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Global estimates on the number of people blind or visually impaired by age-related macular degeneration: a meta-analysis from 2000 to 2020

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BACKGROUND: We aimed to update estimates of global vision loss due to age-related macular degeneration (AMD).
METHODS: We did a systematic review and meta-analysis of population-based surveys of eye diseases from January, 1980, to October, 2018. We fitted hierarchical models to estimate the prevalence of moderate and severe vision impairment (MSVI; presenting visual acuity from <6/18 to 3/60) and blindness (< 3/60) caused by AMD, stratified by age, region, and year.
RESULTS: In 2020, 1.85 million (95%UI: 1.35 to 2.43 million) people were estimated to be blind due to AMD, and another 6.23 million (95%UI: 5.04 to 7.58) with MSVI globally. High-income countries had the highest number of individuals with AMD-related blindness (0.60 million people; 0.46 to 0.77). The crude prevalence of AMD-related blindness in 2020 (among those aged ≥ 50 years) was 0.10% (0.07 to 0.12) globally, and the region with the highest prevalence of AMD-related blindness was North Africa/Middle East (0.22%; 0.16 to 0.30). Age-standardized prevalence (using the GBD 2019 data) of AMD-related MSVI in people aged ≥ 50 years in 2020 was 0.34% (0.27 to 0.41) globally, and the region with the highest prevalence of AMD-related MSVI was also North Africa/Middle East (0.55%; 0.44 to 0.68). From 2000 to 2020, the estimated crude prevalence of AMD-related blindness decreased globally by 19.29%, while the prevalence of MSVI increased by 10.08%.
CONCLUSIONS: The estimated increase in the number of individuals with AMD-related blindness and MSVI globally urges the creation of novel treatment modalities and the expansion of rehabilitation services.

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INTRODUCTION

Age-related macular degeneration (AMD) is an acquired, degenerative disorder affecting the macula of older adults [1]. The disease is characterised by an array of features in the macular region, such as drusen (deposits that accumulate between the retinal pigment epithelium -RPE- and the Bruch's membrane), RPE cell depigmentation and proliferation, detachment of the RPE, loss of RPE cells and subretinal choroidal neovascularization [1], is categorized into a non-exudative (or "dry") stage and an exudative (or 'wet') stage. Older age, genetic background, family history, European ancestry, and smoking are considered risk factors for the development and progression of the disease [1].

Significant progress has been made in the treatment of the exudative stage of AMD over the last two decades due to the clinical introduction of intraocular injections of anti-vascular endothelial growth factor (VEGF) drugs [2]. Still, AMD has remained a challenge in global eye healthcare due to its relatively high prevalence in older adults and since most cases of the non-exudative stage, the most common form of AMD, cannot effectively be treated yet. AMD has a high importance as a cause of vision impairment and blindness [3], with sequels such as a reduction of the quality of life [4] and economic impact due to loss of productivity [5].

Although AMD-related blindness is a growing global problem due to population aging, its importance is not homogeneous across world regions. In countries with a higher cataract surgical coverage (usually high-income countries), chronic eye conditions such as AMD account for a relatively more significant proportion of blindness [6].

To contribute to the World Health Organization (WHO) World Report on Vision [7] and the implementation of the recommendations generated [8], The Vision Loss Expert Group (VLEG) of the Global Burden of Disease (GBD) Study calculated estimates of the leading causes of vision impairment and blindness, like AMD [3, 9–11]. Such estimates are essential for monitoring, action planning, and advocacy [6]. In this systematic review, we aimed to update estimates of the global vision loss burden due to AMD, presenting estimates for 2020, temporal changes, and distribution by sex and world region.

METHODS

The data was arranged following a review of published population-focused studies on vision impairment and blindness by the VLEG. This review included studies published between Jan 1, 1980, and Oct 1, 2018, incorporating grey literature. After title and abstract screening, abstracts were sent to regional VLEG committees, where at least three ophthalmic epidemiologists independently scored studies for quality against inclusion criteria. They were asked to review and rate each study with a score of 1 (clearly a representative population-based study using a comprehensive

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methodology), 2 (questionable representativeness and/or inadequately described or low-quality methodology), or 3 (definitely neither, warranting exclusion). Reviewers were asked to give their rationale for a rating of 2 or 3. A threshold for inclusion/exclusion was decided based on the average score of each study. Relevant studies from this review were combined with data from Rapid Assessment of Avoidable Blindness (RAAB) studies by VLEG. Data was also sourced from the US National Health and Nutrition Examination Survey 2007-2008 and the WHO Study on Global Ageing and Adult Health (SAGE Wave 1 2007-2010), contributed by the GBD team. A total of 252 studies contributed data on age-related macular degeneration and are grouped by geographical region in the Appendix. More detailed methods are published elsewhere [3, 10] and discussed in brief as follows.

VLEG pinpointed 137 studies and pulled data from 70 studies in their 2010 review and 67 additional studies in their 2014–18 review. Most of these studies were national or subnational cross-sectional surveys. VLEG also arranged to produce 5-year age-segregated RAAB data from the RAAB repository (www.raab.world). To qualify, studies met specific criteria: vision acuity data must be gathered through a test chart compatible with the Snellen scale, and the sample must represent the population. Subjective reports of vision loss were not included. The criteria for vision loss was defined by the International Classification of Diseases 11th edition as employed by WHO. It was based on the vision in the better eye upon presentation. Moderate vision loss was defined as a visual acuity of 6/60 or better but less than 6/18, severe vision loss as a visual acuity of 3/60 or better but less than 6/60, and blindness as a visual acuity of less than 3/60 or less than 10° visual field around central fixation (although the visual field definition was rarely used in population-based eye surveys).

We split the original data into several datasets, creating separate envelopes for each degree of vision loss (mild, moderate, and severe) and blindness. This data was then fed into a meta-regression tool designed by the Institute for Health Metrics and Evaluation (IHME) known as MR-BRT (meta-regression; Bayesian; regularised; trimmed) [12]. The benchmark for each severity level was presenting vision impairment.

When possible, data about uncorrected refractive errors were pulled straight from the data sources. If not, they were calculated by subtracting the best-corrected vision impairment from presenting vision impairment prevalence at each severity level. Other causes were factored into the best-corrected estimates for each level of vision impairment.

Our models for distance vision impairment and blindness were based on the most commonly reported causes found in the literature, and the minimum age for inclusion of data on AMD was 45 years. We created estimates of MSVI and blindness specific to location, year, age, and sex using Disease Modelling Meta-Regression (Dismod-MR) 2.1 [13]. Its data processing steps have been outlined elsewhere [3]. Briefly, Dismod-MR 2.1 models were run for all vision impairment by severity (moderate, severe, blindness) regardless of cause and, separately, for MSVI and blindness due to each modelled cause of vision impairment. Then, models of MSVI due to specific causes were split into moderate and severe estimates using the ratio of overall prevalence in the all-cause moderate presenting vision impairment and severe presenting vision impairment models. Next, prevalence estimates for all causes by severity were scaled to the models of all-cause prevalence by severity. This produced final estimates by age, sex, year, and location for each cause of vision impairment by severity. We age-standardised our estimates using the GBD standard population [14]. Hierarchical logistic regressions with mixed effects were applied using the R package RStanArm to assess the prevalence of blindness independently and MSVI across various country-age groups, structured within a five-tiered hierarchy. The blindness model was based on 270 studies, while the MSVI model included 245 studies, acknowledging that a single study might span multiple countries or years. This framework spanned 187 countries, grouped into 21 subregions and further into seven broader regions, culminating in an analysis of global-level effects. Data on blindness and MSVI due to AMD were presented by seven super-regions (Southeast Asia/East Asia/Oceania, Central Europe/Eastern Europe/Central Asia, High-income, Latin America and Caribbean, North Africa, and the Middle East, South Asia, and Sub-Saharan Africa) and globally. Data on other causes of vision impairment and blindness will be presented in separate publications.

RESULTS

In 2020, 1.85 million (all ages; 95% uncertainty interval (UI): 1.35 to 2.43 million) people were estimated to be blind due to AMD, with 664,000 (472,000 to 894,000) males and 1,185,000 (876,000 to 1,545,000) females affected (Tables 1, 2). AMD-related MSVI affected 6.23 million (95%UI: 5.04 to 7.58) individuals worldwide, among them 2,747,000 (2,207,000 to 3,377,000) males and 2,743,000 (2,202,000 to 3,371,000) females (Tables 1, 3).

High-income countries (0.60 million people; 0.46 to 0.77) accounted for the highest number of individuals with AMD-related blindness per world region, whereas the lowest number of individuals with presenting blindness due to AMD per world region was found in Central Europe / Eastern Europe / Central Asia combined (0.06 million people; 0.04 to 0.08) and Latin America and the Caribbean (0.07 million people; 0.50 to 0.1) (Table 1).

The crude prevalence of AMD-related blindness in those aged ≥ 50 years in 2020 was estimated as 0.10% (0.07 to 0.12) globally. The regions with the highest prevalence of blindness due to AMD were North Africa/Middle East, 0.22% (0.16 to 0.30) and Sub-Saharan Africa, 0.15% (0.11 to 0.20) (Supplementary Fig. 1). Age-standardized estimated prevalence of MSVI due to AMD in those aged ≥ 50 years in 2020 was 0.34% (0.27 to 0.41) globally, and the regions with the highest prevalence of MSVI due to AMD were also North Africa/Middle East (0.55%; 0.44 to 0.68) and Sub-Saharan Africa (0.50%; 0.40 to 0.61) (Table 1).

From 2000 to 2020, the estimated crude prevalence of blindness due to AMD decreased globally by 19.3% (19.6 to 19.0%), with a wide variety between regions, from -32.6% (-32.9 to -32.3%) in Southeast Asia, East Asia, and Oceania to +1.3% (0.9 to 1.7%) in Latin America and the Caribbean, the only region which showed an increase (Table 4). On the other hand, over the same period, the estimated crude prevalence of MSVI due to AMD increased globally by 10.1% (9.8 to 10.3%), with changes varying from −9.3% (−9.5 to −9.0%) in North Africa and Middle East to +7.2% (6.9 to 7.5%) in Southeast Asia, East Asia, and Oceania (Table 5). Figure 2 shows the estimated crude prevalence of MSVI due to AMD in 2020.

DISCUSSION

In 2020, AMD ranked second among the causes of irreversible blindness globally [3]. From 2000 to 2020, there was an estimated decrease in the prevalence of AMD-related blindness in all regions except Latin America and the Caribbean and an increase in the prevalence of AMD-related MSVI in all regions except North Africa, Middle East, and Sub-Saharan Africa, with wide discrepancies between regions. The global population growth and increasing life expectancy can explain the increasing number of individuals with AMD-related vision loss. Yet, the divergences in AMD prevalence and vision impairment necessitate extensive research to unravel the complex interplay of genetic factors, lifestyle choices, and access to healthcare services.

The prevalence of blindness and MSVI due to AMD is higher in older age groups, and countries with a growing life expectancy should take this information into account for better health service planning. But considering the current barriers to accessing AMD treatment and rehabilitation services in many regions, even a minor increase in absolute numbers might put pressure on the already overloaded public health systems. The reduced availability of ophthalmic services during the Covid-19 pandemic [15] and the economic impact that might be seen during the post-pandemic years can increase barriers in managing chronic eye conditions like AMD.

Dealing with AMD from a public health perspective is a complex task. First, although a trained ophthalmologist efficiently performs diagnosis, the availability and distribution of eye care professionals remain an issue in many parts of the world [16]. If well connected to public health initiatives, the growing use of telemedicine and artificial intelligence in eye care will likely reduce the percentage of those with undiagnosed AMD. Second, its first-line treatment, intravitreal anti-VEGF injection, can be expensive; its effect lasts only a few months and is only indicated for the wet form and, more recently, geographic atrophy [17]. And finally, those with MSVI and blindness due to AMD would benefit from rehabilitation services,

Table 1. Number of people (mean [95% UI]) with blindness (presenting visual acuity <3/60) or MSVI (presenting visual acuity <6/18, ≥3/60) due to AMD, the age-standardized prevalence (%) in people of all ages and aged ≥50 years (mean [95% UI]), and the percentage of all blindness or MSVI attributed to AMD (95% UI) in world regions in 2020.

World Region	2020, total population ('000 s) (all ages)	2020, total population ('000 s) (aged ≥ 50 years)	Blindness due to AMD in 2020				MSVI due to AMD in 2020			
			Number of people ('000 s) with blindness in 2020 (all ages)	Number of people ('000 s) with blindness in 2020 (aged ≥ 50 years)	Age-standardized prevalence of AMD blindness in 2020 (aged ≥ 50 years)	Percentage contribution by AMD to all causes of blindness in 2020 (aged ≥50 years)	Number of people ('000 s) with MSVI in 2020 (all ages)	Number of people ('000 s) with MSVI in 2020 (aged ≥ 50 years)	Age-standardized prevalence of AMD MSVI in 2020 (aged ≥ 50 years)	Percentage contribution by AMD to all causes of MSVI in 2020 (aged ≥50 years)
Global	7,890,000	1,898,000	1850 (1349–2434)	1841 (1340–2423)	0.10 (0.08–0.14)	4.30 (3.14–5.66)	6231 (5042–7587)	6221 (5029–7573)	0.34 (0.27–0.41)	2.11 (1.71–2.57)
Southeast Asia, East Asia, and Oceania	2,192,710	664,195	495 (342–680)	493 (339–673)	0.08 (0.06–0.11)	3.29 (2.27–4.51)	2762 (2211–3379)	2758 (2209–3376)	0.46 (0.37–0.56)	3.33 (2.66–4.07)
Central Europe, Eastern Europe, and Central Asia	417,291	137,758	62 (43–84)	62 (43–83)	0.04 (0.03–0.06)	4.43 (3.07–5.95)	228 (182–282)	227 (182–282)	0.16 (0.13–0.19)	1.27 (1.01–1.57)
High-income	1,087,856	423,872	596 (456–769)	595 (455–768)	0.11 (0.08–0.14)	19.82 (15.17–25.60)	739 (584–917)	738 (584–917)	0.14 (0.11–0.17)	2.38 (1.88–2.95)
Latin America and Caribbean	601,551	136,738	71 (49–97)	71 (49–97)	0.05 (0.04–0.07)	1.95 (1.35–2.66)	333 (270–407)	332 (269–406)	0.25 (0.21–0.31)	1.36 (1.10–1.67)
North Africa and Middle East	631,727	105,278	195 (136–264)	194 (136–264)	0.22 (0.16–0.30)	6.31 (4.43–8.55)	493 (391–614)	492 (390–613)	0.55 (0.44–0.68)	2.26 (1.79–2.81)
South Asia	1,841,435	321,354	297 (200–423)	295 (199–421)	0.10 (0.07–0.15)	2.49 (1.68–3.55)	1220 (972–1510)	1217 (968–1507)	0.42 (0.34–0.51)	1.27 (1.01–1.57)
Sub-Saharan Africa	1,114,806	108,805	131 (92–178)	131 (91–178)	0.15 (0.11–0.20)	2.58 (1.81–3.51)	454 (360–565)	452 (358–564)	0.50 (0.40–0.61)	2.22 (1.76–2.77)

and their availability is also scarce [18]. The integration of education for those at a higher risk for developing AMD diagnosis, treatment, and rehabilitation, using a people-centred approach [7], could reduce the burden of AMD. Ideally, addressing AMD from a public health perspective demands a life course, people-centered approach recognizing the importance of early interventions and managing AMD co-morbidities. Preventative measures, such as anti-smoking campaigns targeted at adolescents and adults, could significantly impact the prevalence of AMD in the older population, given the well-established link between smoking and the progression of AMD.

In the healthcare continuum, involving primary care providers (PCPs) in AMD care could alleviate some current issues, especially in low-resource scenarios. They can serve as the initial touchpoint for patient education and promote awareness of AMD risk factors and early symptoms. For example, PCPs could play a crucial role in guiding patients through lifestyle changes that mitigate the risk of AMD, such as advocating smoking cessation, reinforcing the need for regular check-ups for those with diagnosed AMD or at a higher risk of having it, and potentially managing portable fundus cameras that could send images for remote ophthalmologists, or reinforcing the importance of compliance with follow-ups and treatment, and monitoring co-morbidities.

In addition to preventive care, there is a critical need to address the broader spectrum of challenges faced by individuals with AMD, particularly as they often experience other ocular and extraocular health issues. For instance, hearing impairment is a common co-morbidity that can compound the difficulties faced by those with vision loss, intensifying feelings of isolation and hindering effective communication. Moreover, individuals with vision impairment are at an increased risk of falls, which can lead to further physical injury and a decline in their quality of life [6]. Depression is another concern, with the loss of visual function significantly impacting mental health and the overall well-being of affected individuals [6].

The non-physician administration of anti-VEGF injections could be explored as a strategy to decentralize treatment, lowering costs and increasing access, while ensuring the safety and efficacy of such approaches through proper training and oversight [19]. Another option to be considered is conducting the injections within the same day of consultation, and same-day bilateral intravitreal injections to avoid multiple visits [20–22].

In the realm of age-related macular degeneration (AMD) treatments, emerging therapies like Pegcetacoplan and gene therapy offer renewed hope. Pegcetacoplan was recently the first drug approved by the Food and Drug Administration to treat geographic atrophy, the advanced stage of dry AMD known for its relentless progression of retinal cell degeneration and consequent permanent vision loss [17]. This novel drug specifically inhibits the C3 component of the immune system's complement pathway, a system implicated in the exacerbation of GA. In a recently published clinical trial, intravitreal injections of Pegcetacoplan could successfully slow GA progression. However, no differences in visual acuity between eyes injected with either Pegcetacoplan or sham injections were found [17].

Gene therapy presents a frontier approach in AMD treatment by introducing genetic material into cells to correct abnormal genes, suppress harmful gene expression, or produce beneficial proteins. This can involve various strategies, from replacing defective genes with functional ones, silencing genes contributing to disease progression to introducing new genes that could stop disease progression or repair damaged retinal tissue. Initial clinical trials have shed light on gene therapy's capacity for offering a sustained therapeutic effect, potentially simplifying treatment regimens by reducing the need for frequent injections, which are the current standard of care for wet AMD. Despite these promising developments, gene therapy for AMD remains in the experimental phase, and ongoing research is focused on

Table 2. Number of males and females with blindness (presenting visual acuity <3/60), and the age-standardized prevalence (% [95% UI]) of blindness due to AMD (all ages and people aged ≥50 years) in 2020.

World Region	Total Population	Total number of AMD blindness and aged-standardized AMD blindness in 2020 (all ages)				Total Number of AMD blindness and aged-standardized AMD blindness in people aged 50+ years in 2020			
	2020, total population ('000 s)	Number of males('000 s) with AMD blindness in 2020	Number of females ('000 s) with AMD blindness in 2020	Age standardized prevalence of blindness in males in 2020	Age standardized prevalence of blindness in females in 2020	Number of males('000 s) (50+ years) with AMD blindness in 2020	Number of females('000 s) (50+ years) with AMD blindness in 2020	Age standardized prevalence of blindness in males in 2020	Age standardized prevalence of blindness in females in 2020
Global	7,890,000	664 (472–894)	1185 (876–1545)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	660 (469–890)	1180 (871–1540)	0.1 (0.1–0.1)	0.1 (0.1–0.2)
Southeast Asia, East Asia, and Oceania	2,192,710	185 (128–257)	309 (214–424)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	184 (126–254)	307 (212–422)	0.1 (0.1–0.1)	0.1 (0.1–0.1)
Central Europe, Eastern Europe, and Central Asia	417,291	20 (14–28)	42 (29–56)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	20 (14–27)	41 (29–56)	0.0 (0.0–0.0)	0.1 (0.0–0.1)
Highincome	1,087,856	168 (124–222)	427 (327–543)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	168 (124–221)	427 (327–542)	0.1 (0.1–0.1)	0.1 (0.1–0.2)
Latin America and Caribbean	601,551	23 (15–32)	48 (33–65)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	23 (15–32)	47 (33–65)	0.0 (0.0–0.1)	0.1 (0.1–0.1)
North Africa and Middle East	631,727	77 (53–105)	117 (81–159)	0.0 (0.0–0.1)	0.1 (0.0–0.1)	77 (53–104)	116 (81–158)	0.2 (0.1–0.3)	0.3 (0.2–0.4)
South Asia	1,841,435	142 (95–199)	155 (105–221)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	141 (94–198)	154 (104–219)	0.1 (0.1–0.2)	0.1 (0.1–0.2)
Sub-Saharan Africa	1,114,806	46 (32–62)	85 (59–115)	0.0 (0.0–0.0)	0.0 (0.0–0.1)	45 (32–62)	84 (59–114)	0.1 (0.1–0.2)	0.2 (0.1–0.2)

Table 3. Number of males and females with AMD MSVI, and the age-standardized prevalence (% [95% uncertainty intervals (UIs)]) of AMD MSVI (all ages and people aged ≥50 years) in 2020.

World Region	Total Population	Total number of AMD MSVI and aged-standardized AMD MSVI in 2020 (all ages)				Total number of AMD MSVI and aged-standardized AMD MSVI in people aged 50+ years in 2020			
	2020, total population ('000 s)	Number of males('000 s) with AMD MSVI in 2020	Number of females ('000 s) with AMD MSVI in 2020	Age standardized prevalence of MSVI in males in 2020	Age standardized prevalence of MSVI in females in 2020	Number of females('000 s) (50+ years) with AMD MSVI in 2020	Number of females('000 s) (50+ years) with AMD MSVI in 2020	Age standardized prevalence of MSVI in males in 2020	Age standardized prevalence of MSVI in females in 2020
Global	7,890,000	2747 (2207–3377)	3483 (2823–4236)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	2743 (2202–3371)	3478 (2816–4226)	0.3 (0.3–0.4)	0.4 (0.3–0.4)
Southeast Asia, East Asia, and Oceania	2,192,710	1231 (982–1501)	1530 (1224–1865)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	1230 (981–1500)	1528 (1223–1862)	0.4 (0.4–0.5)	0.5 (0.4–0.6)
Central Europe, Eastern Europe, and Central Asia	417,291	75 (60–94)	152 (121–188)	0.0 (0.0–0.0)	0.0 (0.0–0.1)	75 (60–94)	152 (121–188)	0.1 (0.1–0.2)	0.2 (0.1–0.2)
High–income	1,087,856	294 (232–363)	445 (350–554)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	293 (232–362)	444 (350–553)	0.1 (0.1–0.2)	0.2 (0.1–0.2)
Latin America and Caribbean	601,551	137 (110–168)	196 (159–240)	0.1 (0.0–0.1)	0.1 (0.1–0.1)	136 (109–168)	195 (158–239)	0.2 (0.2–0.3)	0.3 (0.2–0.3)
North Africa and Middle East	631,727	234 (185–295)	258 (204–320)	0.1 (0.1–0.1)	0.1 (0.1–0.2)	234 (185–295)	258 (204–320)	0.5 (0.4–0.7)	0.6 (0.5–0.7)
South Asia	1,841,435	571 (453–704)	649 (518–802)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	570 (452–703)	647 (517–800)	0.4 (0.3–0.5)	0.4 (0.4–0.5)
SubSaharan Africa	1,114,806	202 (160–253)	251 (198–313)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	202 (160–252)	250 (198–313)	0.5 (0.4–0.6)	0.5 (0.4–0.6)

Table 4. Percentage change in crude prevalence, number of people affected, and age-standardised prevalence of AMD blindness (presenting visual acuity <3/60) in adults age 50 years and older between 2000 and 2020 by world super region.

	Crude Prevalence			Number of Cases ('000 s)			Age standardized prevalence		
World Region	**Male (%, 95% UI)**	**Female (%, 95% UI)**	**Both (%, 95% UI)**	**Male (%, 95% UI)**	**Female (%, 95% UI)**	**Both (%, 95% UI)**	**Male (%, 95% UI)**	**Female (%, 95% UI)**	**Both (%, 95% UI)**
Global	−18.8 (−19.1 to −18.5)	−19.5 (−19.8 to −19.3)	−19.3 (−19.6 to −19.0)	43.3 (42.7 to 43.8)	41.4 (40.9 to 41.9)	42.1 (41.6 to 42.5)	−22.2 (−22.5 to −21.9)	−21.7 (−22.0 to −21.5)	−22.6 (−22.8 to −22.3)
High-income	3.9 (3.5 to 4.2)	−4.2 (−4.5 to −3.9)	−3.1 (−3.4 to −2.8)	52.8 (52.3 to 53.3)	33.5 (33.1 to 33.8)	38.4 (38.0 to 38.8)	−12.8 (−13.1 to −12.5)	−14.4 (−14.7 to −14.2)	−15.8 (−16.0 to −15.5)
Central Europe, Eastern Europe, and Central Asia	1.9 (1.5 to 2.3)	−10.0 (−10.4 to −9.7)	−6.9 (−7.3 to −6.6)	32.2 (31.7 to 32.7)	11.3 (10.9 to 11.8)	17.4 (17.0 to 17.9)	−5.0 (−5.3 to −4.6)	−15.1 (−15.4 to −14.7)	−12.7 (−13.0 to −12.3)
Latin America and Caribbean	−2.6 (−3.0 to −2.2)	2.5 (2.1 to 2.9)	1.3 (0.9 to 1.7)	92.0 (91.2 to 92.8)	109.9 (109.0 to 110.7)	103.6 (102.8 to104.5)	−6.6 (−7.0 to −6.3)	−3.7 (−4.1 to −3.3)	−4.1 (−4.5 to −3.7)
North Africa and Middle East	−23.8 (−24.1 to −23.5)	−18.4 (−18.7 to −18.0)	−20.6 (−20.9 to −20.3)	58.4 (57.8 to 59.0)	69.9 (69.2 to 70.6)	65.1 (64.5 to 65.8)	−17.4 (−17.7 to −17.1)	−16.4 (−16.7 to −16.1)	−16.4 (−16.7 to −16.0)
South Asia	−28.3 (−28.7 to −28.0)	−32.7 (−32.9 to −32.4)	−30.5 (−30.8 to −30.2)	35.2 (34.7 to 35.8)	36.2 (35.6 to 36.8)	35.7 (35.1 to 36.3)	−28.5 (−28.8 to −28.2)	−34.1 (−34.4 to −33.9)	−31.4 (−31.7 to −31.1)
Southeast Asia, East Asia, and Oceania	−33.8 (−34.1 to −33.5)	−32.2 (−32.5 to −31.9)	−32.6 (−32.9 to −32.3)	30.9 (30.4 to 31.4)	38.3 (37.8 to 38.9)	35.5 (34.9 to 36.0)	−36.3 (−36.5 to −36.0)	−32.5 (−32.8 to −32.3)	−34.1 (−34.3 to −33.8)
Sub-Saharan Africa	−11.9 (−12.3 to −11.6)	−12.4 (−12.7 to −12.0)	−11.2 (−11.6 to −10.9)	55.8 (55.2 to 56.4)	70.0 (69.3 to 70.6)	64.7 (64.1 to 65.4)	−7.4 (−7.8 to −7.0)	−6.8 (−7.2 to −6.5)	−6.6 (−7.0 to −6.3)

Table 5. Percentage change in crude prevalence, number of people affected, and age-standardised prevalence of AMD MSVI (presenting visual acuity <6/18, ≥3/60) and in adults aged 50 years and older between 2000 and 2020 by world super region.

	Crude Prevalence			Number of Cases ('000 s)			Age standardized prevalence		
World Region	**Male (%, 95% UI)**	**Female (%, 95% UI)**	**Both (%, 95% UI)**	**Male (%, 95% UI)**	**Female (%, 95% UI)**	**Both (%, 95% UI)**	**Male (%, 95% UI)**	**Female (%, 95% UI)**	**Both (%, 95% UI)**
Global	9.8 (9.6 to 10.1)	10.3 (10.0 to 10.6)	10.1 (9.8 to 10.3)	93.7 (93.2 to 94.2)	93.8 (93.3 to 94.2)	93.7 (93.3 to 94.2)	6.5 (6.3 to 6.8)	10.5 (10.2 to 10.8)	8.7 (8.4 to 8.9)
High-income	12.9 (12.6 to 13.2)	2.1 (1.8 to 2.4)	5.6 (5.3 to 5.9)	66.1 (65.7 to 66.6)	42.2 (41.8 to 42.6)	50.8 (50.4 to 51.2)	−3.2 (−3.4 to −2.9)	−5.0 (−5.2 to −4.7)	−4.8 (−5.0 to −4.6)
Central Europe, Eastern Europe, and Central Asia	6.9 (6.6 to 7.2)	7.1 (6.8 to 7.4)	6.6 (6.3 to 6.9)	38.7 (38.3 to 39.1)	32.5 (32.2t o 32.9)	34.5 (34.2 to 34.9)	−0.0 (−0.3 to 0.2)	4.3 (4.0 to 4.6)	2.6 (2.4 to 2.9)
Latin America and Caribbean	3.7 (3.4 to 3.9)	7.8 (7.6 to 8.1)	6.3 (6.0 to 6.5)	104.3 (103.8 to 104.8)	120.7 (120.2 to 121.3)	113.7 (113.2 to 114.2)	0.0 (−0.2 to 0.3)	3.9 (3.7 to 4.2)	2.4 (2.1 t o2.6)
North Africa and Middle East	−11.9 (−12.2 to −11.7)	−6.7 (−7.0 to −6.5)	−9.3 (−9.5 to −9.0)	83.0 (82.5 to 83.5)	94.1 (93.6 to 94.6)	88.6 (88.1 to 89.1)	−4.6 (−4.8 to−4.3)	−3.2 (−3.4 to −2.9)	−3.8 (−4.1 to −3.6)
South Asia	5.8 (5.5 to 6.0)	2.1 (1.8 to 2.3)	4.0 (3.8 to 4.3)	99.6 (99.1 to 100.1)	106.4 (105.8 to 106.9)	103.1 (102.6 to 103.7)	0.4 (0.1 to 0.6)	−3.2 (−3.5 to −3.0)	−1.5 (−1.7 to −1.2)
Southeast Asia, East Asia, and Oceania	7.4 (7.2 to 7.7)	6.8 (6.5 to 7.0)	7.2 (6.9 to 7.5)	112.5 (111.9 to 113.0)	117.8 (117.2 to 118.3)	115.4 (114.8 to 115.9)	5.7 (5.4 to 5.9)	7.3 (7.0 to 7.5)	6.4 (6.2 to 6.7)
Sub-Saharan Africa	−8.4 (−8.7 to −8.2)	−0.5 (−0.8 to −0.2)	−4.2 (−4.4 to −3.9)	62.0 (61.6 to 62.4)	93.1 (92.5 to 93.6)	77.9 (77.4 to 78.3)	−2.5 (−2.7 to −2.3)	4.1 (3.8 to 4.4)	0.7 (0.5 to 1.0)

overcoming hurdles related to precise delivery methods, ensuring lasting benefits, and establishing safety protocols [23].

Strengths of the present study included the number of population-based data accessed and used, analysis of trends in the causes of blindness and MSVI, incorporation of nonlinear age trends and accounting for data that were not reported by age, and systematic quantitative analysis and reporting of uncertainty. Among the limitations of the present study, we can cite the shortage of data in some countries/regions and information on the burden of AMD in ethnic minorities, such as indigenous people. In some countries, population-based data were either collected sub nationally or more than a decade ago, and estimates may not represent the current reality of a given country. Also, most analysed studies used the Rapid Assessment of Cataract Surgical Services or RAAB methodologies, which may underestimate posterior pole diseases, such as AMD. The evolution of population-based studies, especially those employing advanced imaging technologies like fundus photography, should be elaborated to reflect how these methodologies can refine the accuracy of AMD prevalence studies [24].

Policymakers and the academic community should consider that AMD's social and economic impact is expected to increase substantially due to population growth and ageing [6]. Since population growth rates and life expectancies differ across regions, the burden of AMD will vary globally. Different from cataract and uncorrected refractive errors, the leading causes of blindness and vision impairment, respectively, the burden of AMD can only be alleviated if significant advances in research are made. Developing novel, cost-effective treatment modalities ideally restoring sight, and adopting a life course approach integrating all levels of care is paramount for managing AMD for the next decades.

SUMMARY

What was known before:

- Based on the Global Burden of Disease Study 2010, the Vision Loss Expert Group (VLEG) estimated that there were 2.1 million people blind due to macular diseases.

What this study adds:

- In 2020, 1.85 million (95%UI: 1.35 to 2.43 million) people were blind due to AMD, and another 6.23 million (95%UI: 5.04 to 7.58) presented with MSVI globally.
- From 2000 to 2020, there was a reduction in the crude prevalence of age-related macular degeneration (AMD)-related blindness globally and an increase in AMD-related moderate and severe vision impairment.

DATA AVAILABILITY

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the coordinator of the Vision Loss Expert Group (Professor Rupert Bourne; rb@rupertbourne.co.uk) upon reasonable request. Data are located in controlled access data storage at Anglia Ruskin University.

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Please see Appendix for more detailed information about individual author contributions to the research, divided into the following categories: managing the overall research enterprise; writing the first draft of the manuscript; primary responsibility for applying analytical methods to produce estimates; primary responsibility for seeking, cataloguing, extracting, or cleaning data; designing or coding figures and tables; providing data or critical feedback on data sources; developing methods or computational machinery; providing critical feedback on methods or results; drafting the manuscript or revising it critically for important intellectual content; and managing the estimation or publications process.

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VISION LOSS EXPERT GROUP OF THE GLOBAL BURDEN OF DISEASE STUDY

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