Prevalence and causes of vision loss in China from 1990 to 2019: findings from the Global Burden of Disease Study 2019

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Summary

Background Vision loss is an important public health issue in China, but a detailed understanding of national and regional trends in its prevalence and causes, which could inform health policy, has not been available. This study aimed to assess the prevalence, causes, and regional distribution of vision impairment and blindness in China in 1990 and 2019.

Methods Data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 were used to estimate the prevalence of moderate and severe vision impairment and blindness in China and compare with other Group of 20 (G20) countries. We used GBD methodology to systematically analyse all available demographic and epidemiological data at the provincial level in China. We compared the age-standardised prevalences across provinces, and the changes in proportion of vision loss attributable to various eye diseases in 1990 and 2019. We used two different counterfactual scenarios with respect to population structure and age-specific prevalence to assess the contribution of population growth and ageing to trends in vision loss.

Findings In 2019, the age-standardised prevalence was 2·57% (uncertainty interval [UI] 2·28–2·86) for moderate vision impairment, 0·25% (0·22–0·29) for severe vision impairment, and 0·48% (0·43–0·54) for blindness in China, which were all below the global average, but the prevalence of moderate and severe vision impairment had increased more rapidly than in other G20 countries from 1990 to 2019. The prevalence of vision loss increased with age, and the main causes of vision loss varied across age groups. The leading causes of vision impairment in China were uncorrected refractive error, cataract, and macular degeneration in both 1990 and 2019 in the overall population. From 1990 to 2019, the number of people with moderate vision impairment increased by 133·67% (from 19·65 to 45·92 million), those with severe vision impairment increased by 147·14% (from 1·89 to 4·67 million), and those with blindness increased by 64·35% (from 5·29 to 8·69 million); in each case, 20·16% of the increase could be explained by population growth. The contributions to these changes by population ageing were 87·22% for moderate vision impairment, 116·06% for severe vision impairment, and 99·22% for blindness, and the contributions by age-specific prevalence were 26·29% for moderate vision impairment, 10·91% for severe vision impairment, and –55·04% for blindness. The prevalence and specific causes of vision loss differed across provinces.

Interpretation Although a comprehensive national policy to prevent blindness is in place, public awareness of visual health needs improving, and reducing the prevalence of moderate and severe vision impairment should be prioritised in future work.

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For the Chinese translation of the abstract see Online for appendix 1

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Introduction

Vision loss is an important public health and socioeconomic issue, not only affecting economic and educational opportunities,[1] but also reducing quality of life[2] and increasing the risk of death.[3] According to the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019,[4] about 41·91 million people worldwide were blind, 253·08 million people had moderate vision impairment, and 33·78 million people had severe vision impairment. Data from WHO showed that at least 2·2 billion people were affected by blindness and vision impairment around the world, of whom 1 billion had preventable vision impairment or impairment that had yet to be addressed.[5] Uncorrected refractive error, cataract, age-related macular degeneration, glaucoma, and diabetic retinopathy were the leading causes of vision impairment globally.[5]

As the most populous country in the world, China has an enormous number of people with moderate-to-severe vision impairment or blindness. The years lived with

Research in context

Evidence before this study

We used the key words "vision loss", "vision impairment", "blindness", "low vision", "eye diseases", "ophthalmopathy", "prevalence", and "epidemiology" to search PubMed, Science Direct, Web of Science, and the official websites of the Chinese Government and other institutions for studies and reports on eye diseases and vision health in China published in English or Chinese until Dec 31, 2019. Although many studies had established the prevalence and causes of vision impairment and blindness in China, analysis of their regional distribution across the country was missing. This study systematically analysed the prevalence, trends, and causes of vision loss in China and its regional distribution on the basis of the results of the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019.

Added value of this study

This study comprehensively assessed vision loss in all the provinces across the country, and updated the prevalence estimates of vision impairment and blindness in China in 2019. The GBD 2019 China study incorporated important developments since 2013, including expanded data sources, enhanced data accuracy, and improved model estimates.

Implications of all the available evidence

Our research provides important information for planning of public health services through the analysis of moderate and severe vision impairment and blindness. We showed that the burden of vision loss, especially moderate and severe vision impairment, was heavy in China, and we emphasised that the overall visual health of the Chinese population, not only blindness, deserves attention and intervention efforts. In particular, actions should be taken to prevent and control cataracts in older people and refractive error in adolescents and children.

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disability due to blindness and vision loss rank second out of all health impairments, next only to hearing loss. In the past decade, all levels of the Government in China have been vigorously promoting the prevention and treatment of blindness, establishing and continuously improving the management systems, technical guidance systems, and service systems at the national and provincial level. The main blinding eye diseases have been reported to be effectively contained.[6] However, with population ageing and the rise in obesity and diabetes,[7] vision impairment due to age-related eye diseases, diabetic retinopathy, and other chronic eye diseases could continue to increase.[8]

Previous studies have identified refractive errors and cataract as the leading causes of vision impairment and blindness in China.[9–11] However, to date, a systematic analysis of the prevalence, sociodemographic distribution and causes of vision loss across all provinces of the country has not been available. The purpose of this study was to use GBD 2019 to analyse the prevalence, trends, causes, and regional distribution of moderate and severe vision impairment and blindness in China from 1990 to 2019.

Methods

Overview

We used the data from GBD 2019[4] to carry out this study. GBD 2019 comprehensively analysed the incidence and prevalence of 369 diseases and injuries and 3473 sequelae in 204 countries and territories from 1990 to 2019, using a unified and comparable method. Detailed description of the background and overview of this study can be found in GBD 2019.[4] The relevant indicators of vision impairment and blindness were selected for the current analysis.

Definitions

We used definitions according to the Snellen chart for moderate vision impairment (presenting visual acuity [PVA] ≥6/60 and <6/18), severe vision impairment (PVA ≥3/60 and <6/60), and blindness (PVA <3/60 or visual field around central fixation <10%), based on the better eye and measuring distant vision (apart from the explicit measurement of near vision loss). The diseases covered in this study included uncorrected refractive error, cataract, glaucoma, macular degeneration, diabetic retinopathy, trachoma, and other causes of vision impairment including vitamin A deficiency, retinopathy of prematurity, meningitis, encephalitis, onchocerciasis, and a residual category of other vision loss.

Data sources

The GBD 2019 China Study used data from national censuses, demographic surveys, disease surveillance point systems, and death cause registration report information systems, and systematically reviewed the published literature on the incidence and prevalence of various diseases. The current study then used the GBD methodology to systematically analyse all available demographic and epidemiological data at the provincial level in China, and used DisMod-MR 2.1, a Bayesian meta-regression tool, as the main estimation method to ensure consistency between incidence, prevalence, and mortality for each condition.[4] China's population censuses, done every 10 years (in 1990, 2000, and 2010), were the main source of demographic data by age and gender. In addition, data from the national population sample surveys conducted every 5 years were integrated, and a standardised methodology was used to estimate the population data of the other years. The annual and

single-year age estimates of net migration and population in China were generated using a Bayesian hierarchical cohort component model. Standard population structure used in age standardisation was generated using the estimated age structures of the population for selected national level population with at least 5 million in each group.[12] By systematically processing the data of various surveys and literature abstracts, we obtained the prevalence of each disease type by age group, and we obtained the corresponding number of patients according to the population and demographic composition of China.

Data on overall vision loss came from surveys measuring visual acuity in representative population-based studies, either from publications in peer-reviewed and grey literature or surveys for which we had the unit record data. We excluded studies that did not explicitly state that they measured acuity in both eyes. Only the data filtered by quality control criteria were included for the modelling estimation (appendix 2 pp 2–10). GBD 2019 also added literature sources from a systematic review conducted by collaborators in the Vision Loss Expert Group (VLEG), in which all screened abstracts were sent to regional expert groups to assess the data quality for inclusion. The VLEG was composed of more than 100 optometrists and epidemiologists specialising in vision loss. The VLEG was subdivided into regional expert groups, which then completed an in-depth review of articles within their area of geographical specialisation.

Data analysis

We analysed the prevalence and causes of vision loss in China in 1990 and 2019 and compared them with age-standardised prevalence of moderate vision impairment, severe vision impairment, and blindness in 2019 across the Group of 20 (G20, an international economic cooperation forum composed of 20 major economies, from which we excluded the EU from analysis and compared only 19 countries) and with the global average trends in visual impairment from 1990 to 2019, also from the GBD dataset. We then assessed the age-standardised prevalence of moderate vision impairment, severe vision impairment, and blindness in the Chinese provinces in 1990 and 2019, and the changes in the proportion of vision loss caused by various eye diseases from 1990 to 2019. Age-standardised population in the GBD was calculated using the GBD world population age standard.[12,13]

For each major disease, we estimated the changes in number of patients between 1990 and 2019 attributable to population growth, population structure, and age-specific prevalence.[14,15] The observed change in the total number of patients equalled the net change of these three aspects. The decomposition analysis used two counterfactual scenarios to calculate the number of patients. The first scenario assumed that the total population grew as observed from 1990 to 2019, but that the population structure and age-specific prevalence were the same in 2019 as in 1990. In the second scenario, total population and population structure changed from 1990 to 2019 as observed, but the age-specific disease prevalences were the same in 2019 as in 1990. The difference between the number of patients observed in 1990 and the first scenario was the change in the number of patients exclusively from population growth. The difference between the first and the second scenario was the change in the number of patients exclusively attributable to population ageing. The difference between the second scenario and the number of patients observed in 2019 was the change in the number of patients exclusively attributable to age-specific prevalence.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. All authors had full access to all the data in the study, and the corresponding author had responsibility for the decision to submit for publication.

Results

In 2019, the age-standardised prevalence was 2·57% (uncertainty interval [UI] 2·28–2·86) for moderate vision impairment, 0·25% (0·22–0·29) for severe vision impairment, and 0·48% (0·43–0·54) for blindness in China, which were all lower than the global average (appendix 2 pp 11–12). From 1990 to 2019, the age-standardised prevalence of moderate vision impairment in China increased by 12·17% (95% UI 10·78–13·46), which was the largest increase among the G20 countries and was much higher than the global average of 1·48% (0·95–2·07). Although the age-standardised prevalence of severe vision impairment in South Africa, China, and Australia increased, that in the other G20 countries and the global average decreased. With the exception of the USA, the age-standardised prevalence of blindness in all the other G20 countries declined. China had a decrease in the age-standardised prevalence of blindness of 24·53% (95% UI 21·73–27·07), which was slightly lower than the global average of 27·14% (26·33–27·94) and ranked only 13th among the G20 (appendix 2 pp 11–12).

In 2019 in China, 45·92 million (95% UI 40·35–51·94) people had moderate vision impairment, 4·67 million (4·03–5·41) had severe vision impairment, and 8·69 million (7·54–9·89) had blindness (table 1). The crude prevalence was 3·23% (95% UI 2·84–3·65) for moderate vision impairment, 0·33% (0·28–0·38) for severe vision impairment, and 0·61% (0·53–0·70) for blindness (table 1). The prevalence of moderate vision impairment was substantially higher than that of severe vision impairment and blindness (table 1).

The main causes of moderate vision impairment and severe vision impairment in 2019 were uncorrected refractive error, cataract, and macular degeneration. The main causes of blindness were cataract, uncorrected refractive error, and glaucoma. Compared with 1990, the leading

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	Moderate vision impairment		Severe vision impairment		Blindness	
	Prevalence, % (95% UI)	Number, millions (95% UI)	Prevalence, % (95% UI)	Number, millions (95% UI)	Prevalence, % (95% UI)	Number, millions (95% UI)
All	3·23% (2·84–3·65)	45·92 (40·35–51·94)	0·33% (0·28–0·38)	4·67 (4·03–5·41)	0·61% (0·53–0·70)	8·69 (7·54–9·89)
Males	2·71% (2·38–3·07)	19·61 (17·22–22·26)	0·26% (0·23–0·30)	1·88 (1·63–2·17)	0·54% (0·47–0·62)	3·92 (3·40–4·47)
<5 years	0·58% (0·38–0·76)	0·26 (0·20–0·33)	0·06% (0·04–0·08)	0·02 (0·02–0·03)	0·10% (0·07–0·13)	0·04 (0·03–0·06)
5–14 years	0·96% (0·74–1·22)	0·75 (0·57–0·95)	0·04% (0·03–0·04)	0·03 (0·02–0·03)	0·12% (0·09–0·15)	0·10 (0·07–0·12)
15–49 years	0·81% (0·67–0·95)	3·00 (2·48–3·52)	0·06% (0·05–0·07)	0·21 (0·18–0·25)	0·23% (0·20–0·26)	0·84 (0·72–0·98)
50–69 years	4·65% (3·81–5·74)	8·57 (7·04–10·59)	0·44% (0·36–0·52)	0·81 (0·66–0·97)	0·84% (0·70–1·01)	1·54 (1·28–1·86)
≥70 years	14·30% (11·67–17·18)	7·04 (5·75–8·46)	1·64% (1·33–2·07)	0·81 (0·65–1·02)	2·83% (2·30–3·45)	1·40 (1·13–1·70)
Females	3·77% (3·31–4·26)	26·30 (23·10–29·68)	0·40% (0·35–0·46)	2·79 (2·41–3·23)	0·68% (0·59–0·78)	4·77 (4·14–5·42)
<5 years	0·62% (0·47–0·80)	0·23 (0·18–0·30)	0·04% (0·03–0·05)	0·01 (0·01–0·02)	0·07% (0·05–0·09)	0·03 (0·02–0·04)
5–14 years	1·09% (0·84–1·38)	0·71 (0·55–0·90)	0·03% (0·03–0·04)	0·02 (0·02–0·03)	0·09% (0·07–0·12)	0·06 (0·05–0·08)
15–49 years	0·99% (0·82–1·17)	3·49 (2·87–4·12)	0·07% (0·06–0·08)	0·24 (0·20–0·29)	0·21% (0·18–0·25)	0·74 (0·63–0·86)
50–69 years	5·78% (4·71–7·14)	10·65 (8·69–13·17)	0·59% (0·48–0·71)	1·09 (0·88–1·30)	0·94% (0·78–1·12)	1·73 (1·44–2·06)
≥70 years	19·11% (15·78–22·64)	11·22 (9·26–13·30)	2·42% (1·98–3·04)	1·42 (1·16–1·79)	3·77% (3·11–4·52)	2·21 (1·82–2·66)

95% UI=95% uncertainty interval.

Table 1: **Number and prevalence of vision loss by sex and age in China in 2019**

	Cataract	Uncorrected refractive error	Macular degeneration	Glaucoma	Diabetic retinopathy	Trachoma	Other causes	Total
Moderate vision impairment								
1990	3·47 (17·67%)	13·01 (66·19%)	0·67 (3·39%)	0·21 (1·05%)	0·27 (1·36%)	0·09 (0·43%)	1·95 (9·90%)	19·65 (100%)
2019	13·84 (30·15%)	23·81 (51·87%)	2·09 (4·56%)	0·78 (1·70%)	0·77 (1·68%)	0·04 (0·08%)	4·58 (9·96%)	45·92 (100%)
Severe vision impairment								
1990	0·36 (19·04%)	1·06 (56·00%)	0·06 (3·36%)	0·02 (1·04%)	0·03 (1·59%)	0·01 (0·46%)	0·35 (18·51%)	1·89 (100%)
2019	1·35 (28·93%)	2·32 (49·61%)	0·19 (4·14%)	0·07 (1·53%)	0·09 (1·85%)	<0·01 (0·07%)	0·65 (13·88%)	4·67 (100%)
Blindness								
1990	1·77 (33·57%)	0·75 (14·20%)	0·16 (2·98%)	0·36 (6·75%)	0·06 (1·21%)	0·13 (2·47%)	2·05 (38·81%)	5·29 (100%)
2019	2·95 (33·92%)	1·15 (13·19%)	0·32 (3·64%)	0·48 (5·57%)	0·23 (2·63%)	0·06 (0·69%)	3·51 (40·36%)	8·69 (100%)

Data are n (%), where n is in millions and % is proportion of total annual vision loss cases represented by each cause.

Table 2: **Number (in millions) and proportion of vision loss by cause in China in 1990 and 2019**

causes of vision loss remained the same in 2019 (table 2). From 1990 to 2019, the proportion of people with moderate vision impairment caused by uncorrected refractive error decreased from 66·19% (13·01/19·65 million) to 51·87% (23·81/45·92 million), the proportion caused by macular degeneration increased from 3·39% (0·67/19·65 million) to 4·56 % (2·09/45·92 million), and the proportion caused by cataract increased significantly from 17·67% (3·47/19·65 million) to 30·15% (13·84/45·92 million). For severe vision impairment from 1990 to 2019, the proportion caused by uncorrected refractive error decreased from 56·00% (1·06/1·89 million) to 49·61% (2·32/4·67 million), that by macular degeneration increased from 3·36% (0·06/1·89 million) to 4·14% (0·19/4·67 million), and that by cataracts increased substantially from 19·04% (0·36/1·89 million) to 28·93% (1·35/4·67 million). The proportion of blindness caused by various diseases showed no marked change. It is worth noting that the number of people with vision loss caused by trachoma in China dropped substantially.

The causes of vision loss by age and sex in China in 2019 are in the appendix (appendix 2 pp 13–14). The overall prevalence of vision loss in females was higher than that in males. The number of women older than 70 years with moderate vision impairment, severe vision impairment, and blindness caused by cataracts was about twice as high as the number in men older than 70 years (appendix 2 p 14). The prevalence of vision loss increased with age, and the main causes of vision loss were different in different age groups. The main cause of moderate vision impairment in people younger than 70 years was uncorrected refractive error, whereas the main causes in those older than 70 years were cataract and uncorrected refractive error (appendix 2 p 13). For severe vision impairment, among children younger than 15 years, the main cause was what we labelled other causes; among people aged 15–70 years it was uncorrected refractive error; and among people older than 70 years it was uncorrected refractive error and cataract (appendix 2 pp 13–14). Blindness among people younger than 50 years was mainly caused

	Cataract	Uncorrected refractive error	Macular degeneration	Glaucoma	Diabetic retinopathy	Trachoma	Other causes	Total
Moderate vision impairment								
Observed number of people in 1990	3·47	13·01	0·67	0·21	0·27	0·09	1·95	19·65
Number expected with 2019 population, 1990 population age structure, and 1990 prevalence	4·17	15·63	0·80	0·25	0·32	0·10	2·34	23·61
Number expected with 2019 population, 2019 population age structure, and 1990 prevalence	9·84	23·81	1·77	0·57	0·69	0·21	3·87	40·75
Observed number of people in 2019	13·84	23·81	2·09	0·78	0·77	0·04	4·58	45·92
Percentage change from 1990 due to population growth	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%
Percentage change from 1990 due to population ageing	163·05%	62·86%	144·85%	156·04%	138·58%	125·37%	78·98%	87·22%
Percentage change from 1990 due to change in age-specific prevalence	115·43%	0·07%	49·00%	102·55%	30·55%	–203·56%	36·03%	26·29%
Observed percentage change from 1990 to 2019	298·64%	83·09%	214·02%	278·75%	189·29%	–58·03%	135·18%	133·67%
Severe vision impairment								
Observed number of people in 1990	0·36	1·06	0·06	0·02	0·03	0·01	0·35	1·89
Number expected with 2019 population, 1990 population age structure, and 1990 prevalence	0·43	1·27	0·08	0·02	0·04	0·01	0·42	2·27
Number expected with 2019 population, 2019 population age structure, and 1990 prevalence	1·03	2·52	0·17	0·06	0·08	0·02	0·58	4·46
Observed number of people in 2019	1·35	2·32	0·19	0·07	0·09	<0·01	0·65	4·67
Percentage change from 1990 due to population growth	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%
Percentage change from 1990 due to population ageing	167·24%	118·44%	150·79%	163·77%	136·86%	120·43%	45·34%	116·06%
Percentage change from 1990 due to change in age-specific prevalence	88·13%	–19·69%	33·25%	80·52%	29·75%	–201·73%	19·76%	10·91%
Observed percentage change from 1990 to 2019	275·53%	118·92%	204·20%	264·45%	186·78%	–61·14%	85·26%	147·14%
Blindness								
Observed number of people in 1990	1·77	0·75	0·16	0·36	0·06	0·13	2·05	5·29
Number expected with 2019 population, 1990 population age structure, and 1990 prevalence	2·13	0·90	0·19	0·43	0·08	0·16	2·47	6·35
Number expected with 2019 population, 2019 population age structure, and 1990 prevalence	4·60	1·45	0·42	1·00	0·15	0·32	3·67	11·60
Observed number of people in 2019	2·95	1·15	0·32	0·48	0·23	0·06	3·51	8·69
Percentage change from 1990 due to population growth	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%	20·16%
Percentage change from 1990 due to population ageing	138·77%	72·62%	146·62%	159·60%	108·82%	127·23%	58·53%	99·22%
Percentage change from 1990 due to change in age-specific prevalence	–92·90%	–40·19%	–66·01%	–144·08%	126·53%	–201·64%	–7·77%	–55·04%
Observed percentage change from 1990 to 2019	66·04%	52·59%	100·77%	35·69%	255·51%	–54·25%	70·92%	64·35%

Data are n or %, where n is in millions. Table shows both modelled values under hypothetical counterfactual scenarios and actual values observed in the real world.

Table 3: **Attribution analysis of changes in the number of people (in millions) with vision loss by cause in China in 1990 and 2019**

by other causes, whereas among those older than 50 years it was mainly caused by cataract and other causes (appendix 2 p 14).

The changes in the number of people with moderate vision impairment, severe vision impairment, and blindness across disease types was, by varying degrees, accounted for by population growth, population ageing, and changes in age-specific prevalence (table 3). Population ageing was the most important factor in the increase in moderate vision impairment, severe vision impairment, and blindness. From 1990 to 2019, the number of people with moderate vision impairment increased by 133·67% (from 19·65 to 45·92 million), of which 87·22% was due to population ageing, 26·29% was due to the increase in age-specific prevalence, and 20·16% was due to population growth (table 3). The number of people with severe vision impairment increased by 147·14% (from 1·89 to 4·67 million), of which 116·06% was due to population ageing, 20·16% was due to population growth, and 10·91% was due to the increase in age-specific prevalence. The number of people with blindness increased by 64·35% (from 5·29 to 8·69 million), of which 99·22% was due to population ageing, and 20·16% was due to population growth, although there was a 55·04% decrease in blindness attributable to age-specific prevalence. Among the diseases leading to moderate vision impairment and severe vision impairment, cataract and glaucoma had the largest increase. Except for uncorrected refractive error and trachoma, changes in age-specific prevalence of all other diseases leading to moderate vision impairment and severe vision impairment contributed positively to the increase in the number of patients. Among the diseases leading to blindness, only the age-specific

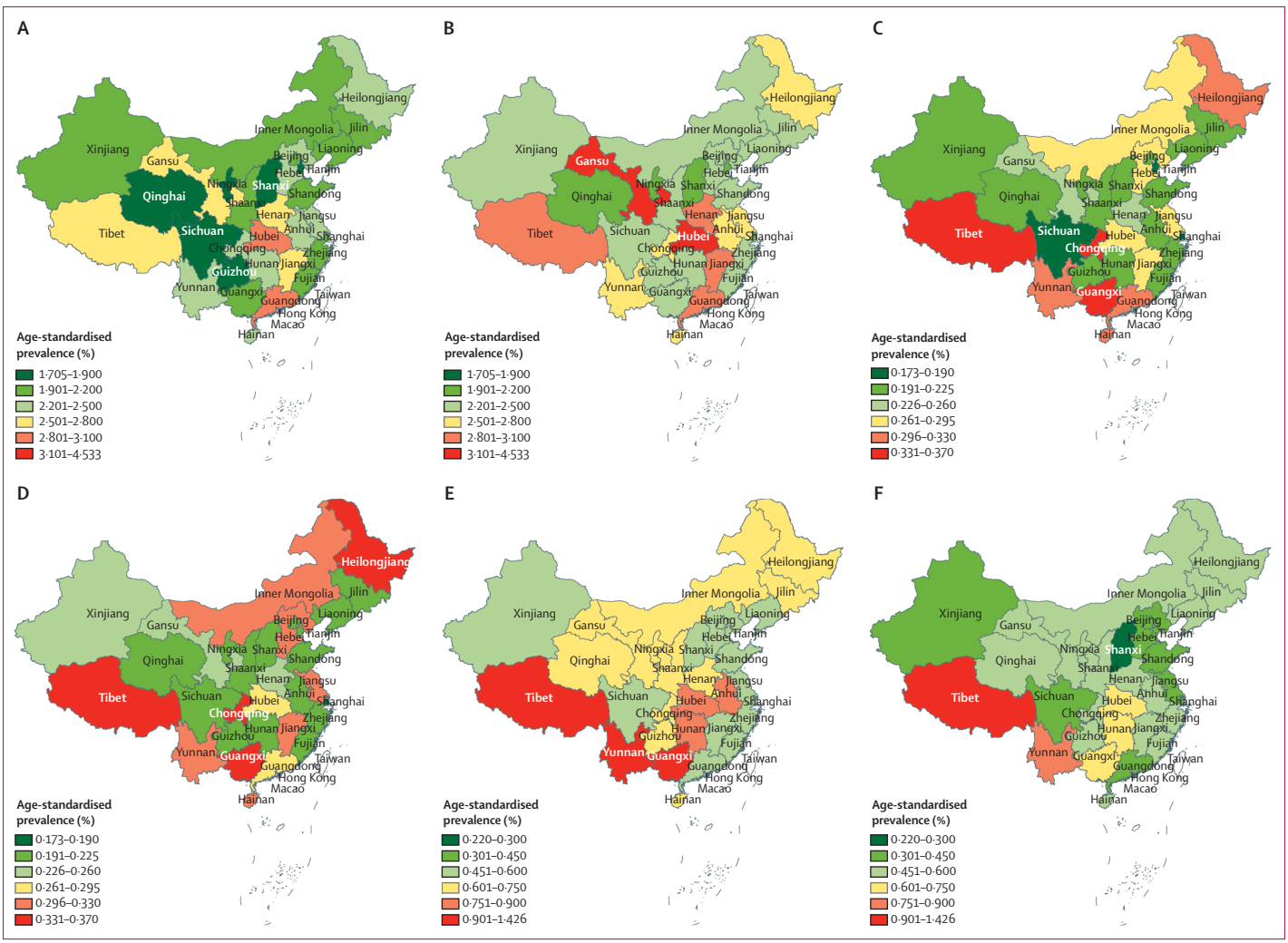

Figure: **Age-standardised prevalence of moderate vision impairment, severe vision impairment, and blindness in China in 1990 and 2019**
(A) Moderate vision impairment in 1990. (B) Moderate vision impairment in 2019. (C) Severe vision impairment in 1990. (D) Severe vision impairment in 2019. (E) Blindness in 1990. (F) Blindness in 2019.

prevalence of diabetic retinopathy had a positive effect on the increase in the number of people with blindness, and this factor contributed more to the increase in the number of people with blindness than did population ageing. The decline in age-specific prevalence alleviated the growth rate of blindness, but it was not enough to offset the effect of population ageing and population growth on the increase in the number of people with blindness.

A significant upward trend was observed in the age-standardised prevalence of moderate vision impairment between 1990 and 2019 in all provinces of China (figure A, B). In 2019, Hong Kong, Gansu, and Hubei had the highest prevalence (in order of prevalence), followed by Guangdong, Henan, Tibet, and Jiangxi. The age-standardised prevalence in Shanghai, Shanxi, Tianjin, Ningxia, and Qinghai was relatively low. For severe vision impairment, age-standardised prevalence also rose in most provinces (figure C, D), with that in 2019 in Tibet, Chongqing, Guangxi, and Heilongjiang being the highest, and that in Shanghai being the lowest. The age-standardised prevalence in the eastern and central regions were lower than that in other regions. By contrast to the increase in moderate vision impairment, the age-standardised prevalence of blindness in all provinces decreased from 1990 to 2019 (figure E, F). Hong Kong, Shanxi, and Macao had a large decline and remained with the lowest prevalences in the country. The age-standardised prevalence of blindness in Tibet and Yunnan remained high.

The specific causes of vision loss in all provinces of China in 2019 are in the appendix (appendix 2 pp 15–20). More than 75% of moderate vision impairment in all provinces except Sichuan was caused by cataract and uncorrected refractive error. Hong Kong had the highest prevalence of moderate vision impairment caused by cataracts at 2711·63 per 100 000 people, which was more

than double that of the next highest region, Heilongjiang (1373·93 per 100 000 people). The provinces with the highest prevalence of moderate vision impairment caused by uncorrected refractive error were Hong Kong, Hubei, and Chongqing. Cataracts and uncorrected refractive errors accounted for more than 75% of all causes of severe vision impairment in most provinces, except Sichuan, Hainan, Inner Mongolia, and Yunnan. Jiangsu and Heilongjiang had the highest prevalence of severe vision impairment caused by cataract, whereas Chongqing, Jiangsu, and Hong Kong had the highest prevalence of severe vision impairment caused by uncorrected refractive error. Hubei, Heilongjiang, and Hunan had the highest prevalence of blindness caused by cataracts, whereas Inner Mongolia, Chongqing, and Tibet had the highest prevalence of blindness caused by uncorrected refractive error.

Discussion

This study clarified the prevalence, causes, and regional distribution of vision loss in China. Although the prevalence of vision loss in China was lower than the global average, the increase in moderate vision impairment, severe vision impairment, and blindness from 1990 to 2019 was still concerning. During this time, the age-standardised prevalence of moderate vision impairment in China had the largest increase among the G20, and China was one of the few G20 countries in which the age-standardised prevalence of severe vision impairment increased. Among people older than 70 years, about one in every five had some degree of vision loss. Considering the huge population of China, the burden of vision loss[16] is heavy. Vision impairment and blindness remain an important public health problem in China that calls for attention.

From 1990 to 2019, the number of people with blindness in China rose by 64·35%. The age-specific prevalence of all blinding eye diseases other than diabetic retinopathy decreased, indicating that the increase in the absolute number of individuals with blindness was mainly due to population ageing and population growth. For severe vision impairment, although the absolute number of people increased by 147·14%, the change in age-specific prevalence accounted for only 10·91% of the increase. Cause analysis showed that the pathogenic factors leading to moderate and severe vision impairment, including cataract, macular degeneration, glaucoma, and diabetic retinopathy, substantially increased. Analysis of the changes in the number of patients with vision loss indicated that China has made great progress in the control of severe eye diseases in recent years, and the prevention and treatment of blindness has been especially effective.[6,17,18] However, public awareness of overall visual health should be raised further. Future intervention efforts, including the establishment of research and medical institutions, the development of government policies, and the distribution of ophthalmic medical resources, should be directed at the prevention and treatment of severe and moderate vision impairment. Targeted public education programmes and corresponding health insurance and social security policies for visual health need to be developed. Notably, trachoma was the only disease with a substantial decline in the absolute numbers among all causes of vision impairment and blindness. In 2014, the prevalence of active trachoma in China was 0·20%,[19] which was far below the WHO criteria[20] for blind trachoma epidemic areas, meaning that China had successfully eliminated blinding trachoma.[21]

In 2019, the main causes of blindness in China were cataract, uncorrected refractive error, and glaucoma, whereas the main causes of severe vision impairment and moderate vision impairment were uncorrected refractive error, cataract, and macular degeneration. The ranking of the major causes of vision impairment and blindness remained the same in 2019 as in 1990. Cataract remained the leading cause of blindness, accounting for one-third of all causes. It was also the second leading cause of severe vision impairment and moderate vision impairment. Under the guidance of the project Sight First China Action[17] and the major national public health service project, One Million Poor Cataract Patients Restoring Vision, the cataract surgery rate (CSR) in China steadily increased from 370 per million population in 2000 to 2205 in 2017,[22] effectively reducing the blindness rate among patients with cataract. However, China still fell behind the countries in western Europe in the treatment of cataract. For example, the CSR in France exceeded 10 000 in 2012.[23] Some other low-income and middle-income countries have also achieved better results than China, such as Iran with a CSR of 6328 in 2010.[24] A previous study[25] on Chaonan District, Guangdong Province, China observed that the leading obstacle to cataract surgery was a low level in patient awareness of cataract as the cause of visual impairment (74·5%), followed by failure to recognise the necessity of surgery (7·4%) and financial reasons (5·5%). Given that cataracts are more common in people older than 50 years, particularly in women older than 70 years, the prevention and treatment of cataracts in older people should be prioritised. We call for efforts in patient education on basic eye care knowledge[26] and the importance of timely treatment.

Consistent with previous global and regional studies,[27] uncorrected refractive error was the main cause of moderate and severe vision impairment, and the second leading cause of blindness. Priority should be given to uncorrected refractive error because it is avoidable and readily treatable. Refractive correction, such as wearing corrective glasses or refractive surgery, can effectively solve the issue of blurred vision caused by refractive error.[28] Unlike in other countries,[29] uncorrected refractive error has dropped considerably in China. Compared with other eye diseases, uncorrected refractive error was relatively less affected by population ageing, and the population affected are becoming younger. It should be

noted that myopia was the biggest burden of refractive error.[30] Excessive eye use (ie, high-intensity and close working or screen time), improper reading posture (ie, close reading), and prolonged eye use in a dark environment can lead to refractive error. The popularity of electronic products and the reduction of outdoor activity time could have contributed to the high incidence and low age of onset of myopia.[31] Previous studies showed that the prevalence of myopia in children and adolescents increased rapidly with age, and that the average prevalence of myopia among children aged 10 years in China reached 52·2% in 2013.[32] The Chinese Government has realised the seriousness of myopia among children and adolescents, and formulated a plan to address and prevent myopia among children and young students in 2018.[33] The implementation plan states that by 2030, the prevalence of myopia should be reduced to around 3% in children aged 6 years, less than 38% in primary school students, less than 60% in junior high school students, and less than 70% in senior high school students. However, the majority of parents do not have enough knowledge about children's vision protection because of a low level of public health education, and visual health education in schools is also ineffective. Successful prevention and treatment of myopia in pre-schools and schools relies on ample support from professional ophthalmology institutions. It is also important to communicate the scientific evidence for the importance of eye health and to promote early screening and correction of refractive errors in adolescents.[34] The establishment of visual health documentation could be fundamental in promoting the overall visual health of adolescents in China.

Diabetic retinopathy is a preventable and controllable blinding eye disease. It is not yet a major cause of vision impairment and blindness in China, but the prevalence has risen since 1990. The number of people with blindness caused by diabetic retinopathy has increased substantially, and the increase was attributed more to age-specific prevalence than to population ageing. In the past three decades, great changes have taken place in the lifestyle of Chinese people. Hypertension, hyperlipidaemia, and hyperglycaemia have become important problems affecting people's health.[35] In 2019, there were 116 million people with diabetes in China,[36] who were at high risk of developing diabetic retinopathy. The rapid increase of systemic diseases related to lifestyle changes, such as metabolic diseases, will increase the burden of eye disease in China. Bringing the prevention and control of chronic eye diseases into the national management of chronic diseases could be of great importance in reducing the burden of vision loss in the future.

Glaucoma ranked third in blinding eye diseases in China, and most of the blindness caused by glaucoma is irreversible. Regular ophthalmological examinations for high-risk groups[37] and early detection and diagnosis of patients with glaucoma are essential for delaying the progression of glaucoma and reducing vision loss.

Macular degeneration was the third most common cause of moderate to severe vision impairment and the fourth most common cause of blindness in the Chinese population. It has also become a common cause of vision impairment and blindness in high-income countries.[38,39] Previous studies have found that the prevalence of macular degeneration is higher among older populations.[40] With the acceleration of population ageing, vision loss caused by age-related macular degeneration is expected to increase in the future.

We also studied the prevalence and causes of vision loss in different provinces, which was important for understanding the geographical distribution of various eye diseases and informing prevention and treatment strategies. Our research showed that although the trend of vision loss in most provinces was consistent with the overall trend in China over the past 29 years, there were clear differences between provinces. In 2019, Gansu, Hong Kong, and Hubei had high age-standardised prevalence of moderate vision impairment; southwest and southern regions (Chongqing, Guangxi, and Tibet) had high age-standardised prevalence of severe vision impairment; and southwest regions (Tibet and Yunnan) had high age-standardised prevalence of blindness. These patterns could be explained by the difference in local economic development, the quality of health services, and people's health-related knowledge and health-related behaviour.[41–43] Some studies in China have shown that the coverage of cataract surgery in Hainan province was high, but the quality of surgery was not satisfactory, which might have affected the recovery of postoperative visual acuity.[44] In addition, the unique high altitude environment in Tibet could influence visual health.[45]

The analysis of the causes of vision loss in various provinces of China revealed the high incidence areas of different diseases. Chongqing, Heilongjiang, Hong Kong, Hubei, and Jiangsu had a high prevalence of moderate and severe visual impairment caused by cataract and uncorrected refractive error. In particular, Hong Kong had the highest cause-specific prevalence of all the major causes of moderate and severe visual impairment, indicating a gap in the public visual health efforts in that area. In addition, uncorrected refractive error in Chongqing, Hubei, and Jiangsu, macular degeneration in Guangdong and Yunnan, and cataract in Heilongjiang were the main causes of vision impairment. Severe vision impairment caused by cataract and diabetic retinopathy in Chongqing and Jiangsu was also concerning. Although national policies on the prevention and treatment of blindness are well developed and implemented, there are still some areas with high cause-specific prevalence of blindness. For example, uncorrected refractive error in Chongqing, Inner Mongolia, and Tibet, macular degeneration in Jiangsu and Yunnan, glaucoma in

Inner Mongolia, and diabetic retinopathy in Jilin were particularly concerning. Therefore, prevention and control strategies for vision loss need to be designed according to local situations.

The current study is subject to all the limitations of the GBD studies.[4,7] First, GBD 2019 estimated the models of vision impairment and blindness mainly through the available provincial-level data and previous literature in China.[4] The absence of relevant data in some provinces and the failure to differentiate between urban and rural areas might have led to bias in the model estimates. Second, different clinical procedures were used to measure visual acuity, which might result in increased measurement errors. In particular, Snellen is generally not the recommended way to measure visual acuity because its reproducibility is worse than that of the Early Treatment Diabetic Retinopathy Study. Third, although the data for vision loss were considered reasonably representative, estimates before 2005 might be uncertain due to the limited knowledge of underlying causes and the scarcity of the data sources before 2005. Fourth, many causes could lead to vision loss and it would be difficult to analyse all potential causes in detail, and therefore the interpretation of some of the results might not be conclusive. Moreover, some people might suffer from multiple diseases simultaneously, making it difficult to determine the main cause of vision loss outcomes.

In summary, vision loss is an important public health problem in China. Although China has made notable progress in reducing the age-specific prevalence of blindness, the situation of moderate and severe vision impairment is still severe. Public health policies related to eye health in China should increase their focus on the overall visual health of the public and on raising their awareness of eye care. The uneven distribution of vision loss across provinces requires customised intervention strategies for different regions. Additionally, priority should be given to cataracts in older people, refractive error in adolescents and children, and to the rising number of patients with potential to develop diabetic retinopathy.

Contributors

TX, BW, NW, and MZ conceived the ideas for this research and provided overall guidance. NW and MZ accessed and verified the data. TX, BW, HL, HW, PY, NW, and MZ prepared the first draft and finalised the manuscript based on comments from all other authors. All other authors contributed to the analysis and approved the manuscript.

Declaration of interests

We declare no competing interests.

Data sharing

TX, HW, and MZ had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Additional results are available on the IHME website.

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References

1 Eckert KA, Carter MJ, Lansingh VC, et al. A simple method for estimating the economic cost of productivity loss due to blindness and moderate to severe visual impairment. *Ophthalmic Epidemiol* 2015; **22:** 349–55.

2 Ramrattan RS, Wolfs RC, Panda-Jonas S, et al. Prevalence and causes of visual field loss in the elderly and associations with impairment in daily functioning: the Rotterdam Study. *Arch Ophthal* 2001; **119:** 1788–94.

3 McCarty CA, Nanjan MB, Taylor HR. Vision impairment predicts 5 year mortality. *Br J Ophthalmol* 2001; **85:** 322–26.

4 GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020; **396:** 1204–22.

5 WHO. Blindness and vision impairment. Oct 8, 2020. https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment (accessed Nov 3, 2020).

6 China National Blindness Prevention and Treatment. China national eye health plan. Jun 6, 2017. http://www.moheyes.com/(S(uopc5255puqgor24zxpd4qeo))/News/Details/96981b4a-c53c-483e-8fe3-a3d11cafaa52 (accessed March 26, 2020).

7 Zhou M, Wang H, Zeng X, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2019; **394:** 1145–58.

8 Wong TY, Zheng Y, Jonas JB, et al. Prevalence and causes of vision loss in east Asia: 1990–2010. *Br J Ophthalmol* 2014; **98:** 599–604.

9 Zhao J, Ellwein LB, Cui H, et al. Prevalence of vision impairment in older adults in rural China. *Ophthalmology* 2010; **117:** 409–16.

10 Zhao J, Xu X, Ellwein LB, et al. Causes of visual impairment and blindness in the 2006 and 2014 Nine-Province Surveys in rural China. *Am J Ophthalmol* 2019; **197:** 80–87.

11 Gilbert CE, Ellwein LB. Prevalence and causes of functional low vision in school-age children: results from standardized population surveys in Asia, Africa, and Latin America. *Invest Ophthalmol Vis Sci* 2008; **49:** 877–81.

12 GBD 2019 Demographics Collaborators. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020; **396:** 1160–203.

13 Murray CJL, Callender CSKH, Kulikoff XR, et al. Population and fertility by age and sex for 195 countries and territories, 1950–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018; **392:** 1995–2051.

14 GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016; **388:** 1459–544.

15 Das Gupta P. Standardization and decomposition of rates: a user's manual. Washington, DC: US Bureau of the Census, 1993.

16 Wang B, Congdon N, Bourne R, et al. Burden of vision loss associated with eye disease in China 1990-2020: findings from the Global Burden of Disease Study 2015. *Br J Ophthalmol* 2018; **102:** 220–24.

17 National Health Commission of the People's Republic of China. Notice of the General Office of the Ministry of Health on the third phase of the project Sight First China Action. http://www.nhc.gov.cn/xxgk/pages/viewdocument.jsp?dispatchDate=&staticUrl=/zwgkzt/wsbysj/201211/ (accessed March 26, 2020).

18 China National Blindness Prevention and Treatment. Notice on distributing "National Plan for the Prevention and Treatment of Blindness (2012–2015)". March 17, 2014. http://www.moheyes.com/(S(uopc5255puqgor24zxpd4qeo))/News/Details/e2c67372-9ae2-4711-8e17-3a07550fd4c3 (accessed March 26, 2020).

19 Yang X, Hu A, Wang N. From the prevention and treatment of blindness to the universal eye health. *Ophthalmol CHN* 2017; **26:** 1–3.

20 WHO. Trachoma. Aug 11, 2020. https://www.who.int/news-room/fact-sheets/detail/trachoma (accessed Nov 3, 2020).

21 Wang N, Deng S, Tian L. A review of trachoma history in China: research, prevention, and control. *Sci China Life Sci* 2016; **59:** 541–47.

For **additional results** see http://ghdx.healthdata.org/gbd-2019

22 China National Blindness Prevention and Treatment. Ranking of Chinese cataract surgery reporting situation in 2017. Aug 30, 2018. http://www.moheyes.com/News/Details/3bed44657e8c40e3853225eeb128565b (accessed March 29, 2020).

23 Daien V, Pape A L, Heve D, Carriere I, Villain M. Incidence and characteristics of cataract surgery in France from 2009 to 2012: a national population study. *Ophthalmology* 2015; **122:** 1633–38.

24 Hassan H, Akbar F, Farhad R, et al. Cataract surgical rate in Iran: 2006 to 2010. *Optom Vis Sci* 2014; **91:** 1355–59.

25 Zhang X, Li EY, Leung KS. Prevalence of visual impairment and outcomes of cataract surgery in Chaonan, south China. *PLoS One* 2017; **12:** e0180769.

26 Li Z, Song Z, Wu S, et al. Outcomes and barriers to uptake of cataract surgery in rural northern China: the Heilongjiang Eye Study. *Ophthalmic Epidemiol* 2014; **21:** 161–68.

27 Naidoo KS, Leasher J, Bourne RR, et al. Global vision impairment and blindness due to uncorrected refractive error, 1990–2010. *Optom Vis Sci* 2016; **93:** 227–34.

28 Jeganathan VSE, Robin AL, Woodward MA. Refractive error in underserved adults: causes and potential solutions. *Curr Opin Ophthalmol* 2017; **28:** 299–304.

29 Keeffe J, Taylor HR, Fotis, K, et al. Prevalence and causes of vision loss in southeast Asia and Oceania: 1990–2010. *Br J Ophthalmol* 2014; **98:** 586–91.

30 Williams KM, Verhoeven VJM, Cumberland P, et al. Prevalence of refractive error in Europe: the European Eye Epidemiology (E^3) Consortium. *Eur J Epidemiol* 2015; **30:** 305–15.

31 Zeng CQ, Zhou LH, Zhang P, et al. The epidemiology of myopia in primary school students of grade 1 to 3 in Hubei province. *Chin J Ophthalmol* 2018; **54:** 756–61.

32 Ma Y, Qu X, Zhu X, et al. Age-specific prevalence of visual impairment and refractive error in children aged 3–10 years in Shanghai, China. *Invest Ophthalmol Vis Sci* 2016; **57:** 6188–96.

33 Ministry of Education of the People's Republic of China. Notice on a plan to tackle and prevent myopia among children and young students. Aug 30, 2018. http://www.moe.gov.cn/srcsite/A17/moe_943/s3285/201808/t20180830_346672.html (accessed July 24, 2020).

34 Wei S, Sun Y, Li SM, et al. Visual impairment and spectacle use in university students in central China: the Anyang University Students Eye Study. *Am J Ophthalmol* 2019; **206:** 168–75.

35 Hu FB, Liu Y, Willett WC. Preventing chronic diseases by promoting healthy diet and lifestyle: public policy implications for China. *Obes Rev* 2011; **12:** 552–59.

36 International Diabetes Federation. IDF Diabetes Atlas, 9th edn. 2019. https://www.diabetesatlas.org (accessed March 29, 2020).

37 Gupta D, Chen PP. Glaucoma. *Am Fam Physician* 2016; **93:** 668–74.

38 Wong W L, Su X, Li X, et al. Global prevalence of age-related macular degeneration and disease burden projection for 2020 and 2040: a systematic review and meta-analysis. *Lancet Glob Health* 2014; **2:** e106–16.

39 Bourne RRA, Jonas JB, Flaxman SR, et al. Prevalence and causes of vision loss in high-income countries and in eastern and central Europe: 1990–2010. *Br J Ophthalmol* 2014; **98:** 629–38.

40 Jonas JB, Bourne RR, White RA, et al. Visual impairment and blindness due to macular diseases globally: a systematic review and meta-analysis. *Am J Ophthalmol* 2014; **158:** 808–15.

41 Sun J, Luo H. Evaluation on equality and efficiency of health resources allocation and health services utilization in China. *Int J Equity Health* 2017; **16:** 127.

42 Zhao J, Xu X, Ellwein L B, et al. Prevalence of vision impairment in older adults in rural China in 2014 and comparisons with the 2006 China Nine-Province Survey. *Am J Ophthalmol* 2018; **185:** 81–93.

43 Xu Y, He J, Lin S, et al. General analysis of factors influencing cataract surgery practice in Shanghai residents. *BMC Ophthalmol* 2018; **18:** 102.

44 Li EY, Liu Y, Zhan X, et al. Prevalence of blindness and outcomes of cataract surgery in Hainan Province in South China. *Ophthalmology* 2013; **120:** 2176–83.

45 Wang GQ, Bai ZX, Shi J, Luo S, Chang HF, Sai XY. Prevalence and risk factors for eye diseases, blindness, and low vision in Lhasa, Tibet. *Int J Ophthalmol* 2013; **6:** 237–41.