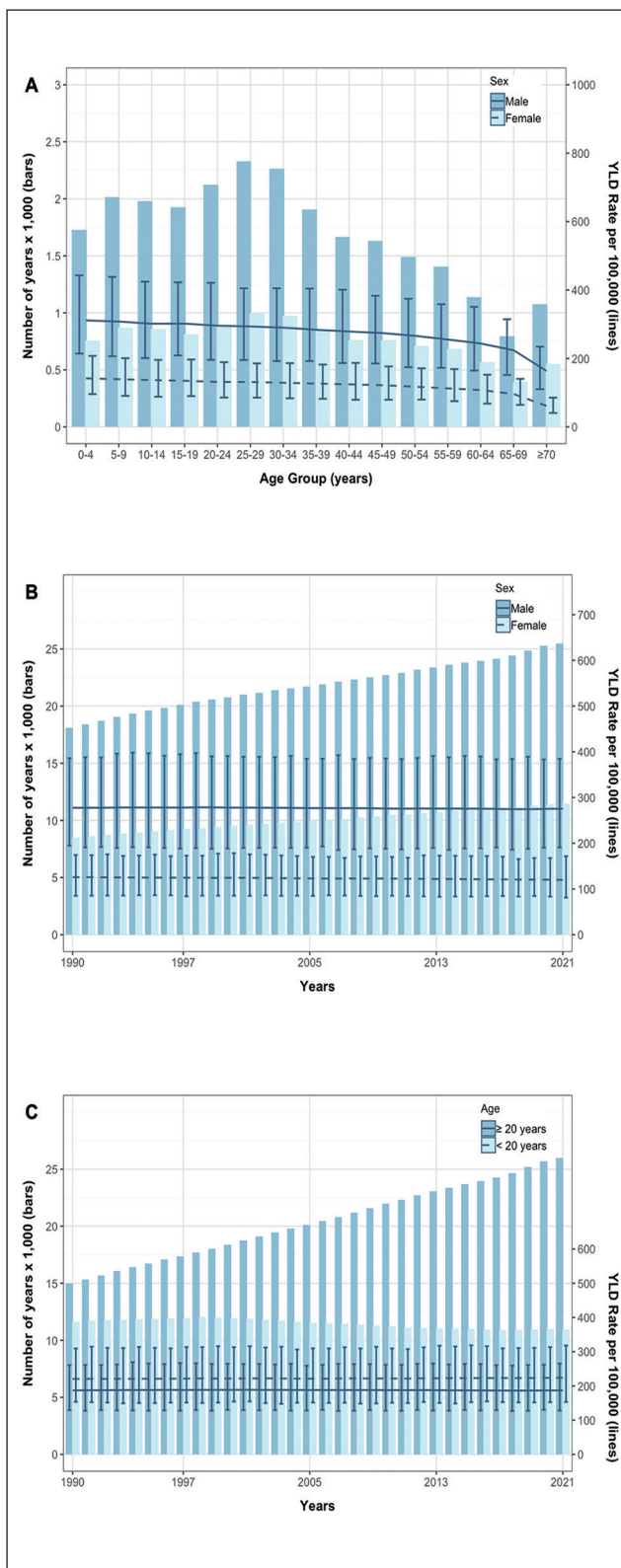


Figure 2. Distribution of the Years Lived with Disability (YLD) Rate of Autism Spectrum Disorder (ASD) in Chile. **A.** Age- and sex-specific YLD rate of ASD in Chile in 2021. **B.** Sex-specific YLD rate of ASD in Chile from 1990 to 2021. **C.** Age-specific YLD rate of ASD (< 20 years and ≥ 20 years) in Chile from 1990 to 2021. Vertical error bars represent the 95% confidence interval for the annual YLD rate.

is considered independently of comorbidities²¹. These findings support the need to implement a systematic assessment of health-related quality of life in people with ASD, which can be achieved through the use of specific instruments to monitor changes over time²².

Limitations

The results should be interpreted in light of the quality and coverage of the available data. Ecological studies, such as ours, are valuable tools for analyzing population trends. However, the absence of standardized registries at the national level could lead to an underestimation of prevalent cases, which would affect the precision of prevalence estimates and limit the generalizability of the results. Estimating the burden of disease based on YLDs alone could underestimate the impact of the diagnosis throughout life, especially considering the evidence of mortality directly associated with neurodevelopmental disorders²³.

The estimates of health indicators presented in this study are derived from Bayesian models that rely heavily on previously collected information, which could under- or overestimate the indicators presented. Nevertheless, the data selection and modeling process used by GBD 2021 has been transparent and openly published, facilitating the replicability of the analyses^{3,24}. Finally, given the complexity of the analysis and the reliance on multiple predictors for the calculation of the indicators, the models used may be susceptible to collinearity between variables, which could affect the precision of the estimates. However, the GBD 2021 researchers employed various strategies in both the design (particularly, careful variable selection) and statistical modeling (application of robust models to address collinearity and multistep sensitivity analysis) to reduce the risk of bias³.

Conclusions

Analysis of ASD health indicators in Chile over the last three decades reveals a decreasing trend in female-specific prevalence, with rates approximately 2 to 3 times higher in males than in females. In the pediatric population, there is an increasing trend in the preva-

lence of ASD, with a stable number of prevalent cases between 1990 and 2021. In adults, although there are no significant annual changes in ASD prevalence, the number of prevalent cases increased markedly over the 32-years period, suggesting underreporting of pediatric cases in previous decades.

ASD continues to represent a significant public health challenge in Chile. Detection and care efforts must be adapted to the evolving needs of the population. In this regard, the creation of a standardized diagnostic registry would allow for a more accurate assessment of its impact and evolution over time—a fundamental step toward effectively guiding national public health policies.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: This study was approved by the respective Research Ethics Committee, which, according to the study's characteristics, has accepted the non-use of Informed Consent.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

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