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The burden of near vision loss from 1990 to 2021, and projections until 2032–findings from the Global Burden of Disease Study 2021

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BACKGROUND: Near vision loss (NVL) represents a major global health challenge. However, its epidemiological research is less extensive compared to that of distance vision impairment. To fill this gap, this study examined worldwide patterns in NVL prevalence and disease burden from 1990 to 2021 and forecasted trends up to 2032.
METHODS: Using data from the Global Burden of Disease (GBD) 2021 study, which covers 204 countries and territories, we assessed four key epidemiological measures: prevalence, disability-adjusted life years (DALYs), age-standardised prevalence rates (ASPRs), and age-standardised DALY rates (ASDRs). Future trends through 2032 were predicted employing Bayesian age-period-cohort (BAPC) modelling.
RESULTS: Between 1990 and 2021, global ASPRs for NVL rose by 37% (95% UI: 28–46%), and ASDRs increased by 38% (29–47%). In 2021, over 1.1 billion people worldwide were affected by NVL, leading to 11.6 million DALYs. The low-middle socio-demographic index (SDI) regions showed the highest ASPRs (16,252.9 per 100,000) and ASDRs (162.8 per 100,000), with females consistently experiencing higher rates than males. Projections suggest that ASPRs will continue to rise through 2032.
CONCLUSIONS: With the growing burden of NVL, it remains a significant global health issue. Consequently, focused allocation of resources toward NVL prevention and management is essential. Particular attention should be given to older adults and women, who are more susceptible to this condition.

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INTRODUCTION

Near vision loss (NVL) is an age-related condition marked by a decline in the eye's ability to focus on close objects, caused by decreased flexibility of the crystalline lens. This condition leads to progressively greater difficulty with near-vision tasks and is clinically equivalent to presbyopia, a specific type of isolated near visual impairment (NVI).

According to the World Health Organization, 2.2 billion people worldwide suffer from vision impairment, with 1 billion lacking access to necessary vision care services. Presbyopia is the primary cause of NVL, affecting about 826 million people [1]. From 1990 to 2017, the global burden of disease due to NVL rose by 82.4%, increasing from 5.3 million to 9.8 million DALYs [2]. In 2020, over 510 million individuals were estimated to have NVI caused by uncorrected presbyopia, with projections indicating this number could reach 866 million by 2050 [3].

Geographically, uncorrected NVI rates exceed 80% in Western, Eastern, and Central sub-Saharan Africa, whereas high-income regions such as North America, Australasia, Western Europe, and the Asia-Pacific report much lower rates, around 10% [1]. Epidemiological data show that NVL is more severe in low-income areas, regions with low SDI scores, and Southeast Asia [4].

NVL significantly impacts quality of life, comparable to distance vision impairment [5]. Assuming all individuals under 65 are economically active, the estimated productivity loss due to presbyopia is $25.37 billion, accounting for 0.037% of the global gross domestic product [6]. Beyond economic effects, uncorrected vision impairment and age-related eye diseases reduce educational achievement and workforce participation [7, 8], while increasing mortality risk [9, 10]. In older adults, NVI is strongly linked to depression [11, 12] and may worsen age-related conditions such as cognitive decline [13] and injuries from falls [14].

As a major cause of vision impairment worldwide, NVL is expected to rise with aging populations. A comprehensive analysis of its disease burden and trends over time is crucial for fair resource distribution and targeted interventions. Although prior research has addressed aspects of NVL, these studies have often been limited to specific regions with limited data, lacking a thorough global perspective.

Using data from the GBD 2021 study, we measured the prevalence of NVL along with DALYs, ASPRs and ASDRs. This research examined global epidemiological patterns of NVL from 1990 to 2021 and projected trends for the next ten years. Our

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Table 1. Prevalent cases and DALYs for NVL in 2021 for both sexes and percentage change of age-standardised rates by Global Burden of Disease region.

Location	Prevalence (95% UI)			DALYs (95% UI)		
	Number (thousand)	ASPRs	Percentage change in ASPRs between 1990 and 2021	Number (thousand)	ASDRs	Percentage change in ASDRs between 1990 and 2021
Global	1,155,063 (875,226, 1,514,597)	13,436 (10,223, 17586)	0.37 (0.28, 0.46)	11,650 (5214, 22,422)	136 (61, 260)	0.38 (0.29, 0.47)
High-income Asia Pacific	21,311 (15,551, 28,891)	6702 (4908, 9142)	−0.02 (−0.03, 0.00)	214 (97, 415)	68 (30, 136)	−0.02 (−0.03, 0.00)
High-income North America	29,530 (21,165, 40,047)	5787 (4069, 8165)	0.10 (−0.01, 0.20)	295 (131, 579)	58 (25, 114)	0.09 (-0.02, 0.20)
Western Europe	43,596 (31,512, 59,930)	5913 (4354, 7967)	−0.01 (−0.03, 0.00)	433 (194, 841)	59 (27, 117)	−0.01 (−0.03, 0.00)
Australasia	2699 (1965, 3643)	6314 (4586, 8626)	0.00 (−0.04, 0.03)	27 (12, 53)	64(28,125)	0.00 (−0.04, 0.03)
Andean Latin America	8284 (6116, 11,066)	13,195 (9802, 17,479)	0.00 (−0.03, 0.03)	84 (37, 164)	133 (59, 259)	−0.01 (−0.04, 0.03)
Tropical Latin America	35,910 (26,725, 47,943)	13,933 (10,429, 18,438)	0.00 (−0.02, 0.03)	359 (157, 713)	139 (62, 275)	0.00 (−0.01, 0.03)
Central Latin America	30,125 (22,467, 39,773)	11,629 (8718, 15,324)	0.15 (0.08, 0.23)	303 (135, 598)	117 (52, 228)	0.15 (0.08, 0.23)
Southern Latin America	5302 (3870, 7281)	6575 (4787, 9033)	−0.01 (−0.05, 0.03)	53 (24, 105)	66 (30, 131)	−0.01 (-0.05, 0.03)
Caribbean	5792 (4324, 7686)	11,037 (8207, 14,588)	0.00 (−0.02, 0.01)	58 (26, 114)	111 (49, 218)	−0.01 (−0.03, 0.01)
Central Europe	11,562 (8386, 15,909)	6077 (4523, 8108)	−0.01 (−0.02, 0.01)	114 (50, 225)	61 (27, 119)	0.00 (−0.02, 0.02)
Eastern Europe	42,262 (31,417, 55,347)	13,645 (10,229, 17,973)	0.22 (0.14, 0.33)	420 (195, 799)	136 (63,261)	0.23 (0.14, 0.33)
Central Asia	7433 (5516, 9858)	8642 (6442, 11,441)	−0.02 (−0.06, 0.01)	75 (32, 146)	86 (38, 168)	−0.02 (−0.06, 0.01)
North Africa and Middle East	55,508 (41,264, 74,064)	10,491 (7902, 13,754)	0.07 (−0.01, 0.16)	558 (247, 1106)	105 (47, 202)	0.06 (−0.01, 0.16)
South Asia	350,461 (261,815, 452,218)	20,747 (15,692, 26,642)	0.55 (0.36, 0.75)	3531 (1600, 6461)	208 (94, 378)	0.56 (0.37, 0.77)
Southeast Asia	74,162 (55,499, 98,610)	10,504 (7966, 13,743)	0.07 (0.04, 0.10)	750 (331, 1466)	106 (47, 205)	0.07 (0.04, 0.10)
East Asia	333,186 (244,311, 447,060)	15,509 (11,531, 20,445)	0.52 (0.34, 0.71)	3382 (1554, 6452)	158 (71, 301)	0.54 (0.35, 0.72)
Oceania	975 (716, 1327)	10,405 (7696, 13,982)	0.00 (−0.03, 0.02)	10 (4, 20)	104 (46, 204)	0.00 (−0.03, 0.02)
Western Sub-Saharan Africa	37,371 (27,660, 50,262)	12,861 (9701, 17,011)	0.01 (−0.01, 0.02)	381 (165, 751)	130 (57, 253)	0.01 (0.00, 0.03)
Eastern Sub-Saharan Africa	25,848 (19,024, 34,555)	10,621 (7968, 13,874)	0.01 (−0.01, 0.02)	262 (114, 507)	106 (47, 206)	0.01 (0.00, 0.02)
Central Sub-Saharan Africa	15,591 (11,390, 21,299)	17,981 (13,559, 23,697)	−0.01 (−0.04, 0.02)	159 (70, 312)	181 (81, 351)	0.00 (−0.03, 0.03)
Southern Sub-Saharan Africa	18,155 (13,872, 23,381)	25,064 (19,716, 31,575)	0.03 (−0.01, 0.07)	183(81, 358)	252 (114, 483)	0.03 (−0.02, 0.06)

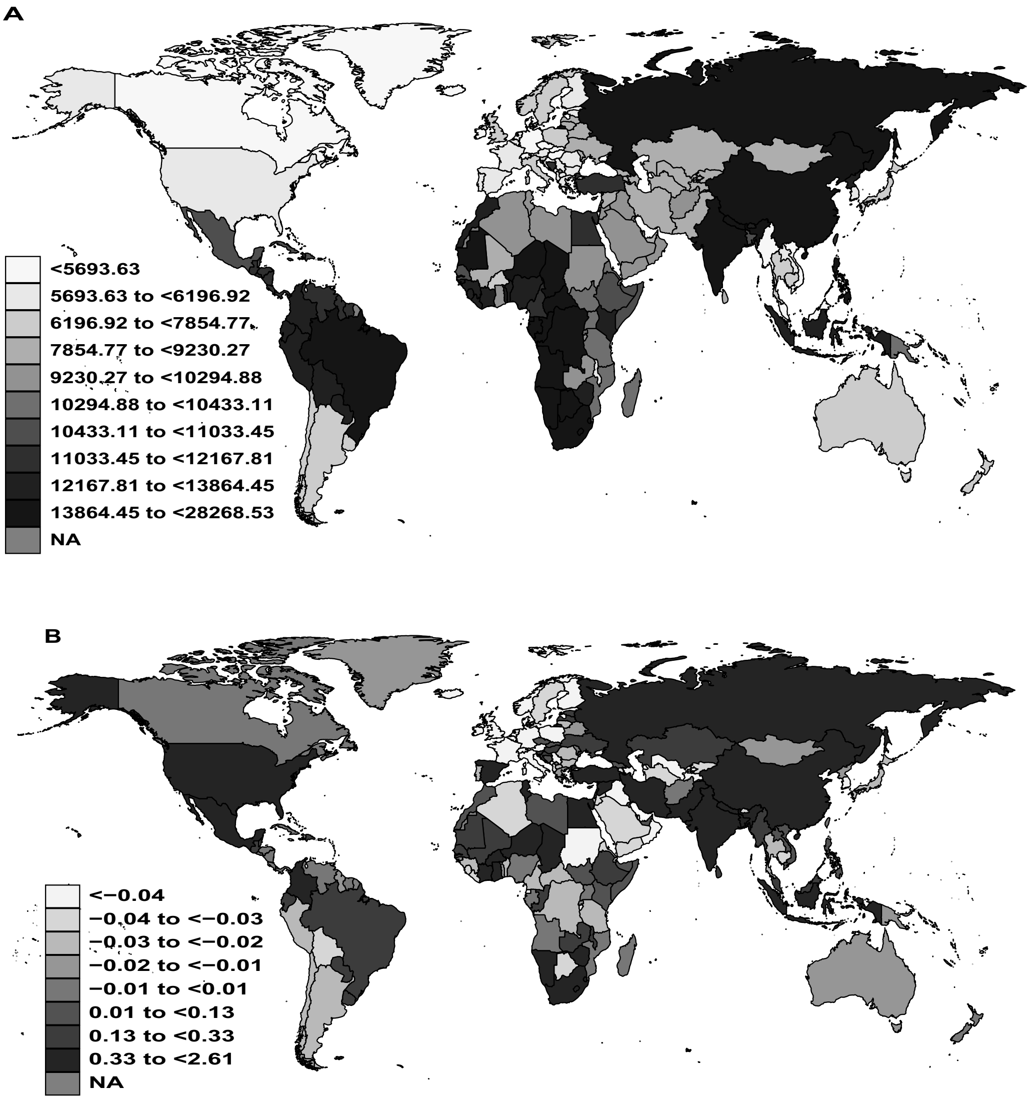

Fig. 1 Global prevalence of near vision loss across 204 countries and regions. A ASPRs of NVL in 2021; **B** EAPCs in NVL ASPR from 1990 to 2021.

results aim to provide a solid evidence base to inform policies addressing the growing public health challenges posed by NVL.

METHODS

Data source and disease definition

The analysis employed NVL data from the Global Burden of Diseases, Injuries, and Risk Factors Study, spanning the years 1990–2021. This standardised epidemiological database offers global estimates for 371 diseases and injuries across 204 countries and territories, as well as 21 geographic regions, accessible through the Global Health Data Exchange platform. Within the GBD framework, diseases are organised using a four-level hierarchical system, with NVL classified as a Level 4 cause. NVL is characterised as the gradual loss of the ability to focus on nearby objects due to aging, commonly referred to as presbyopia. The methodological procedures for GBD 2021 have been comprehensively detailed in relevant publications [15, 16].

Socio-demographic index (SDI)

The SDI is a composite measure that evaluates health determinants across three domains, each scaled from 0 to 1: fertility rates among women under 25 years old, average years of schooling completed by adults aged 15 and above, and lagged per capita income adjusted for purchasing power parity. Based on SDI scores, countries and territories are categorised into five groups: low (SDI < 0.46), low-middle (0.46–0.60), middle (0.61–0.69), high-middle (0.70–0.81), and high (>0.81).

Disability-adjusted life years (DALYs)

DALYs serve as a public health metric that quantifies the total health burden in populations by combining two elements: years of life lost due to premature death (YLLs) and years lived with disability (YLDs), which represent reduced quality of life caused by health conditions. Since the GBD methodology does not assign mortality to NVL, YLLs are effectively zero. Consequently, DALYs for NVL correspond solely to YLDs.

Estimated annual percentage change and percentage change

The EAPC, a widely used measure for evaluating temporal trends in epidemiological rates, was applied to quantify changes in NVL prevalence from 1990 to 2021. The EAPC was calculated by fitting a linear regression model to the natural logarithm of age-standardised rates over time (Eq. (1)):

$$ln(y) = \alpha + \beta_x + \epsilon \tag{1}$$

where x represents the calendar year, ln(y) is the log-transformed rate, α is the intercept, β is the slope coefficient, and ϵ is the error term. The EAPC

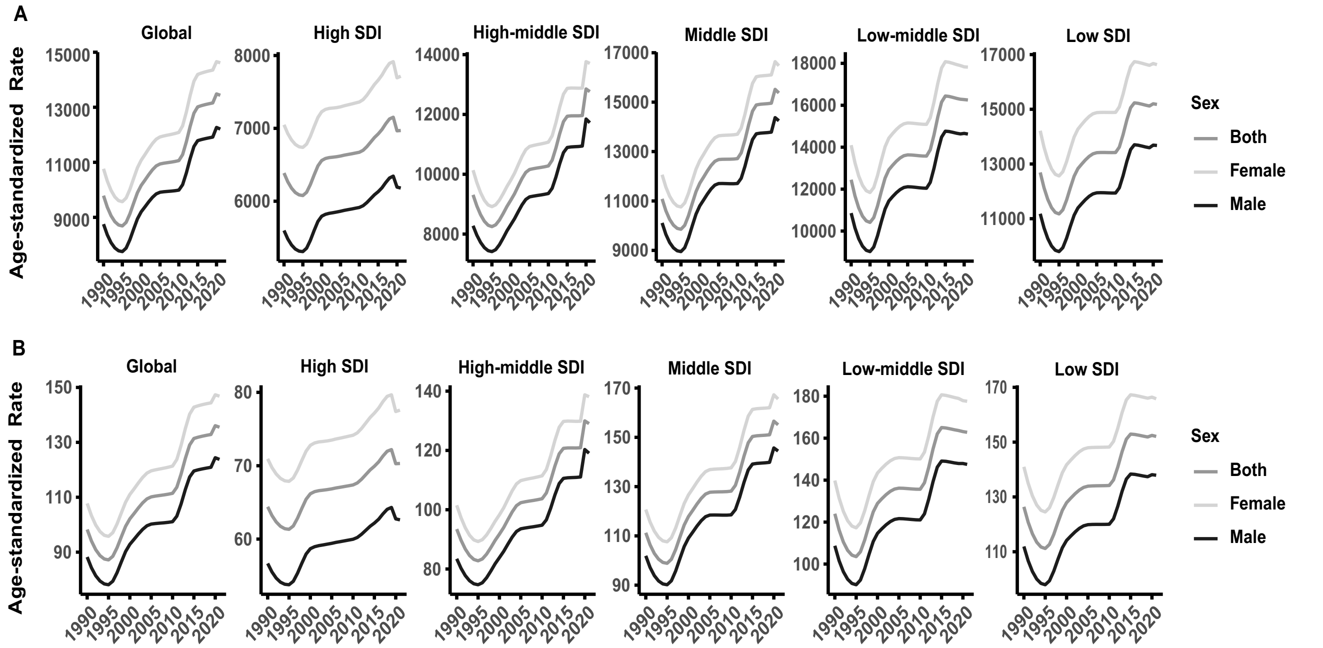

Fig. 2 Temporal trends of age-standardised prevalence and DALY rates of near vision loss by sex from 1990 to 2021. A The ASPRs of NVL; **B** The ASDRs of NVL.

and its 95% confidence interval were computed as follows (Eq. (2)):

$$EAPC = 100 \times (e^{\beta} - 1) \quad (2)$$

Temporal trends were interpreted based on the 95% confidence interval: a lower bound above zero indicates a significant upward trend, an upper bound below zero indicates a significant downward trend, and inclusion of zero suggests no statistically significant change. Additionally, proportional changes in age-standardised prevalence and DALY values between 1990 and 2021 were calculated using the formula below (Eq. (3)):

$$\text{Percentage change} = \frac{Rate2021 - Rate1990}{Rate1990} \times 100 \quad (3)$$

In this research, forecasts of NVL-related ASPRs from 2022 to 2032 were produced using BAPC modelling with nested Laplace approximation. The BAPC model breaks down temporal trends into age, period, and cohort components, assuming these effects add together and that period and cohort effects change smoothly over time [17]. Although the period effect may capture general temporal patterns, our projections mainly represent demographic changes (aging and cohort progression) and modelled disease risk trends, rather than specific assumptions about future modifications in eye care access or interventions. Data cleaning, computational analyses, and visualisations were conducted using R software (version 4.3.3), with final graphical adjustments made in Adobe Illustrator (version 26.0.1).

RESULTS

NVL burden in 2021

In 2021, NVL affected ~1.16 billion people worldwide (95% UI: 0.88–1.51 billion), with an ASPR of 13,436 per 100,000 population (95% UI: 10,223–17,586). Between 1990 and 2021, the ASPR increased by 37% (28–46%). NVL was responsible for 11.65 million DALYs (5.21–22.42 million), corresponding to an ASDR of 136 per 100,000 (61–260). Over this period, the ASDR rose by 38% (29–47%) (Table 1).

There were notable regional differences in NVL ASPRs in 2021. The highest rates were found in Southern Sub-Saharan Africa (25,064 per 100,000; 95% UI: 19,716–31,575), South Asia (20,747 per 100,000; 15,692–26,642), and Central Sub-Saharan Africa (17,981 per 100,000; 13,559–23,697). In contrast, the lowest ASPRs were recorded in High-Income North America (5787 per 100,000; 4069–8165), Western Europe (5913 per 100,000; 4354–7967), and Central Europe (6077 per 100,000; 4523–8108) (Table 1).

Similarly, ASDRs varied significantly by region, with the greatest burdens in Southern Sub-Saharan Africa (252 per 100,000; 95% UI: 114–483), South Asia (208 per 100,000; 94–378), and Central Sub-Saharan Africa (181 per 100,000; 81–351). The lowest ASDRs were observed in High-Income North America (58 per 100,000; 25–114), Western Europe (59 per 100,000; 27–117), and Central Europe (61 per 100,000; 27–119) (Table 1).

Figure 1 presents the global distribution of ASPRs and EAPCs across 204 countries from 1990 to 2021. In 2021, the highest ASPRs were concentrated in South Africa, Niger, and Mauritania (Sub-Saharan Africa), as well as India and Nepal (South Asia), while the lowest rates were found in Malaysia, Slovakia, Hungary, Myanmar, and Vietnam (Fig. 1A). From 1990 to 2021, most countries experienced declines in ASPRs, with the largest decreases in Dominica (−0.13, 95% CI: −0.13 to −0.12) and Equatorial Guinea (−0.09, −0.10 to −0.08). Conversely, India (2.61, 2.25–2.97) and Nepal (2.27, 1.83–2.71) showed the most pronounced increases (Fig. 1B).

Globally, NVL prevalence rates in 2021 varied significantly by sex and age. Females consistently had higher prevalence rates than males, with the highest rate among females aged 55–59 years (41,539 per 100,000) compared to males aged 60–64 years (36,218 per 100,000). Interestingly, the pattern of prevalent cases differed from prevalence rates, showing a single peak occurring earlier, at ages 50–54 for both sexes, followed by a decline in older age groups (Supplementary Fig. 1A).

The analysis of disease burden showed similar patterns in DALYs. Females consistently had higher DALY rates, which increased with age. However, the total number of DALYs peaked in the 50–54 age group for both sexes, then gradually decreased in older age groups (Supplementary Fig. 1B).

Time trends of NVL burden from 1990 to 2021

Our longitudinal analysis revealed significant variation in the changes of ASPRs across GBD 2021 regions between 1990 and 2021. The largest increases were seen in South Asia (55%, 95% UI:

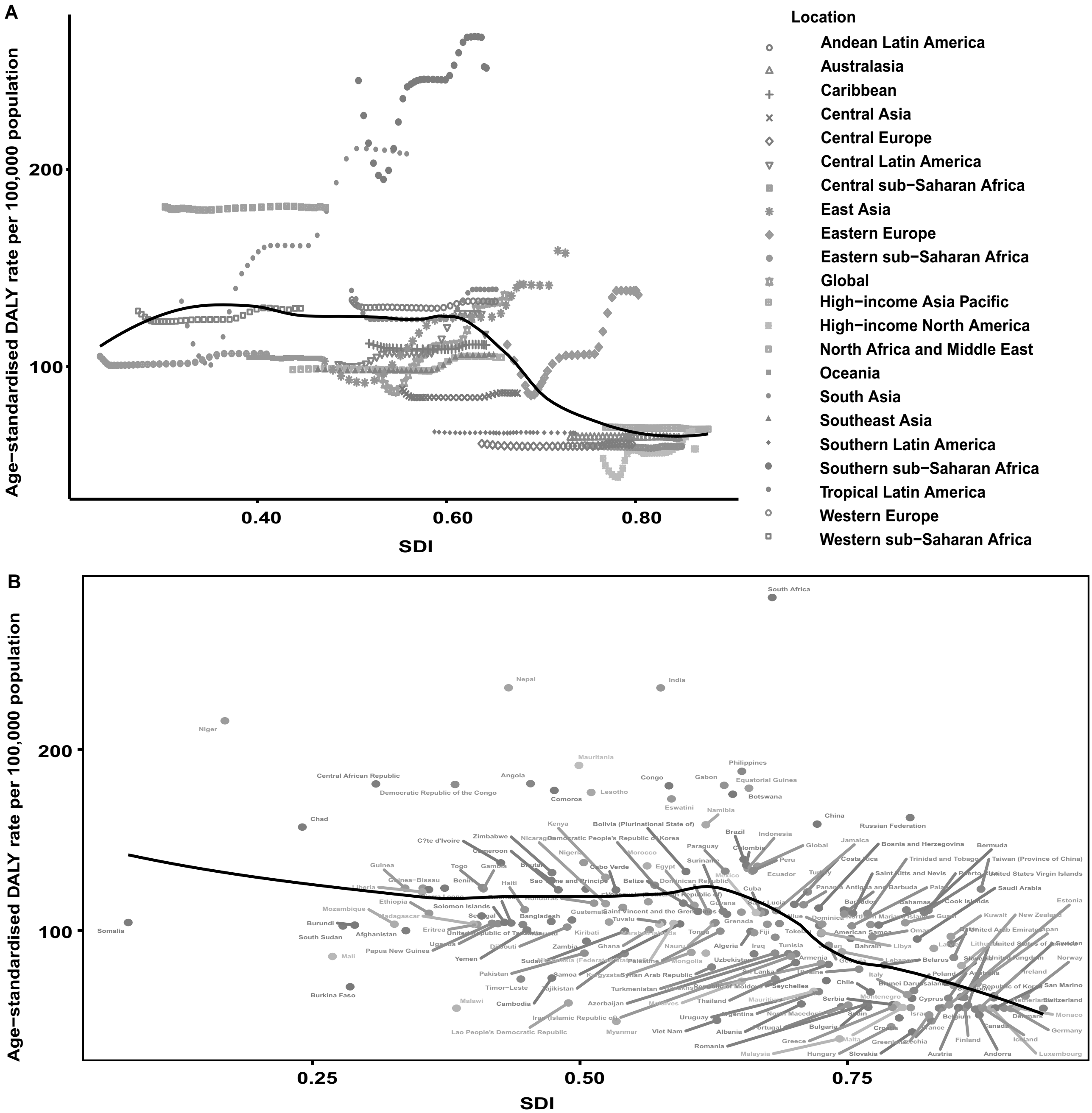

Fig. 3 Trends and distribution of NVL ASDRs by SDI, 1990–2021. Where expected values based on SDI and disease rates across all locations are shown as the black line. **A** For each GBD region, 32 data points are plotted, representing the observed ASDRs from 1990 to 2021; **B** Each point represents the observed ASDR for a specific country in 2021.

36–75%), East Asia (52%, 34–71%), and Eastern Europe (22%, 14–33%). Conversely, notable decreases occurred in High-Income Asia Pacific (−2%, −3% to 0) and Central Asia (−2%, −6% to 1%) (Table 1). Meanwhile, the global number of prevalent NVL cases more than doubled during this period, rising from 0.43 billion (95% UI: 0.32–0.56 billion) in 1990 to 1.16 billion (0.88–1.51 billion) in 2021.

The time-trend analysis demonstrated continuous increases in both ASPRs and ASDRs of NVL worldwide from 1990 to 2021, with a disproportionately higher rise among females (Table 1, Fig. 2). When broken down by SDI quintiles, all development levels showed increases, though with notable differences in magnitude. The greatest growth occurred in the middle SDI quintile, followed by the high-middle and low-middle quintiles (Fig. 2). Importantly, ASPR levels reflected developmental disparities, with high and high-middle SDI regions maintaining rates below the global average throughout the study period (Fig. 2A). Similarly, ASDR trends showed a comparable pattern, where middle, low-middle, and low SDI regions consistently exceeded global average, while high SDI regions remained below the global average (Fig. 2B).

Burden of NVL by SDI

Our geospatial analysis identified a nonlinear relationship between ASDRs and the SDI at the regional level. This relationship showed multiple phases of increase and decrease, ultimately reaching its lowest point when the SDI was around 0.78. Within the Latin America super-region, Central Latin America and Tropical Latin America experienced rising ASDRs from 1990 to

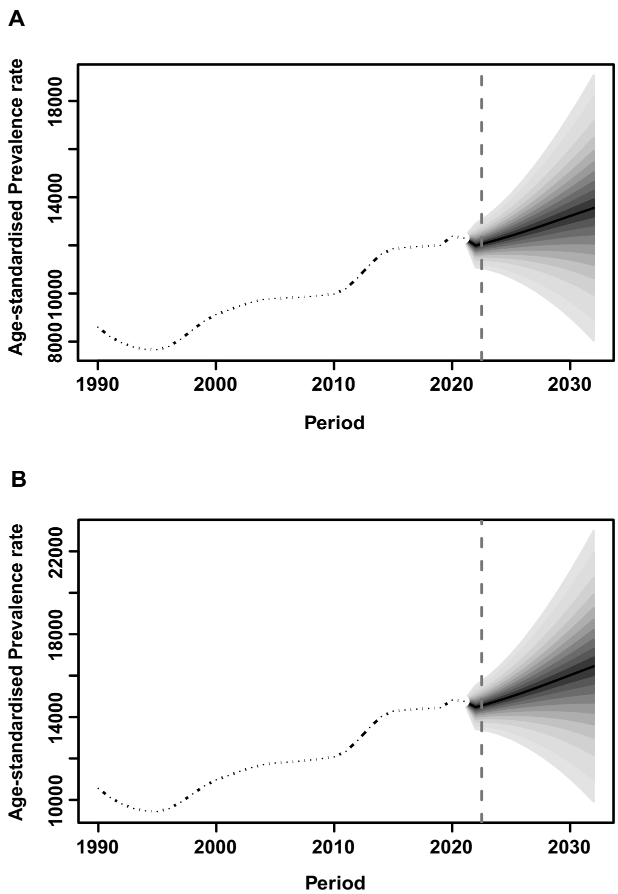

Fig. 4 Projected trends in the ASPRs of NVL by sex from 1990 to 2032, globally. A The ASPRs in men; **B** The ASPRs in women.

2021, while Andean Latin America had higher-than-expected ASDRs, and the Caribbean had lower-than-expected ASDRs.

Central and Southern Sub-Saharan Africa had higher-than-expected ASDRs throughout 1990 to 2021. Conversely, Eastern Sub-Saharan Africa, Oceania, Southeast Asia, Central Asia, North Africa and the Middle East, and Central Europe showed lower-than-expected ASDRs during the same timeframe. Between 1990 and 2021, South Asia, Eastern Europe, and East Asia exhibited distinct trends marked by an initial decrease followed by later increases in ASDRs (Fig. 3A).

At the national level, ASDRs were found to depend on SDI. Importantly, high NVL burdens were observed not only in the most or least developed countries. Nations such as South Africa, India, Nepal, Niger, China, New Zealand, Norway, and the United Kingdom had ASDRs significantly above expectations. In contrast, countries like Thailand, Malaysia, Myanmar, Vietnam, Austria, and Germany showed ASDRs considerably below expectations (Fig. 3B).

Predictions of NVL from 2022 to 2032

Using the BAPC methodological framework, sex-specific and age-specific projections of ASPRs were generated for the period from 2022 to 2032. A steady increase in ASPRs was expected for both males and females throughout this timeframe (Fig. 4). The projections suggested that ASPRs for NVL would either level off or continue rising among different male age groups. Females showed a similar trend, with comparative analysis indicating a faster rate of increase in women compared to men, aligning with the upward trend observed from 1990 to 2021. Importantly, epidemiological modelling forecasted stabilisation in ASPRs for the 25–29, 30–34, and 40–44 age groups in both sexes, which contrasts with the significant upward trends seen between 1990 and 2021. Nonetheless, it is anticipated that ASPRs for other age groups will experience a notable increase over the coming decade (Supplementary Table 1).

DISCUSSION

Using data from GBD 2021, this study measured the significant global impact of NVL across 204 countries between 1990 and 2021. The main findings indicate that NVL is a major but often overlooked public health issue, with more than 1.1 billion cases and 11.6 million DALYs reported in 2021. There were notable increases in both the total number of cases and DALYs, as well as in age-standardised rates. In 2021, the worldwide ASPR and ASDR for NVL reached 13,436 and 135.5 per 100,000 person-years, respectively, markedly higher than the 2019 values (ASPR: 5937.8; ASDR: 58.9) [4]. The temporal analysis (Fig. 2) showed a two-phase rise in ASPRs, with rapid growth from 1996 to 2005, followed by another increase from 2011 to 2020. ASDRs exhibited a similar pattern, confirming NVL as a leading cause of global blindness and visual impairment [18, 19].

There is significant geographic variation in the global burden of NVL. Importantly, our analysis identified a nonlinear threshold relationship between the SDI and ASDR (Fig. 3), which helps explain the disproportionate burden in low-resource areas. Specifically, regions with an SDI below 0.4 experience a sharp increase in burden due to a severe lack of optometric resources, turning normal presbyopia into functional vision impairment. In areas with an SDI between 0.4 and 0.6, the burden levels off as population aging outpaces the growth of eye care services, despite some infrastructure improvements. For SDI values from 0.6 to 0.8, there is a marked reduction in burden thanks to effective tertiary care systems that provide accessible refraction and correction services, converting NVL into correctable vision problems. Finally, regions with an SDI above 0.8 maintain a low but steady burden, where new vision risks related to digital device use combine with irreversible aging effects. This model explains why regions like Africa, South Asia, and Southeast Asia bear much higher burdens compared to North America and Western Europe [20], with low-SDI areas facing three main challenges: inadequate coverage of effective refractive error correction, limited awareness and access to eye health services, and a shortage of trained professionals and facilities [21–23].

High DALY rates, especially in low-SDI areas, are mainly due to limited access to basic eye care, particularly uncorrected refractive error (URE), which is a largely preventable cause of vision impairment. Fortunately, most of the NVL burden linked to URE can be effectively reduced. Providing affordable eyeglasses is the most cost-efficient solution to lower NVL-related DALYs [24, 25]. Therefore, expanding accessible refractive services and eyeglass availability is critical to reducing the high DALY burden in underserved communities.

NVL primarily affects people aged 40–80 years, with prevalence increasing clearly with age [26, 27]. Women consistently show higher prevalence and DALY rates than men (Supplementary Fig. 2), consistent with earlier studies [28, 29]. While longer female life expectancy partly explains this difference, gender-specific barriers to eye care, such as limited mobility, economic dependence, and prioritising family health needs [30, 31], likely worsen the inequality. Addressing this vulnerability requires targeted approaches. Community-based outreach screenings are vital for reaching women, especially older individuals in remote areas, through mobile clinics or accessible locations like community centres, markets, and religious sites [32, 33]. Additionally, incorporating vision screening and affordable eyeglass distribution into existing women's health programs can improve efficiency by utilising established access points [34, 35].

This study has some limitations. First, the absence of relevant data in the GBD database prevented us from evaluating NVL incidence or its risk factors. Second, NVL was treated as a broad category in this study, with limited research available on its specific subtypes.

In conclusion, NVL represents a significant and growing global burden marked by notable disparities related to SDI and gender. Our new BAPC model forecasts this burden will continue to rise over the next decade. To effectively address this trend, coordinated priority actions are needed: greatly increasing access to affordable refractive correction (eyeglasses), which drives high DALYs in resource-poor settings; implementing gender-sensitive measures such as community outreach and integration with women's health services to overcome female-specific barriers; and promoting evidence-based eye care alongside strengthening eye health systems. These comprehensive strategies are essential to substantially reduce the large and unequal global burden caused by NVL.

SUMMARY

What was known before

- Previous research has quantified the global health burden of near vision loss (NVL).
- Additionally, significant regional disparities in the NVL burden have been identified.

What this study adds

- Utilising data from the Global Burden of Disease study, we examined the distribution of the global NVL burden by region and sex from 1990 to 2021.
- From 1990 to 2021, the number and rate of global NVL prevalence and Disability-Adjusted Life Years (DALY) increased significantly. During this period, the age-standardised prevalence and DALY rate of NVL also rose markedly.
- The disease burden of NVL is more pronounced in regions with lower Sociodemographic Index (SDI) values, among middle-aged and older adults, and in females.
- The age-standardised DALY rate of NVL is nonlinearly associated with the SDI.
- From 2022 to 2032, the age-standardised prevalence of NVL is projected to continue increasing in both males and females.

DATA AVAILABILITY

The data used in this study can be derived from the GBD 2021 (Available at: https://ghdx.healthdata.org/gbd-2021).

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AUTHOR CONTRIBUTIONS

TTG developed the concept for the manuscript, enrolment of participants, data gathering and drafting the manuscript, and conducted data analysis. XYM and XW critically verified the data obtained from the GBD database. RTC drafted and revised the manuscript. All authors read and approved the final manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

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