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Burden of patients with visual impairment: a questionnaire survey in two tertiary hospitals in Beijing

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2 **1 Burden of patients with visual impairment: a questionnaire survey in two**
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4 **2 tertiary hospitals in Beijing**

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1
2 22 **Abstract**

3
4 23 **Objectives** To quantify the economic burden, prevalence of catastrophic healthcare
5 24 expenditure (CHE) and the quality of life (QoL) of patients with visual impairment (VI) in
6 25 China.

7
8 26 **Methods** We conducted a questionnaire survey from March to May 2016 by structured face-
9 27 to-face interviews of patients with VI. The economic burden was estimated by calculating
10 28 participants' direct costs covered in 2015 and the definition of CHE was out of pocket costs
11 29 exceeding 30% of annual household income. QoL was weighed by health utility value using
12 30 time trade off valuation techniques.

13
14 31 **Results** A total of 302 patients were included and 298 completed questionnaires were
15 32 eligible for the study, yielding a response rate of 98.7%. Annual direct costs per patient
16 33 caused by VI were US\$6988.6±10834.3 and 70.3% were direct medical costs. 32.2%
17 34 households suffered from CHE, especially for less wealthy patients who were blind, living
18 35 in rural areas and without medical insurance. The health utility value was rated at 0.65 on
19 36 average and patients who were blind, aged 51-57, living alone and insured by commercial
20 37 medical insurance had relatively poorer QoL.

21 38 **Conclusion** Our study quantified the economic burden and QoL of patients with VI in
22 39 China, indicating a substantial burden and poor life quality. Preferential medical insurance
23 40 policies should be designed in relation to people with VI to further reduce the health
24 41 inequalities, avoid the CHE and promote QoL.

1
2 42 **Article Summary**

3
4 43 **Strengths and limitations of this study**

5 44 1. To our knowledge, this is the first study to quantify the prevalence of CHE and the QoL of
6
7 45 patients with VI in China.

8
9 46 2. The face-to-face interviews were conducted in tertiary general hospitals in Beijing, which
10
11 47 might result in potential sample selection bias.

12 48 3. There could have been recall bias because the data were self-reported by the patients.
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INTRODUCTION

With a rapidly aging population in mainland China, visual impairment (VI) is emerging as a public health concern [1]. According to the World Health Survey (2003), one in five adults reported some degree of far visual difficulty [2]. In 2015, the number of people with moderate VI or worse was estimated to be 253 million globally [3]. More than 80% of the global total of VI occurs in developing countries [4], and 26.5% of the total of VI occurs in China [5]. The prevalence of VI in China is 0.94% yet, as for the people older than 50, the prevalence rises to 5.8%. In Tibet, one of the highest and harshest human habitations on earth, the prevalence is 13.2% [6-8].

The main impact of VI is a diminished ability to perform daily activities [9], which often results in high health expenditures and the loss of independence [10]. The total financial cost of VI worldwide was estimated to be \$3 trillion in 2010 or \$4,030 per person who is visually impaired [11]. In addition to the economic burden, VI also has extensive social ramifications in terms of participation in society, employment and quality of life (QoL). The World Health Organization (WHO) estimated that 1% of the total global burden of disease measured as Disability-Adjusted Life Years (DALY) was attributable to VI increased by 47% from 12.9 million DALYs in 1990 to 18.8 million DALYs in 2010 [12-13].

The burden of VI has been well researched in countries such as the U.S., Australia, and some European countries [13-16]. However, little is known about the economic burden and QoL of patients with VI in China. Therefore, we aim to achieve an assessment to: quantify the economic burden; identify the prevalence of catastrophic healthcare expenditure (CHE); and describe the QoL of patients with VI in China.

METHODS

Questionnaire design

We conducted a questionnaire survey by structured face-to-face interviews of patients with VI. The study questionnaire included standardized items developed by reviewing related research as well as items developed by consulting ophthalmologists and pharmacists. The survey questionnaire included four parts: sociodemographic information, clinic-related information, economic burden and QoL.

Sociodemographic information

Age, gender, ethnicity, educational level, profession, marital status, living status, current living place, medical insurance, personal income, household size and household income were included.

Clinic-related information

1
2 86 Healthcare service utilization, treatment history and visual condition were included. Visual
3
4 87 condition was divided into three categories based on the WHO vision visual acuity (VA)
5
6 88 categorization principles: moderate VI ($6/60 < VA < 6/18$), severe VI ($3/60 < VA < 6/60$) and
7
8 89 blind ($VA < 3/60$) [17].

90 ***Economic burden***

91 Economic burden was estimated by calculating participants' direct costs covered in 2015,
92 including direct medical costs and direct non-medical costs.

93 ***Quality of life***

94 QoL was weighed by the "utility value" to evaluate patients' perception of their own health,
95 using time trade-off (TTO) valuation technique [18]. TTO determined the length of lifetime the
96 respondent would be willing to forego to live in perfect health [19], by asking "Assuming you
97 will only live for 10 years, what is the maximum amount of that time, if any, you would be
98 willing to trade for a return to permanent perfect vision (1.0) during the years that remain?"

99 The questionnaire was designed and optimized by ophthalmologists and clinical
100 pharmacists. After conducting a pilot field research study in a tertiary hospital in Beijing, all
101 of the experts agreed that the questionnaire was valid. The items and descriptions of survey
102 questionnaire were shown in **Appendix 1**.

103 104 **Recruitment and sampling**

105 Participants were eligible for inclusion in the study if they were diagnosed with moderate
106 VI or worse in both eyes ($VA < 6/18$) and were physically and mentally able to participate in
107 the survey and agreed to participate in the study. We excluded participants who were pregnant,
108 had a concomitant malignant disease or an inability to complete the questionnaire.

109 110 **Data collection and quality control**

111 A questionnaire survey was conducted from March to May 2016 by structured face-to-face
112 interviews of patients admitted in ophthalmic department in two tertiary hospitals in Beijing.
113 All the investigators were trained for standard processes via a workshop. During the face-to-
114 face interviews, the investigators read all the contents of the questionnaire to establish that
115 patients with VI could hear and understand the questions. The interviews lasted approximately
116 0.5-1 hours to collect detailed information. Survey data were recorded on paper forms and
117 translated using Epidata3.1.

118 119 120 **Outcome measures**

121 ***Catastrophic healthcare expenditure***

122 CHE was defined as out-of-pocket (OOP) for healthcare over a year that exceeded a certain
123 proportion of a household's income. This threshold had been defined in many ways: one of
124 the most common definitions was OOP costs exceeding 30% of annual household income [20].

125 ***Quality of life***

126 Answers to the time trade-off questions were converted to utility value.

$$127 Z = (10 - N) / 10$$

128 Z was the health utility value; N was the number of years that the respondents were willing
129 to trade for a return to permanent perfect vision. Utility values were anchored on a scale
130 between 0 (the preference for death rather than living in the patient's current state of health)
131 and 1 (a perception of perfect health) [18].

133 **Statistical analysis**

134 Costs and income were assessed in Chinese Yuan (CNY) and converted into United States
135 dollars (USD) uniformly based on exchange rates in June 1, 2016 (1 USD=6.5889 CNY) to
136 make the results more comparable to other published studies.

137 STATA 14.0 was applied to conduct the following statistical analysis: (a) descriptive
138 analysis of the participants' demographic information, healthcare service utilization,
139 expenditures, CHE prevalence and QoL; (b) bivariate chi-square test on the difference of CHE
140 prevalence and QoL value between subgroups. The level of statistical significance was $p <$
141 0.05 (two-sided).

143 **Ethics Statement**

144 Ethics committee approval obtained from Peking University Institution Review Board
145 (No. IRB00001052-16003). All participants were informed by an information sheet and
146 have signed the declaration of consent to participate in the study.

148 **RESULTS**

149 **Description of demographic characteristics**

150 A total of 302 patients were included and 298 completed questionnaires were eligible for
151 this study, yielding a response rate of 98.7%. Patients' demographic data are shown in **Table**
152 **1**. The mean age in sample was 65.4 and there were slightly fewer males (47.7%). Most of the
153 participants were married (85.2%), living with family (94.6%) and in urban areas (71.8%).
154 41.3% of the participants were covered by Urban Employee Basic Medical Insurance
155 (UEBMI), 23.8% by New Cooperative Medical Scheme (NCMS), 14.1% by Government

1
2 156 Medical Insurance (GMI), and 13.4% by Urban Resident Basic Medical Insurance (URBMI).
3
4 157 Of the visual-related health conditions reported, 58.4% had moderate VI, 28.9% had severe
5 158 VI, and 12.8% were blind. 71.8% of the participants had been suffered from VI for more than
6
7 159 one year. The annual personnel income and household income of the participants were
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9 160 US\$6,266.4±10,403.2 and US\$13,457.8±16,711.9, respectively.

10 161

12 162 **Healthcare service utilization**

14 163 As shown in **Table 1**, the average number of healthcare service utilization due to VI within
15
16 164 1 year was 9.7 outpatient visits, ranging from 4.8 visits (cataract) to 16.7 visits (glaucoma).
17
18 165 Average number and length of inpatient hospital visits were 0.6 visit within 1 year and 2.7
19 166 days of hospital staying per visit.

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22 168 **Direct costs**

24 169 The total direct medical costs were US\$6,988.6±10,834.3 in 2015, including direct medical
25
26 170 costs of US\$4,909.8±8,981.7 (70.3%) and direct non-medical costs of US\$2,078.8±4,430.6
27
28 171 (29.7%).

29 172 As shown in **Table 2**, of the direct medical costs, outpatient fees represented the largest
30
31 173 costs at US\$3,408.5 (69.4%), followed by inpatient costs at US\$1,369.5 (27.9%). Except
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33 174 outpatient and inpatient costs, the participants also purchased drugs by themselves in retail
34
35 175 pharmacy (2.7%). Only 10.6% of the outpatient costs, 24.4% of the inpatient costs and 2.6%
36
37 176 of the self-purchased drug costs were covered by the medical insurance. Average total OOP
38 177 costs per patient were US\$4211.6 (85.8%).

39 178 Direct non-medical costs occurred mostly due to long-term home care at US\$1,216.6
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41 179 (58.5%). Nutrition or assistive devices, food and accommodation, escort, transportation, and
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43 180 home modifications costs accounted for 13.3%, 8.5%, 7.7%, 7.2% and 4.7% respectively.

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45 181 The specific costs among different groups were shown in the **Appendix 2**.

46 182

48 183 **Prevalence of CHE**

50 184 Patients with VI paid in direct medical costs an average amount equal to 111.5% of their
51
52 185 individual annual income and 51.9% of their household's annual income. As shown in **Table**
53
54 186 **1**, 32.2% households suffered from CHE caused by VI. The prevalence of CHE was generally
55
56 187 correlated with the severity of VI (moderate VI 28.2%, severe VI 31.4%, blind 52.6%; $p<0.05$).
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58 188 Patients living in rural areas generally had greater risk of CHE compared with urban residents
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60 189 (47.6%, 26.2%; $p<0.001$). Of all of the different types of medical insurances, the CHE
190 prevalence of patients without medical insurance and insured by NCMS ostensibly

1
2 191 outweighed those insured by GMI and CMI (none 50.0%, NCMS 47.9%, GMI 16.7%, CMI
3 192 21.4%; $p<0.01$). In relation to the patients' economic status, the less wealthy patients (those
4 193 with the lowest or lower economic status) were much more likely to encounter CHE than
5 194 wealthier patients ($p<0.01$).

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10 196 **QoL**

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12 197 As shown in **Table 1**, the value of QoL was 0.65 on average and correlated with the severity
13 198 of VI (moderate VI 0.69, severe VI 0.65, blind 0.49; $p<0.01$). Middle-aged patients (51-70)
14 199 had the poorest life quality (0.58; $p<0.001$) and patients living alone had relatively poorer
15 200 QoL than living with family (0.58, 0.68; $p<0.01$). Of all of the different types of medical
16 201 insurances, the health utility values of patients insured by CMI were significantly lower than
17 202 those insured by URBMI (0.49, 0.81; $p<0.01$).

18 203

19 204 **DISCUSSION**

20 205 This study quantified the economic burden and QoL of VI patients in China, indicating a
21 206 substantial burden of VI, with considerable variation among the different age groups, rural or
22 207 urban, type of medical insurance, visual condition and economic status.

23 208 We found annual direct cost per patient caused by VI in China was much lower than the
24 209 US [13]. The direct medical costs occurred mostly due to outpatient visit, which was
25 210 inconsistent with formal findings in the US. and Australia that direct medical costs occurred
26 211 mostly due to hospitalization [13]. Previous studies demonstrated that even mild visual
27 212 impairment had a significant and independent impact on vision-specific functioning [21] and
28 213 diminished ability to perform activities of daily living alone, which led to long-term care for
29 214 patients. Therefore, it was not surprising that the highest direct non-medical costs came from
30 215 long-term home care (58.5%). A possible explanation for high nutrition or assistive devices
31 216 costs (13.3%) in our study was that people in China were keen on buying nutrition or devices
32 217 that usually advertised in the media [22], especially those visually impaired patients who rarely
33 218 went out and had no other choices but to listen to TV for entertainment.

34 219 Our research showed that patients with VI had a relatively high financial burden in China,
35 220 resulting in 32.2% households suffered from CHE. Patients with VI paid in direct costs an
36 221 average amount equal to 111.5% of their individual annual income and 51.9% of their
37 222 household's annual income, which indicated that the patients themselves are clearly unable to
38 223 meet such substantial costs and the exorbitant burden was too costly for even the entire
39 224 household to maintain. In particular, for households that have a lower economic status, the
40 225 discrepancy between costs and income was greater, which made them more vulnerable facing

1
2 226 the CHE. Furthermore, patients without medical insurance recording the highest CHE
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4 227 prevalence and the relative CHE prevalence also differed among different medical insurances,
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6 228 which may largely due to the different reimbursement rate of each insurance. Patients insured
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8 229 by NCMS, with the relatively lowest reimbursement rate ^[23,24], had substantially higher CHE
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10 230 prevalence than those with highest reimbursement rate (GMI and CMI). As patients living in
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12 231 rural areas have a relatively low income and were insured by NCMS ^[25], they were ostensibly
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14 232 at greater risk of CHE.

15 233 Except for the economic burden, our study also suggested that VI had a substantial negative
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17 234 effect on health related QoL, and the life quality of patients with VI (0.65) in our study was
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19 235 worse than patients with cancer (0.92), mild stroke (0.9), gout (0.86), heart failure (0.78) and
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21 236 HIV/AIDS (0.70) ^[26]. This may largely due to the significant association between VI and
22
23 237 mental stress such as anxiety ^[27], depression ^[10] and cognitive functions ^[28]. Among the study
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25 238 population, the utility value decreased dramatically with perceived total loss of vision.
26
27 239 Previous studies have suggested that the utility values most highly correlated with the visual
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29 240 acuity in the better seeing eye, and as the vision in the better seeing eye decreased, the
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31 241 corresponding utility value decreased ^[29]. Besides, living with family could slightly enhance
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33 242 the life quality than living alone in our study, because family members were often called on
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35 243 to provide physical and emotional support ^[30]. However, unlike CHE, life quality of visual
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37 244 impaired patients was not associated with their wealth and patients with the highest
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39 245 reimbursement rate insurance (CMI) had the poorest life quality in our study. Thus, efforts
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41 246 are needed to promote the access to adequate and effective treatment for visual impaired
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43 247 patients to alleviate their diseases and recover their sight. Moreover, the government should
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45 248 evade the inconvenience with daily living of the visual impaired patients by consciously
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47 249 redesigning the built environment, public facilities and services.

48 250 We spent 3 months in two tertiary hospitals to interview 298 individuals. Due to the
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50 251 limitation of movement for patients with VI in China several limitations to this study should
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52 252 be noted. First, the face-to-face interviews were conducted in tertiary general hospitals in
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54 253 Beijing, which might result in a sample with higher education level, income, treatment costs,
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56 254 better health insurance, more serious disease than the average level of all the patients with VI
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58 255 in China. Second, there could have been recall bias because the data were self-reported by the
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60 256 patients.

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260 **CONCLUSION**

1
2 261 In general, our study quantified the economic burden and QoL of VI patients in China,
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4 262 indicating that compared with people who were sighted, people with VI experienced greater
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6 263 difficulties with daily living, higher economic burden, greater chance of CHE and poorer
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8 264 QoL. The findings in this study suggested that preferential medical insurance policies should
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10 265 be designed of VI to further reduce the health inequalities, avoid the CHE and enhance the
11
12 266 QoL.

13 267

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20
21 272 study. Fanghui Lin and Mengyuan Fu conducted the questionnaire survey. Mengyuan Fu and
22
23 273 Dawei Zhu contributed to analysis of the data. Xiaodong Guan, Luwen Shi, Daniel Vuillermin
24
25 274 and Mengyuan Fu conducted the final analysis and drafted the initial manuscript. All authors
26
27 275 contributed to the critical revision of the paper and approved the final manuscript.

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34 280 **Ethics approval** Ethics committee approval obtained from Peking University Institution
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36 281 Review Board (No. IRB00001052-16003). All participants were informed by an information
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38 282 sheet and have signed the declaration of consent to participate in the study.

39
40 283 **Provenance and peer review** Not commissioned; externally peer reviewed.

41 284 **Data sharing statement** No additional data are available.

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359 **Table 1** Characteristic of study participants with visual impairment.

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)	CHE		QoL	
						Proportion (%)	P	Mean	P
Total	298	9.7	0.6	2.7	13,457.8	32.2		0.65	
Age									
19-50 years old	39(13.1)	11.4	1.1	3.5	12,696.0	35.9	0.574	0.74	0.000
51-70 years old	125(41.9)	10.8	0.6	2.6	13,452.4	34.4		0.58	
71-90 years old	134(45.0)	8.1	0.4	2.5	13,684.4	29.1		0.70	
Gender									
Male	142(47.7)	10.7	0.6	2.7	14,408.2	33.8	0.576	0.66	0.689
Female	156(52.3)	8.8	0.5	2.7	12,592.6	30.8		0.65	
Ethnicity									
Han	278(93.3)	9.4	0.6	2.7	12,788.9	30.9	0.078	0.66	0.125
Minority	20(6.7)	13.9	0.7	2.1	22,755.0	50.0		0.54	
Educational level									
Primary and below	71(23.8)	9.3	0.5	1.9	6,945.0	39.4	0.190	0.63	0.755
Middle and high school	159(53.4)	9.9	0.6	2.7	13,853.7	32.1		0.66	
College and above	68(22.8)	9.6	0.7	3.3	19,332.0	25.0		0.66	
Occupation									
Management personnel	32(10.7)	12.1	0.8	12.0	15,623.8	20.7	0.107	0.73	0.865
Professional personnel	81(27.2)	9.0	0.6	12.5	16,599.2	37.5		0.65	
General staff	89(29.9)	10.1	0.6	8.0	14,206.2	25.9		0.65	
Farmer	56(18.8)	6.9	0.4	5.6	4,707.6	30.3		0.65	
Other professions	11(3.7)	14.0	0.5	10.0	28,215.5	46.4		0.58	
Unemployed	29(9.7)	7.7	1.0	10.9	11,295.3	36.4		0.75	
Marital status									
Unmarried	44(14.8)	5.0	0.8	2.4	12,740.7	25.0	0.267	0.65	0.234
Married	254(85.2)	10.5	0.5	2.7	13,582.0	33.5		0.65	
Living status									
Alone	16(5.4)	7.9	0.6	5.6	6,304.6	50.0	0.118	0.58	0.002
With family	282(94.6)	9.8	0.6	2.5	13,863.6	31.2		0.68	
Current living place									
Urban	214(71.8)	9.7	0.6	2.7	15,792.0	26.2	0.000	0.67	0.450
Rural	84(28.2)	9.6	0.6	2.6	7,511.1	47.6		0.62	
Medical insurance *									

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)	CHE		QoL	
						Proportion (%)	P	Mean	P
None	8(2.7)	18.1	1.4	26.2	18,299.2	50.0	0.008	0.64	0.003
NCMS	71(23.8)	9.8	0.6	11.3	15,099.4	47.9		0.63	
URBMI	40(13.4)	8.1	0.4	6.9	11,345.5	25.0		0.81	
UEBMI	123(41.3)	10.2	0.5	4.9	6,333.6	30.9		0.63	
GMI	42(14.1)	7.9	0.5	15.4	31,936.8	16.7		0.66	
CMI	14(4.7)	5.5	1.5	30.0	4,249.6	21.4		0.49	
Visual condition									
Moderate VI	174(58.4)	9.7	0.4	1.8	15,021.5	28.2	0.014	0.69	0.001
Severe VI	86(28.9)	9.6	0.7	3.5	12,308.5	31.4		0.65	
Blind	38(12.8)	10.0	1.2	4.7	8,898.5	52.6		0.49	
VI duration									
3-6 months	36(12.1)	4.6	0.4	1.3	12,948.3	27.8	0.804	0.58	0.066
6-12 months	48(16.1)	7.5	0.5	2.8	9,755.8	31.2		0.73	
More than 12 months	214(71.8)	11.1	0.6	2.9	14,373.8	33.2		0.65	
Ocular diseases condition									
Cataract	80(26.8)	4.8	0.3	4.3	10,898.1	17.5	0.018	0.76	0.000
Glaucoma	17(5.7)	16.7	1.2	19.7	17,850.1	41.2		0.64	
AMD	35(11.7)	12.1	0.3	7.6	12,185.9	51.4		0.72	
Retinal vascular disease	27(9.1)	8.9	0.9	9.4	14,326.4	37.0		0.67	
Other eye diseases	43(14.4)	7.9	0.6	7.7	11,445.6	30.2		0.58	
Congenital or traumatic	17(5.7)	15.9	0.7	4.6	11,677.6	35.3		0.63	
Complex diseases	759(26.5)	12.0	0.7	15.5	16,849.5	35.4		0.56	
Economic status †									
Lowest	59(19.8)	10.0	0.6	4.7	2,445.9	54.2	0.001	0.59	0.559
Lower	59(19.8)	7.7	0.8	12.0	6,464.2	33.9		0.66	
Middle	60(20.1)	8.3	0.5	9.8	10,890.3	26.7		0.68	
Higher	60(20.1)	14.2	0.5	5.5	15,481.5	21.7		0.73	
Highest	60(20.1)	8.4	0.6	15.6	32,134.7	25.0		0.62	

*New cooperative medical scheme in rural area (NCMS), urban employee basic medical insurance (UEBMI), urban resident basic medical insurance (URBMI), government medical insurance (GMI), and commercial medical insurance (CMI)

† Economic status was divided into five equal intervals based on household income per capita of the study participants. Lowest US\$[60.7,1274.9]; Lower US\$[1365.9, 2428.3]; Middle US\$[2529.5,4097.8]; Higher US\$[4249.6, 6677.9]; Highest US\$[7183.8, 37942.6].

364 **Table 2** Annual direct costs of visual impaired patients in China.

Characteristics	Mean (USD)	Median (USD)	Max (USD)	Min (USD)	Proportion (%)
Direct medical costs					70.3
Outpatient costs					69.4
Total	3,408.5	607.1	68,296.7	0.0	
Drug	2,352.7	215.5	54,637.3	0.0	
Out-of-pocket	3,048.5	324.8	68,296.7	0.0	
Inpatient costs					27.9
Total	1,369.5	0.0	31,871.8	0.0	
Drug	408.8	0.0	12,748.7	0.0	
Out-of-pocket	1,034.8	0.0	31,871.8	0.0	
Self-purchased drugs costs					2.7
Total	131.8	0.0	4,553.1	0.0	
Out-of-pocket	128.3	0.0	4,553.1	0.0	
Total direct medical costs	4,909.8	1,517.7	70,573.2	0.0	100.0
Direct non-medical costs					29.7
Long-term home care	1,216.6	0.0	28,836.4	0.0	58.5
Transportation	149.8	15.2	5,463.7	0.0	7.2
Food or accommodation	176.8	0.0	9,106.2	0.0	8.5
Escort	161.1	15.2	6,677.9	0.0	7.7
Nutrition or assistive devices	277.1	0.0	4,629.0	0.0	13.3
Home modifications	97.5	0.0	6,070.8	0.0	4.7
Total direct non-medical costs	2,078.8	440.1	33,237.7	0.0	100.0
Total direct costs	6,988.6	2,281.8	101,079.1	45.5	100.0

365

366

367 **Appendix 1** The items of the survey questionnaire.

Variable name	Description
Sociodemographic information	
age	[19,50], [51,70], [71,90]
gender	Male, Female
ethnicity	Han, Minority
educational level	Primary and below, Middle and high school, College and above
Occupation *	Management personnel, Professional personnel, General staff, Farmer, Other professions, Unemployed
marital status	Unmarried, Married
living status	Alone, With family
current living place	Urban, Rural
medical insurance †	GMI, UEBMI, URBMI, NCMS, CMI, None
personal income	Continuous
household size	Continuous
household income	Continuous
Clinic-related information	
Visual condition	moderate VI , severe VI , blind
VI duration ‡	3-6 months, 6-12 months, More than 12 months
Ocular diseases condition	Cataract, Glaucoma, AMD, Retinal vascular disease, Other eye diseases, Congenital or traumatic, Complex diseases
Outpatient visit	Continuous
Inpatient visit	Continuous
Hospital stay per visit	Continuous

Economic burden**Direct medical costs §**

Outpatient costs	Continuous
Outpatient drug costs	Continuous
Outpatient OOP costs	Continuous
Inpatient costs	Continuous
Inpatient drug costs	Continuous
Inpatient OOP costs	Continuous
Self-purchased drugs costs	Continuous
Self-purchased drugs OOP costs	Continuous

Direct non-medical costs

Long-term home care costs	Continuous
Transportation costs	Continuous
Food or accommodation costs	Continuous
Escort costs	Continuous
Nutrition or assistive devices costs	Continuous
Home modifications	Continuous

Quality of life

Continuous

368 * Occupation included current profession of unretired participants and former profession for the retired. Professional
 369 personnel were professional and technical personnel, i.e. teachers, doctors, lawyers, engineer, etc.

370 † Public insurance included new cooperative medical scheme in rural area (NCMS), urban employee basic medical insurance
 371 (UEBMI), urban resident basic medical insurance (URBMI) and government medical insurance (GMI). Commercial medical
 372 insurance (CMI) was supplements of public medical insurance purchased by respondents' employers or by themselves.

373 ‡ Duration of VI was defined by the period from the time which the participants became their current visual impaired level.

374 § Direct medical costs measured the cost of resources used for treating a particular illness, consisted of outpatient costs,
 375 inpatient costs and self-purchased drugs costs. Expenditures for medicine prescribed and purchased during outpatient and
 376 inpatient visits in hospitals were included in outpatient and inpatient drug costs, respectively. The cost of self-purchased
 377 drugs was the expense of the drugs that patients bought in pharmacies (not in hospitals) for their ocular disease treatment
 378 after the initial diagnosis.

379 || Cost of escort were meals, transport and accommodation costs encountered by patients' escorts during all outpatient or
 380 inpatient visits.

381 **Appendix 2** Annual direct costs of different visual impaired patients in China.

Characteristics	Direct medical costs (USD)				Direct non-medical costs (USD)							Total direct costs (USD)
	Outpatient	Inpatient	Self-purchased drugs	Total	Long-term home care	Transportation	Food or accommodation	Escort	Nutrition or assistive devices	Home modifications	Total	
Total	3,408.5	1,369.5	131.8	4,909.8	1,216.6	149.8	176.7	161.1	277.1	97.5	2,078.8	6,988.6
Age												
19-50 years old	2,009.3	3,572.4	211.5	5,793.2	1,269.1	248.1	407.7	249.6	77.8	43.2	2,295.5	8,088.7
51-70 years old	3,479.0	1,062.6	156.3	4,697.9	963.7	161.1	216.6	178.5	226.3	75.3	1,821.6	6,519.6
71-90 years old	3,749.9	1,014.6	85.8	4,850.3	1,437.2	110.6	72.4	119.1	382.4	134.0	2,255.7	7,106.0
Gender												
Male	3,321.3	1,860.7	98.6	5,280.6	1,069.2	130.7	132.7	179.2	300.4	118.4	1,930.6	7,211.2
Female	3,487.8	922.4	162.0	4,572.3	1,350.8	167.2	216.9	144.6	255.8	78.5	2,213.8	6,786.0
Ethnicity												
Han	3,404.2	1,325.0	130.2	4,859.4	1,039.7	135.5	166.1	167.0	250.6	86.5	1,845.5	6,704.8
Minority	3,468.1	1,988.2	154.7	5,611.0	3,675.2	348.7	324.7	78.2	645.0	250.4	5,322.3	10,933.2
Educational level												
Primary and below	2,924.6	991.6	85.3	4,001.6	2,331.9	173.9	138.3	96.1	146.7	51.3	2,938.2	6,939.8
Middle and high school	3,894.0	1,440.2	174.5	5,508.7	887.0	134.9	163.0	210.6	237.4	117.8	1,750.8	7,259.6
College and above	2,778.4	1,598.7	80.5	4,457.7	822.8	159.4	248.9	113.2	505.8	98.3	1,948.5	6,406.2
Occupation												
Management personnel	5,325.1	2,859.9	131.6	8,316.6	840.4	125.8	115.9	149.4	274.8	38.4	1,544.7	9,861.3
Professional personnel	3,924.7	1,129.7	137.3	5,191.6	1,035.5	182.0	281.2	207.9	503.9	111.5	2,322.1	7,513.7
General staff	2,751.8	1,414.9	97.5	4,264.1	1,592.0	156.1	136.3	97.0	211.6	109.5	2,302.4	6,566.5
Farmer	3,246.6	483.0	137.8	3,867.3	1,036.3	128.3	141.2	147.0	127.0	32.6	1,612.5	5,479.8
Other professions	2,467.8	2,635.3	146.8	5,249.9	2,731.9	172.9	242.8	226.6	531.3	275.9	4,181.6	9,431.4
Unemployed	2,536.8	1,487.3	204.9	4,229.1	758.8	100.0	119.8	242.1	40.4	144.4	1,405.7	5,634.8
Marital status												
Unmarried	869.9	1,715.0	172.2	2,757.1	1,922.0	78.0	59.7	71.5	120.7	79.4	2,331.4	5,088.5
Married	3,848.2	1,309.6	124.8	5,282.7	1,094.4	162.2	197.0	176.6	304.2	100.6	2,035.1	7,317.8
Living status												
Alone	1,546.6	1,218.0	138.6	2,903.2	1,015.9	82.9	39.2	126.8	158.1	95.8	1,518.7	4,422.0
With family	3,514.1	1,378.1	131.4	5,023.6	1,228.0	153.6	184.6	163.0	283.8	97.6	2,110.6	7,134.3
Current residence												
Urban	3,463.3	1,411.9	105.2	4,980.5	1,347.2	143.6	176.7	136.5	319.9	111.6	2,235.7	7,216.1
Rural	3,268.7	1,261.5	199.5	4,729.8	883.8	165.5	176.9	223.8	167.8	61.5	1,679.8	6,409.1

Characteristics	Direct medical costs (USD)				Direct non-medical costs (USD)							Total direct costs (USD)
	Outpatient	Inpatient	Self-purchased drugs	Total	Long-term home care	Transportation	Food or accommodation	Escort	Nutrition or assistive devices	Home modifications	Total	
Medical insurance												
None	298.9	4,249.6	202.1	4,750.5	4,078.8	192.6	147.0	180.2	154.5	151.8	4,905.0	9,655.5
NCMS	3,488.4	1,208.2	209.3	4,905.9	881.5	156.2	173.2	233.0	96.9	42.8	1,583.8	6,489.6
URBMI	3,258.8	359.3	65.0	3,683.1	1,061.2	71.0	23.5	86.2	103.0	25.0	1,370.0	5,053.1
UEBMI	3,351.3	1,658.9	123.1	5,133.3	1,251.4	181.4	225.9	115.2	326.5	112.1	2,212.4	7,345.7
GMI	3,924.8	1,368.5	92.1	5,385.3	1,585.7	128.4	183.4	252.0	500.4	195.1	2,845.0	8,230.3
CMI	4,160.8	888.9	85.7	5,135.4	311.7	104.2	197.8	130.1	653.7	130.1	1,527.6	6,663.0
Visual condition												
Moderate VI	3,120.7	853.8	118.6	4,093.1	916.4	142.4	138.5	125.9	222.0	65.3	1,610.4	5,703.5
Severe VI	4,479.9	1,694.5	147.5	6,321.8	1,793.8	158.7	226.7	128.2	293.3	137.0	2,737.6	9,059.5
Blind	2,301.6	2,995.5	156.8	5,453.9	1,284.8	163.9	238.9	396.6	492.7	155.8	2,732.6	8,186.5
VI duration												
3-6 months	1,574.8	503.8	225.0	2,303.6	1,643.7	103.1	89.4	110.6	308.8	123.5	2,379.2	4,682.7
6-12 months	2,182.5	1,070.6	70.9	3,324.0	429.4	152.8	282.8	104.2	104.5	85.4	1,159.1	4,483.0
More than 12 months	3,992.0	1,582.2	129.8	5,703.9	1,321.3	157.0	167.6	182.4	310.4	95.9	2,234.6	7,938.6
Ocular diseases condition												
Cataract	1,236.9	583.9	27.5	1,848.3	790.1	55.1	67.7	48.4	63.2	19.4	1,043.7	2,892.0
Glaucoma	4,909.7	2,297.1	208.0	7,414.8	380.0	78.6	100.9	102.7	118.7	35.7	816.6	8,231.4
AMD	8,162.3	524.7	134.8	8,821.8	346.9	189.3	172.0	174.6	480.9	0.0	1,363.7	10,185.5
Retinal vascular disease	4,151.1	2,270.9	249.9	6,671.9	930.5	139.1	84.9	141.1	237.9	194.2	1,727.8	8,399.7
Other eye diseases	1,392.9	2,191.8	185.5	3,770.2	2,309.9	331.9	486.5	149.8	175.0	28.6	3,461.8	7,232.0
Congenital or traumatic	2,324.4	2,750.6	166.8	5,241.7	444.2	192.2	232.7	337.4	70.1	197.3	1,473.9	6,715.7
Complex diseases	4,255.0	1,286.8	142.7	5,684.5	1,882.8	149.8	156.4	256.8	550.9	216.2	3,212.9	8,897.5
Economic status												
Lowest	3,662.3	1,342.8	177.1	5,182.2	1,523.5	254.6	315.7	294.5	173.4	36.0	2,597.8	7,780.0
Lower	1,996.4	1,738.2	95.0	3,829.6	479.0	174.2	295.0	158.1	200.8	54.9	1,362.1	5,191.7
Middle	2,614.7	1,345.7	142.5	4,102.9	1,196.1	94.0	37.3	77.9	220.6	76.1	1,702.0	5,804.9
Higher	4,761.2	934.9	114.9	5,811.0	800.9	84.0	49.2	108.5	250.0	5.0	1,297.7	7,108.7
Highest	3,988.4	1,491.6	129.7	5,609.8	2076.3	144.4	190.8	168.6	537.5	313.7	3,431.3	9,041.1

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	
		(d) If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	7-8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	

		(b) Report category boundaries when continuous variables were categorized	13-14
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15-16
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Burden of visual impairment associated with eye diseases: an exploratory survey of 298 Chinese patients

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2 **1 Burden of visual impairment associated with eye diseases: an exploratory**
3
4 **2 survey of 298 Chinese patients**
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6 3

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28 16 **Keywords:** economic burden, catastrophic healthcare expenditure, quality of life, visual
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1
2 **Abstract**

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4 **Objectives** To explore the economic burden, prevalence of catastrophic healthcare
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8 expenditure (CHE) and the quality of life (QoL) of Chinese patients with visual impairment
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10 (VI) associated with eye diseases.

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12 **Design** A questionnaire survey from March to May 2016 by structured face-to-face interviews
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14 of patients with VI.

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16 **Participants** 302 patients who were diagnosed with moderate VI or worse in both eyes
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18 (VA<6/18) were included and 298 patients (98.7%) completed the survey questionnaires were
19
20 eligible for the study.

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22 **Outcome measures** The economic burden was estimated by calculating participants' direct
23
24 costs covered in 2015 and the definition of CHE was out-of-pocket costs exceeding 30% of
25
26 annual household income. QoL was weighed by health utility value using time-trade-off
27
28 valuation techniques.

29
30 **Results** Annual average direct costs per patient caused by VI were US\$6988.6±10834.3 and
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32 70.3% were direct medical costs of which only 26.9% were reimbursable by medical
33
34 insurance. 32.2% of households suffered from CHE, in particular, less wealthy patients with
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36 VI living in rural areas and without medical insurance. The health utility value was rated at
37
38 0.65 on average and VI patients aged 51-57, living alone and insured by commercial medical
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40 insurance had relatively less QoL.

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42 **Conclusion** Our study explored the economic burden and QoL of visual impairment
43
44 associated with patients with eye diseases in China, indicating a substantial economic burden
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46 and poor quality of life. Preferential medical insurance policies should be designed in relation
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48 to people with VI to further reduce the health inequalities, avoid CHE and promote QoL.
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2 45 **Article Summary**

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4 46 **Strengths and limitations of this study**

5 47 1. To our knowledge, this is the first study to explore the prevalence of CHE and QoL of
6 Chinese patients with VI associated with eye diseases.

7 48
8 49 2. The face-to-face interviews were conducted in two tertiary general hospitals in Beijing,
9 which might result in potential sample selection bias.

10 50
11 51 3. There could have been recall bias because the data were self-reported by the patients.
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For peer review only

54 INTRODUCTION

55 With a large rapidly-aging population in mainland China, visual impairment (VI) is
56 emerging as a significant public health concern [1]. According to the World Health Survey
57 (2003), one in five adults reported some degree of far visual difficulty [2]. In 2015, the number
58 of people with moderate VI or worse was estimated to be 253 million globally [3]. More than
59 80% of the global total of VI occurs in developing countries [4], and 26.5% of the total of VI
60 occurs in China [5]. The prevalence of VI in China is 0.94% yet, for the people older than 50,
61 this figure rises to 5.8%. In Tibet, one of the highest and harshest human habitations on earth,
62 the prevalence is 13.2% [6-8].

63 The main impact of VI is a diminished ability to perform daily activities, which often results
64 in high health expenditures and the loss of independence [9]. The total financial cost of VI
65 worldwide was estimated to be \$3 trillion in 2010 or \$4,030 per person who is visually
66 impaired [10]. In addition to the economic burden, VI also has extensive social ramifications in
67 terms of participation in society, employment and quality of life (QoL). The World Health
68 Organization (WHO) estimated that 1% of the total global burden of disease measured as
69 Disability-Adjusted Life Years (DALY) attributable to VI increased by 47% from 12.9
70 million DALYs in 1990 to 18.8 million DALYs in 2010 [11, 12].

71 The burden of VI has been well researched in countries such as the United States, Australia
72 and some European countries [12-14]. However, little is known about the economic burden and
73 QoL of patients with VI associated with eye diseases in China. Therefore, we undertook an
74 explanatory survey to: quantify the economic burden; identify the prevalence of catastrophic
75 healthcare expenditure (CHE); and describe the QoL of Chinese patients with VI associated
76 with ocular diseases. The results will provide primary information for policy-makers when
77 allocating limited public insurance financial resources in mainland China.

79 METHODS

80 Questionnaire design

81 We conducted a questionnaire survey by structured face-to-face interviews of patients with
82 VI. The study questionnaire included standardized items developed by reviewing related
83 research as well as items developed by consulting ophthalmologists and pharmacists. The
84 survey questionnaire included four parts: 1. sociodemographic information; 2. clinic-related
85 information; 3. economic burden; 4. Quality of life.

86 *Sociodemographic information*

87 Age, gender, ethnicity, educational level, occupation, marital status, living status, current
88 living place, medical insurance, personal income, household size and household income were

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2 89 included.

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4 90 ***Clinic-related information***

5 91 Healthcare service utilization, treatment history and level of visual impairment were
6 92 included. The level of VI was divided into three categories based on the WHO visual acuity
7 93 (VA) categorization principles: 1. moderate VI ($6/60 < VA < 6/18$); 2. severe VI
8 94 ($3/60 < VA < 6/60$); 3. Total blindness ($VA < 3/60$)^[15]. Causes of VI were noted using standard
9 95 WHO methodology for surveys on VI^[16].

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14 96 ***Economic burden***

15 97 Economic burden was estimated by calculating participants' direct costs related to the
16 98 diagnosis, treatment and follow up care of eye diseases leading to VI and the expenses related
17 99 to the vision loss/inability to see in the year 2015. Direct costs included direct medical costs,
20 100 which were further divided into insurance covered and out-of-pocket parts, and direct non-
21 101 medical costs.

22
23
24 102 ***Quality of life***

25 103 The time trade-off (TTO) valuation technique is a commonly used QoL measurement,
26 104 which is understood by the majority of patients and shows good reproducibility^[17]. In our
27 105 study, TTO determined the length of lifetime the respondent would be willing to forego to
28 106 live in perfect health by asking, "Assuming you will only live for 10 years, what is the
29 107 maximum amount of that time, if any, you would be willing to trade for a return to permanent
30 108 perfect vision (1.0) during the years that remain?"^[18]

31 109 The questionnaire was designed and optimized by ophthalmologists and clinical
32 110 pharmacists in Beijing, China. After conducting a pilot field research study in a tertiary
33 111 hospital in Beijing, all of the experts agreed that the questionnaire was valid. The items and
34 112 descriptions of survey questionnaire were shown in **Appendix 1**.

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37 114 **Recruitment and sampling**

38 115 Two tertiary hospitals in Beijing were recruited based on the volume of ocular outpatient
39 116 visits using convenience sampling methods. Participants were eligible for inclusion in the
40 117 study if they were diagnosed with moderate VI or worse in both eyes ($VA < 6/18$) and were
41 118 physically and mentally able to participate in the survey and agreed to participate in the study.
42 119 We excluded participants who were pregnant, had a concomitant malignant disease or an
43 120 inability to complete the questionnaire. Given the time required for each face-to-face
44 121 interview and the volume of VI patient visits in the both sample hospitals per day, we aimed
45 122 to collect data from approximately 300 patients.

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124 **Data collection and quality control**

125 A questionnaire survey was conducted from March to May 2016 by structured face-to-face
126 interviews of outpatients admitted in ophthalmic department in Peking University Third
127 Hospital and Beijing Hospital. These two hospitals accept most ocular outpatient visits in
128 Beijing. All of the investigators were trained for standard processes via a workshop before
129 implementation of the survey to minimize performance bias. In order to control ascertainment
130 bias, the investigators read all the contents of the questionnaire during the face-to-face
131 interviews to establish that patients with VI could hear and understand the questions. The
132 interviews lasted approximately 0.5-1 hours to collect detailed information. The researchers
133 emphasized to participants that only vision-related costs were to be included after reading
134 through every question in the economic burden section to ensure accurate recording of
135 economic burden. Survey data were recorded on paper forms and translated using Epidata3.1.
136 All patients were de-identified into a unique project sequence number during data analysis to
137 ensure anonymity and control analysis bias.

139 **Outcome measures**

140 *Catastrophic healthcare expenditure*

141 CHE was defined as out-of-pocket (OOP) for healthcare over a year that exceeded a certain
142 proportion of a household's income. This threshold had been defined in many ways. One of
143 the most common definitions was OOP costs exceeding 30% of annual household income^[19].

144 *Quality of life*

145 Answers to the time trade-off questions were converted to utility value.

$$146 Z = (10 - N) / 10$$

147 Z was the health utility value; N was the number of years that the respondents were willing
148 to trade for a return to permanent perfect vision. Utility values were anchored on a scale
149 between 0 (the preference for death rather than living in the patient's current state of health)
150 and 1 (a perception of perfect health)^[17].

152 **Statistical analysis**

153 Costs and income were assessed in Chinese Yuan (CNY) and converted into United States
154 dollars (USD) uniformly based on exchange rates on June 1, 2016 (1 USD=6.5889 CNY) to
155 make the results more comparable to other published studies.

156 STATA 14.0 was applied to conduct the following statistical analysis: 1. descriptive
157 analysis of the participants' demographic information, healthcare service utilization,
158 insurance reimbursement rate, expenditures, CHE prevalence and QoL; 2. bivariate chi-square

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2 159 test on the difference of CHE prevalence and QoL value between subgroups. The level of
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4 160 statistical significance was $p < 0.05$ (two-sided).

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6 162 **Ethics Statement**

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9 163 Ethics committee approval obtained from Peking University Institution Review Board (No.
10 164 IRB00001052-16003). All participants were informed by an information sheet and have
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12 165 signed the declaration of consent to participate in the study.

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15 167 **Patient and public involvement**

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17 168 There were no patients and public involved in the development of the research
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19 169 questionnaire, the outcome measures, the design, recruitment and implementation of the study.
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21 170 The results will be disseminated through scientific journals.

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24 172 **RESULTS**

25 173 **Description of demographic characteristics**

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27 174 A total of 302 patients were included and 298 completed questionnaires were eligible for
28
29 175 this study, yielding a response rate of 98.7%. Patients' demographic data are shown in **Table**
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31 176 **1**. The mean age in sample was 65.4 and there were slightly fewer males (47.7%). Most of the
32
33 177 participants were married (85.2%), living with family (94.6%) and in urban areas (71.8%).
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35 178 41.3% of the participants were covered by Urban Employee Basic Medical Insurance
36
37 179 (UEBMI), 23.8% by New Cooperative Medical Scheme (NCMS), 14.1% by Government
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39 180 Medical Insurance (GMI), and 13.4% by Urban Resident Basic Medical Insurance (URBMI).

40 181 Of the visual-related health conditions reported, 58.4% had moderate VI, 28.9% had severe
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42 182 VI, and 12.8% were blind. 71.8% of the participants had been suffered from VI for more than
43
44 183 one year. 26.8%, 11.7% and 9.1% of the participants' VI were caused by cataract, AMD and
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46 184 vascular retinopathy separately, while 26.5% by multiple ocular diseases. The annual
47
48 185 personnel income and household income of the participants were US\$6,266.4±10,403.2 and
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50 186 US\$13,457.8±16,711.9, respectively.

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52 188 **Healthcare service utilization**

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54 189 As shown in **Table 1**, the average number of healthcare service utilization due to VI within
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56 190 1 year was 9.7 outpatient visits, ranging from 4.8 visits (cataract) to 16.7 visits (glaucoma).
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58 191 Average number and length of inpatient hospital visits were 0.6 visit within 1 year and 2.7
59
60 192 days of hospital staying per visit.

193

194 **Direct costs**

195 The total direct medical costs were US\$6,988.6±10,834.3 in 2015, including direct medical
196 costs of US\$4,909.8±8,981.7 (70.3%) and direct non-medical costs of US\$2,078.8±4,430.6
197 (29.7%).

198 As shown in **Table 2**, of the direct medical costs, outpatient fees represented the largest
199 costs at US\$3,408.5 (69.4%), followed by inpatient costs at US\$1,369.5 (27.9%). Except
200 outpatient and inpatient costs, the participants also purchased drugs by themselves in retail
201 pharmacies (2.7%). Only 10.6% of the outpatient costs, 24.4% of the inpatient costs and 2.6%
202 of the self-purchased drug costs were covered by the medical insurance. Average total OOP
203 costs per patient were US\$4211.6 (85.8%).

204 Direct non-medical costs occurred mostly due to long-term home care at US\$1,216.6
205 (58.5%). Nutrition or assistive devices, food and accommodation, escort, transportation, and
206 home modifications costs accounted for 13.3%, 8.5%, 7.7%, 7.2% and 4.7% respectively.

207 The specific costs among different groups were shown in the **Appendix 2**.

209 **Insurance reimbursement rate**

210 As shown in **Table 3**, 28.1%, 9.5%, 2.7% and 26.9% of the outpatient, inpatient, self-
211 purchased drugs and total direct medical costs caused by VI were reimbursable. However, the
212 reimbursement rate decreased with the severity of VI (moderate VI 28.1%, severe VI 27.0%,
213 blind 21.4%) and increased with patient's economic status (lowest 15.0%, lower 25.4%,
214 middle 28.7%, higher 31.7% and highest 39.3%). Rural patients received a lower
215 reimbursement rate (13.9%) as most of their medical insurance scheme was NCMS which has
216 much lower reimbursement rate than other insurance schemes. The reimbursement rate of
217 different diseases ranged from AMD (23.9%) and glaucoma (24.8%) to cataract (26.7%) and
218 multiple ocular diseases (32.1%).

220 **Prevalence of CHE**

221 Patients with VI paid in direct medical costs an average amount equal to 111.5% of their
222 individual annual income and 51.9% of their household's annual income. As shown in **Table**
223 **3**, 32.2% households suffered from CHE caused by VI. The prevalence of CHE was generally
224 correlated with the severity of VI (moderate VI 28.2%, severe VI 31.4%, blind 52.6%; $p<0.05$).
225 Patients living in rural areas generally had greater risk of CHE compared with urban residents
226 (47.6%, 26.2%; $p<0.001$). Of all of the different types of medical insurances, the CHE
227 prevalence of patients without medical insurance and insured by NCMS ostensibly
228 outweighed those insured by GMI and CMI (none 50.0%, NCMS 47.9%, GMI 16.7%, CMI

229 21.4%; $p<0.01$). In relation to the patients' economic status, the less wealthy patients (those
230 with lower or the lowest economic status) were much more likely to encounter CHE than
231 wealthier patients ($p<0.01$). Patients with AMD (51.4%) and glaucoma (24.8%) had much
232 higher risk of CHE than those with cataract (17.5%, $p=0.01$).

234 QoL

235 As shown in **Table 3**, the value of QoL was 0.65 on average and correlated with the severity
236 of VI (moderate VI 0.69, severe VI 0.65, blind 0.49; $p<0.01$). Middle-aged patients (51-70)
237 had the poorest life quality (0.58; $p<0.001$) and patients living alone had relatively poorer
238 QoL than living with family (0.58, 0.68; $p<0.01$). Of all of the different types of medical
239 insurances, the health utility values of patients insured by CMI were significantly lower than
240 those insured by URBMI (0.49, 0.81; $p<0.01$). Patients with multiple ocular diseases (0.56)
241 had relatively poorer QoL than those with cataract (0.76) and AMD (0.72, $p<0.001$).

243 DISCUSSION

244 This study provided primary information for the economic burden and QoL of Chinese
245 patients with VI associated with ocular diseases, indicating a substantial burden of VI, with
246 considerable variation among the different level of VI, type of medical insurance and
247 economic status.

248 In our study, annual direct medical costs per VI patient associated with ocular disease were
249 US\$4,093.1 for moderate VI, US\$6,321.8 for severe VI and US\$5,453.9 for blindness, which
250 were much lower than several previous studies in the US, which reported mean annual direct
251 medical expenses per patient to be US\$12,175-14,029 for moderate VI, US\$13,154-16,321
252 for severe VI and US\$14,882-24,180 for blindness^[12]. This was understandable as the gross
253 domestic product per capita of China was much lower than the United States in 2015 (China
254 (US\$8,033.4), US (US\$56,803.5))^[20]. Direct medical costs occurred mostly due to outpatient
255 visits, which was inconsistent with formal findings in the United States and Australia that
256 direct medical costs occurred mostly due to hospitalization^[12]. As for different diseases, AMD
257 and glaucoma reported highest average annual direct medical costs in our study (US\$8,821.8,
258 US\$7,414.8), which were higher than studies of AMD in Thailand (US\$3,604),^[21] and
259 glaucoma in Germany (€814-€1195), UK (€457-1065), France (€313-€1002) and Italy (€153-
260 €791).^[14,22] Previous studies demonstrated that even mild visual impairment had a significant
261 and independent impact on vision-specific functioning^[23] and diminished ability to perform
262 activities of daily living alone, which led to long-term care for patients. Therefore, it was not
263 surprising that the highest direct non-medical costs came from long-term home care (58.5%).

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2 264 A possible explanation for high nutrition or assistive devices costs (13.3%) in our study was
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4 265 that people in China were keen on buying nutrition or devices that usually advertised in the
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6 266 media,^[24] especially those visually impaired patients who rarely went out and had no other
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8 267 choices but to listen to TV for entertainment.

9 268 Our research showed that Chinese patients with VI had a relatively-high financial burden,
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11 269 resulting in 32.2% households suffered from CHE. Patients with VI paid in direct costs an
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13 270 average amount equal to 111.5% of their individual annual income and 51.9% of their
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15 271 household's annual income, which indicated that the patients themselves are clearly unable to
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17 272 meet such substantial costs and the exorbitant burden was too costly for even the entire
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19 273 household to maintain. In particular, for households that have a lower economic status, the
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21 274 discrepancy between costs and income was greater, which made them more vulnerable facing
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23 275 the CHE. Medical insurance plays a vital role in preventing patients from CHE by assisting
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25 276 to cover patients' medical expenses. However, our results showed that the average insurance
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27 277 reimbursement rate of Chinese VI patients was low (26.9%), and varied greatly between
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29 278 different insurance schemes. Patients without medical insurance recorded the highest CHE
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31 279 prevalence and patients insured by NCMS, with the relatively lowest reimbursement rate ^[25],
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33 280 had substantially higher CHE prevalence than those with the highest reimbursement rate (GMI
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35 281 and CMI). Patients living in rural areas, who usually had a relatively low economic status and
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37 282 were insured by NCMS ^[26] were ostensibly at greater risk of CHE. This was the result of the
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39 283 "urban-rural dual structure" of medical insurance system in China, ^[27] which showed a
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41 284 significant difference in coverage reimbursement scope, payment level, funding level, etc.^[28]
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43 285 Besides, our study found that higher severity level of VI caused higher direct costs, but
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45 286 received a lower reimbursement rate, which resulted in dramatically increased risk of CHE
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47 287 with the severity of VI. Furthermore, patients with AMD and glaucoma with a relatively low
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49 288 reimbursement rate had a heavier economic burden and were more likely to incur catastrophic
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51 289 spending. This result may largely due to the high price of AMD treatment therapy, ^[29] which
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53 290 also explain the highest fraction of outpatient costs of AMD patients and limited drug covered
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55 291 by medical insurance. This situation was alleviated after the national pricing negotiations on
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57 292 two innovative but expensive medicines (Razumab and Conbercept) in 2017, which
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59 293 eventually reached an average price discount of 18.74% by the pharmaceutical companies and
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294 70% public medical insurance reimbursement rate by Chinese government. ^[30] Recommended
295 management of glaucoma which requires regular attendance of follow-up clinic visits ^[31] may
296 explain the highest number of outpatient visit, inpatient visit, the longest stay per inpatient
297 visit as well as the high costs.

298 In addition to the economic burden posed by VI, our study also suggested that VI had a

1
2 299 substantial negative effect on health-related QoL. Moreover, the life quality of patients with
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4 300 VI (0.65) in our study was worse than patients with cancer (0.92), mild stroke (0.9), gout
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6 301 (0.86), heart failure (0.78) and HIV/AIDS (0.70)^[32]. This may largely due to the significant
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8 302 association between VI and mental stress such as anxiety,^[33] depression^[9] and cognitive
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10 303 functions.^[34] Among the study population, the utility value decreased dramatically with
11
12 304 perceived total loss of vision, which was consistent with a study in rural Africa^[35]. Previous
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14 305 studies have suggested that the utility values most highly correlated with the visual acuity in
15
16 306 the better seeing eye, and as the vision in the better seeing eye decreased, the corresponding
17
18 307 utility value decreased.^[36] Patients with cataract reported the highest TTO utility value (0.76)
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20 308 than those with other diseases especially multi ocular diseases (0.56). One of the reasons for
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22 309 this is that cataract can be effectively treated by surgery, which is a disability-preventing and
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24 310 highly cost-effective intervention,^[37] and patients' TTO utility value could improve
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26 311 significantly after cataract surgery.^[38] Besides, living with family could slightly enhance the
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28 312 life quality rather than living alone because family members were often called on to provide
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30 313 physical and emotional support.^[39] However, unlike CHE, the life quality of visual impaired
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32 314 patients was not associated with their wealth and patients with one of the highest
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34 315 reimbursement rate insurance (CMI) had the poorest life quality in our study. Thus, efforts
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36 316 are needed to promote the access to adequate and effective treatment for visual impaired
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38 317 patients to alleviate their diseases and recover their sight. Moreover, the government should
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40 318 evade the inconvenience with daily living of the visual impaired patients by consciously
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42 319 redesigning the built environment, public facilities and services.

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44 320 We spent 3 months in two tertiary hospitals to interview 298 individuals. Due to the
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46 321 limitation of movement for patients with VI in China several limitations to this study should
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48 322 be noted. First, the face-to-face interviews were conducted in tertiary general hospitals in
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50 323 Beijing, which might result in a sample with higher education levels, income, treatment costs,
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52 324 better health insurance, more serious disease than the average level of all the patients with VI
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54 325 in China. Second, there could have been recall bias because the data were self-reported by the
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56 326 patients.

57 327

58 328 **CONCLUSION**

59 329 Our study provided primary information for the economic burden and QoL of visual
60 330 impairment associated with eye diseases of patients in China, indicating that compared with
331 331 people who were sighted, people with VI experienced greater difficulties with daily living,
332 332 higher economic burden, greater chance of CHE and poorer QoL. The findings in this study

1
2 333 suggested that preferential medical insurance policies should be designed of VI to further
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4 334 reduce the health inequalities, avoid the CHE and enhance the QoL.

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13
14 340 study. Fanghui Lin and Mengyuan Fu conducted the questionnaire survey. Mengyuan Fu and
15
16 341 Dawei Zhu contributed to analysis of the data. Xiaodong Guan, Luwen Shi, Daniel Vuillermin
17
18 342 and Mengyuan Fu conducted the final analysis and drafted the initial manuscript. All authors
19
20 343 contributed to the critical revision of the paper and approved the final manuscript.

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22
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24
25 346 of the manuscript.

26 347 **Competing interests** None declared.

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28 348 **Ethics approval** Ethics committee approval obtained from Peking University Institution
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30 349 Review Board (No. IRB00001052-16003). All participants were informed by an information
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32 350 sheet and have signed the declaration of consent to participate in the study.

33 351 **Provenance and peer review** Not commissioned; externally peer reviewed.

34 352 **Data sharing statement** Data of this study can be available upon reasonable request from
35
36 353 prof. Luwen Shi, shiluwen211@163.com. In order to ensure full anonymity, confidentiality
37
38 354 and data protection for the participants, the full survey data cannot be made accessible to the
39
40 355 public.

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457 **Table 1** General characteristics of sample visual impaired patients in 2015.

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)
Total	298	9.7	0.6	2.7	13,457.8
Age					
19-50 years old	39 (13.1)	11.4	1.1	3.5	12,696.0
51-70 years old	125 (41.9)	10.8	0.6	2.6	13,452.4
71-90 years old	134 (45.0)	8.1	0.4	2.5	13,684.4
Gender					
Male	142 (47.7)	10.7	0.6	2.7	14,408.2
Female	156 (52.3)	8.8	0.5	2.7	12,592.6
Ethnicity					
Han	278 (93.3)	9.4	0.6	2.7	12,788.9
Minority	20 (6.7)	13.9	0.7	2.1	22,755.0
Educational level					
Primary and below	71 (23.8)	9.3	0.5	1.9	6,945.0
Middle and high school	159 (53.4)	9.9	0.6	2.7	13,853.7
College and above	68 (22.8)	9.6	0.7	3.3	19,332.0
Occupation *					
Management personnel	32 (10.7)	12.1	0.8	2.3	15,623.8
Professional personnel	81 (27.2)	9.0	0.6	2.5	16,599.2
General staff	89 (29.9)	10.1	0.6	2.2	14,206.2
Farmer	56 (18.8)	6.9	0.4	2.0	4,707.6
Other professions	11 (3.7)	14.0	0.5	2.9	28,215.5
Unemployed	29 (9.7)	7.7	1.0	3.1	11,295.3
Marital status					
Unmarried	44 (14.8)	5.0	0.8	2.4	12,740.7

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)
Married	254 (85.2)	10.5	0.5	2.7	13,582.0
Living status					
Alone	16 (5.4)	7.9	0.6	5.6	6,304.6
With family	282 (94.6)	9.8	0.6	2.5	13,863.6
Current living place					
Urban	214 (71.8)	9.7	0.6	2.7	15,792.0
Rural	84 (28.2)	9.6	0.6	2.6	7,511.1
Medical insurance †					
None	8 (2.7)	18.1	1.4	3	18,299.2
NCMS	71 (23.8)	9.8	0.6	2.3	15,099.4
URBMI	40 (13.4)	8.1	0.4	1.8	11,345.5
UEBMI	123 (41.3)	10.2	0.5	3.6	6,333.6
GMI	42 (14.1)	7.9	0.5	1.8	31,936.8
CMI	14 (4.7)	5.5	1.5	1.4	4,249.6
level of VI					
Moderate VI	174 (58.4)	9.7	0.4	1.8	15,021.5
Severe VI	86 (28.9)	9.6	0.7	3.5	12,308.5
Blind	38 (12.8)	10.0	1.2	4.7	8,898.5
Duration of VI ‡					
3-6 months	36 (12.1)	4.6	0.4	1.3	12,948.3
6-12 months	48 (16.1)	7.5	0.5	2.8	9,755.8
More than 12 months	214 (71.8)	11.1	0.6	2.9	14,373.8
Cause of VI					
Cataract	80 (26.8)	4.8	0.3	1.5	10,898.1
AMD	35 (11.7)	12.1	0.3	1.4	12,185.9
Vascular retinopathy	27 (9.1)	8.9	0.9	2.1	14,326.4

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)
Glaucoma	17 (5.7)	16.7	1.2	6.2	17,850.1
Other eye diseases	60 (20.1)	10.1	0.6	2.6	11,511.3
Multiple ocular diseases	79 (26.5)	12.0	0.7	3.8	16,849.5
Economic status §					
Lowest	59 (19.8)	10.0	0.6	2.3	2,445.9
Lower	59 (19.8)	7.7	0.8	3.9	6,464.2
Middle	60 (20.1)	8.3	0.5	3.3	10,890.3
Higher	60 (20.1)	14.2	0.5	1.4	15,481.5
Highest	60 (20.1)	8.4	0.6	2.4	32,134.7

* Occupation included current profession of unretired participants and former profession for the retired. Professional personnel were professional and technical personnel, i.e. teachers, doctors, lawyers, engineer among others.

† Public insurance included new cooperative medical scheme in rural area (NCMS), urban employee basic medical insurance (UEBMI), urban resident basic medical insurance (URBMI) and Government medical insurance (GMI). NCMS was insurance for rural residents, UEBMI was for urban employees of urban enterprises, and URBMI was for those who were not employed or flexible employees and children with urban household registration, students of urban schools, and rural migrants who worked in cities. GMI, also called publicly-funded free medical care, was insurance for some of the civil servants and personnel at public institutions. Commercial medical insurance (CMI) was supplements of public medical insurance, purchased by respondents' employers or by themselves from insurance company.

‡ Duration of VI was defined by the period from the time which the participants became their current visual impaired level.

§ Economic status was divided into five equal intervals based on household income per capita of the study participants. Lowest US\$[60.7, 1274.9]; Lower US\$[1365.9, 2428.3]; Middle US\$[2529.5, 4097.8]; Higher US\$[4249.6, 6677.9]; Highest US\$[7183.8, 37942.6].

Table 2 Annual direct costs of Chinese patients with visual impairment associated with ocular diseases.

Characteristics	Mean (USD)	Median (USD)	Max (USD)	Min (USD)	Proportion (%)
Direct medical costs *					70.3
Outpatient costs					69.4
Total	3,408.5	607.1	68,296.7	0.0	
Drug	2,352.7	215.5	54,637.3	0.0	
Out-of-pocket	3,048.5	324.8	68,296.7	0.0	
Inpatient costs					27.9
Total	1,369.5	0.0	31,871.8	0.0	
Drug	408.8	0.0	12,748.7	0.0	

Out-of-pocket	1,034.8	0.0	31,871.8	0.0	
Self-purchased drugs costs					2.7
Total	131.8	0.0	4,553.1	0.0	
Out-of-pocket	128.3	0.0	4,553.1	0.0	
Total direct medical costs	4,909.8	1,517.7	70,573.2	0.0	100.0
Direct non-medical costs					29.7
Long-term home care	1,216.6	0.0	28,836.4	0.0	58.5
Transportation	149.8	15.2	5,463.7	0.0	7.2
Food or accommodation	176.8	0.0	9,106.2	0.0	8.5
Escort †	161.1	15.2	6,677.9	0.0	7.7
Nutrition or assistive devices	277.1	0.0	4,629.0	0.0	13.3
Home modifications	97.5	0.0	6,070.8	0.0	4.7
Total direct non-medical costs	2,078.8	440.1	33,237.7	0.0	100.0
Total direct costs	6,988.6	2,281.8	101,079.1	45.5	100.0

* Direct medical costs measured the cost of resources used for treating a particular illness and consisted of outpatient costs, inpatient costs and self-purchased drugs costs. Outpatient costs were vision-related medical costs during outpatient visits, including registration fee, medical service fee, treatment fee, examination fee, drug expenses, medical supply expenses, etc. Inpatient costs were vision-related medical costs during hospitalization, including medical service fee, treatment fee, examination fee, surgery fee, drug expenses, medical supply expenses, etc. Expenditures of medicine prescribed and purchased during outpatient and inpatient visits in hospitals were included in outpatient and inpatient drug costs, respectively. The cost of self-purchased drugs was the expense of the drugs that patients bought in pharmacies (not in hospitals) for their ocular disease treatment after the initial diagnosis.

† Cost of escort were meals, transport and accommodation costs encountered by patients' escorts during all outpatient or inpatient visits.

Table 3 Reimbursement rate, proportion of CHE and QoL by related characteristics.

Characteristics	Reimbursement rate (%)*				CHE		QoL	
	Outpatient	Inpatient	SPD	Total	Proportion (%)	<i>p</i>	Mean	<i>p</i>
Total	28.1	9.5	2.7	26.9	32.2		0.65	
Level of VI								
Moderate VI	29.9	6.4	2.9	28.1	28.2	0.014	0.69	0.001
Severe VI	26.9	14.8	2.9	27.0	31.4		0.65	
Blind	22.2	11.7	1.4	21.4	52.6		0.49	
Cause of VI								
Cataract	29.5	4.3	2.3	26.7	17.5	0.010	0.76	0.000
AMD	26.9	7.6	0.6	23.9	51.4		0.72	

Characteristics	Reimbursement rate (%)*				CHE		QoL	
	Outpatient	Inpatient	SPD	Total	Proportion (%)	<i>p</i>	Mean	<i>p</i>
Vascular retinopathy	24.8	9.4	1.7	25.2	37.0		0.67	
Glaucoma	32.4	19.7	0.0	24.8	41.2		0.64	
Other eye diseases	22.2	6.8	5.1	23.5	31.7		0.59	
Multiple ocular diseases	31.7	15.5	3.2	32.1	35.4		0.56	
Current living place								
Urban	30.9	15.0	5.9	33.5	26.2	0.000	0.67	0.450
Rural	27.9	9.2	2.5	26.5	47.6		0.62	
Medical insurance								
None	0.0	0.0	0.0	0.0	50.0	0.008	0.64	0.003
NCMS	14.2	4.9	2.3	13.9	47.9		0.63	
URBMI	24.2	6.9	4.3	21.6	25.0		0.81	
UEBMI	35.7	11.3	2.1	33.5	30.9		0.63	
GMI	38.5	14.5	2.6	38.0	16.7		0.66	
CMI	26.8	15.4	7.1	31.4	21.4		0.49	
Economic status								
Lowest	15.0	4.7	3.1	14.7	54.2	0.001	0.59	0.559
Lower	25.4	12.2	2.5	23.3	33.9		0.66	
Middle	28.7	8.3	2.9	31.3	26.7		0.68	
Higher	31.7	7.0	0.0	27.2	21.7		0.73	
Highest	39.3	15.4	4.9	38.0	25.0		0.62	

* Medical insurance reimbursement rate in our study was the percent of the whole year costs that is covered by insurance.

† Abbreviations: SPD, self-purchased drugs costs; CHE, catastrophic healthcare expenditure; QoL, quality of life; NCMS, new cooperative medical scheme; UEBMI, urban employee basic medical insurance; URBMI, urban resident basic medical insurance; GMI, government medical insurance; CMI, commercial medical insurance.

Supplementary File

Burden of visual impairment associated with eye diseases: an exploratory survey of 298 Chinese patients

Appendix 1 The items of the survey questionnaire.

Variable name	Description
Sociodemographic information	
age	[19,50], [51,70], [71,90]
gender	Male, Female
ethnicity	Han, Minority
educational level	Primary and below, Middle and high school, College and above
Occupation *	Management personnel, Professional personnel, General staff, Farmer, Other professions, Unemployed
marital status	Unmarried, Married
living status	Alone, With family
current living place	Urban, Rural
medical insurance †	None, NCMS, URBMI, UEBMI, GMI, CMI,
personal income	Continuous
household size	Continuous
household income	Continuous
Clinic-related information	
level of visual impairment	moderate VI , severe VI , blind
Duration of visual impairment ‡	3-6 months, 6-12 months, More than 12 months
Cause of visual impairment	Cataract, AMD, Vascular retinopathy, Glaucoma, Other eye diseases, Multiple ocular diseases
Outpatient visit	Continuous
Inpatient visit	Continuous
Hospital stay per visit	Continuous
Economic burden	
Direct medical costs §	
Outpatient costs	Continuous
Outpatient drug costs	Continuous
Outpatient out-of-pocket costs	Continuous
Inpatient costs	Continuous
Inpatient drug costs	Continuous
Inpatient out-of-pocket costs	Continuous
Self-purchased drugs costs	Continuous
Self-purchased drugs out-of-pocket costs	Continuous
Direct non-medical costs	
Long-term home care costs	Continuous
Transportation costs	Continuous
Food or accommodation costs	Continuous
Escort costs	Continuous
Nutrition or assistive devices costs	Continuous
Home modifications	Continuous
Quality of life	Continuous

* Occupation included current profession of unretired participants and former profession for the retired. Professional personnel were professional and technical personnel, i.e. teachers, doctors, lawyers, engineer, etc.

† Public insurance included new cooperative medical scheme in rural area (NCMS), urban employee basic medical insurance (UEBMI), urban resident basic medical insurance (URBMI) and government medical insurance (GMI). Commercial medical insurance (CMI) was supplements of public medical insurance purchased by respondents' employers or by themselves.

‡ Duration of VI was defined by the period from the time which the participants became their current visual impaired level.

§ Direct medical costs measured the cost of resources used for treating a particular illness, consisted of outpatient costs, inpatient costs and self-purchased drugs costs. Expenditures for medicine prescribed and purchased during outpatient and inpatient visits in hospitals were included in outpatient and inpatient drug costs, respectively. The cost of self-purchased drugs was the expense of the drugs that patients bought in pharmacies (not in hospitals) for their ocular disease treatment after the initial diagnosis.

|| Cost of escort were meals, transport and accommodation costs encountered by patients' escorts during all outpatient or inpatient visits.

Supplementary File

Burden of visual impairment associated with eye diseases: an exploratory survey of 298 Chinese patients

Appendix 2 Annual direct costs of different visual impaired patients in China.

Characteristics	Direct medical costs (USD)				Direct non-medical costs (USD)							Total direct costs (USD)
	Outpatient	Inpatient	Self-purchased drugs	Total	Long-term home care	Transportation	Food or accommodation	Escort	Nutrition or assistive devices	Home modifications	Total	
Total	3,408.5	1,369.5	131.8	4,909.8	1,216.6	149.8	176.7	161.1	277.1	97.5	2,078.8	6,988.6
Age												
19-50 years old	2,009.3	3,572.4	211.5	5,793.2	1,269.1	248.1	407.7	249.6	77.8	43.2	2,295.5	8,088.7
51-70 years old	3,479.0	1,062.6	156.3	4,697.9	963.7	161.1	216.6	178.5	226.3	75.3	1,821.6	6,519.6
71-90 years old	3,749.9	1,014.6	85.8	4,850.3	1,437.2	110.6	72.4	119.1	382.4	134.0	2,255.7	7,106.0
Gender												
Male	3,321.3	1,860.7	98.6	5,280.6	1,069.2	130.7	132.7	179.2	300.4	118.4	1,930.6	7,211.2
Female	3,487.8	922.4	162.0	4,572.3	1,350.8	167.2	216.9	144.6	255.8	78.5	2,213.8	6,786.0
Ethnicity												
Han	3,404.2	1,325.0	130.2	4,859.4	1,039.7	135.5	166.1	167.0	250.6	86.5	1,845.5	6,704.8
Minority	3,468.1	1,988.2	154.7	5,611.0	3,675.2	348.7	324.7	78.2	645.0	250.4	5,322.3	10,933.2
Educational level												
Primary and below	2,924.6	991.6	85.3	4,001.6	2,331.9	173.9	138.3	96.1	146.7	51.3	2,938.2	6,939.8
Middle and high school	3,894.0	1,440.2	174.5	5,508.7	887.0	134.9	163.0	210.6	237.4	117.8	1,750.8	7,259.6
College and above	2,778.4	1,598.7	80.5	4,457.7	822.8	159.4	248.9	113.2	505.8	98.3	1,948.5	6,406.2
Occupation												
Management personnel	5,325.1	2,859.9	131.6	8,316.6	840.4	125.8	115.9	149.4	274.8	38.4	1,544.7	9,861.3
Professional personnel	3,924.7	1,129.7	137.3	5,191.6	1,035.5	182.0	281.2	207.9	503.9	111.5	2,322.1	7,513.7
General staff	2,751.8	1,414.9	97.5	4,264.1	1,592.0	156.1	136.3	97.0	211.6	109.5	2,302.4	6,566.5
Farmer	3,246.6	483.0	137.8	3,867.3	1,036.3	128.3	141.2	147.0	127.0	32.6	1,612.5	5,479.8
Other professions	2,467.8	2,635.3	146.8	5,249.9	2,731.9	172.9	242.8	226.6	531.3	275.9	4,181.6	9,431.4
Unemployed	2,536.8	1,487.3	204.9	4,229.1	758.8	100.0	119.8	242.1	40.4	144.4	1,405.7	5,634.8
Marital status												
Unmarried	869.9	1,715.0	172.2	2,757.1	1,922.0	78.0	59.7	71.5	120.7	79.4	2,331.4	5,088.5
Married	3,848.2	1,309.6	124.8	5,282.7	1,094.4	162.2	197.0	176.6	304.2	100.6	2,035.1	7,317.8
Living status												
Alone	1,546.6	1,218.0	138.6	2,903.2	1,015.9	82.9	39.2	126.8	158.1	95.8	1,518.7	4,422.0
With family	3,514.1	1,378.1	131.4	5,023.6	1,228.0	153.6	184.6	163.0	283.8	97.6	2,110.6	7,134.3

Characteristics	Direct medical costs (USD)				Direct non-medical costs (USD)							Total direct costs (USD)
	Outpatient	Inpatient	Self-purchased drugs	Total	Long-term home care	Transportation	Food or accommodation	Escort	Nutrition or assistive devices	Home modifications	Total	
Current residence												
Urban	3,463.3	1,411.9	105.2	4,980.5	1,347.2	143.6	176.7	136.5	319.9	111.6	2,235.7	7,216.1
Rural	3,268.7	1,261.5	199.5	4,729.8	883.8	165.5	176.9	223.8	167.8	61.5	1,679.8	6,409.1
Medical insurance												
None	298.9	4,249.6	202.1	4,750.5	4,078.8	192.6	147.0	180.2	154.5	151.8	4,905.0	9,655.5
NCMS	3,488.4	1,208.2	209.3	4,905.9	881.5	156.2	173.2	233.0	96.9	42.8	1,583.8	6,489.6
URBMI	3,258.8	359.3	65.0	3,683.1	1,061.2	71.0	23.5	86.2	103.0	25.0	1,370.0	5,053.1
UEBMI	3,351.3	1,658.9	123.1	5,133.3	1,251.4	181.4	225.9	115.2	326.5	112.1	2,212.4	7,345.7
GMI	3,924.8	1,368.5	92.1	5,385.3	1,585.7	128.4	183.4	252.0	500.4	195.1	2,845.0	8,230.3
CMI	4,160.8	888.9	85.7	5,135.4	311.7	104.2	197.8	130.1	653.7	130.1	1,527.6	6,663.0
level of VI												
Moderate VI	3,120.7	853.8	118.6	4,093.1	916.4	142.4	138.5	125.9	222.0	65.3	1,610.4	5,703.5
Severe VI	4,479.9	1,694.5	147.5	6,321.8	1,793.8	158.7	226.7	128.2	293.3	137.0	2,737.6	9,059.5
Blind	2,301.6	2,995.5	156.8	5,453.9	1,284.8	163.9	238.9	396.6	492.7	155.8	2,732.6	8,186.5
duration of VI												
3-6 months	1,574.8	503.8	225.0	2,303.6	1,643.7	103.1	89.4	110.6	308.8	123.5	2,379.2	4,682.7
6-12 months	2,182.5	1,070.6	70.9	3,324.0	429.4	152.8	282.8	104.2	104.5	85.4	1,159.1	4,483.0
More than 12 months	3,992.0	1,582.2	129.8	5,703.9	1,321.3	157.0	167.6	182.4	310.4	95.9	2,234.6	7,938.6
Cause of VI												
Cataract	1,236.9	583.9	27.5	1,848.3	790.1	55.1	67.7	48.4	63.2	19.4	1,043.7	2,892.0
AMD	8,162.3	524.7	134.8	8,821.8	346.9	189.3	172.0	174.6	480.9	0.0	1,363.7	10,185.5
Vascular retinopathy	4,151.1	2,270.9	249.9	6,671.9	930.5	139.1	84.9	141.1	237.9	194.2	1,727.8	8,399.7
Glaucoma	4,909.7	2,297.1	208.0	7,414.8	380.0	78.6	100.9	102.7	118.7	35.7	816.6	8,231.4
Other eye diseases	1,656.8	2,350.2	180.2	4,187.1	1,781.2	278.0	414.6	203.0	145.3	76.4	2,898.5	7,085.7
Multiple ocular diseases	4,255.0	1,286.8	142.7	5,684.5	1,882.8	149.8	156.4	256.8	550.9	216.2	3,212.9	8,897.5
Economic status												
Lowest	3,662.3	1,342.8	177.1	5,182.2	1,523.5	254.6	315.7	294.5	173.4	36.0	2,597.8	7,780.0
Lower	1,996.4	1,738.2	95.0	3,829.6	479.0	174.2	295.0	158.1	200.8	54.9	1,362.1	5,191.7
Middle	2,614.7	1,345.7	142.5	4,102.9	1,196.1	94.0	37.3	77.9	220.6	76.1	1,702.0	5,804.9
Higher	4,761.2	934.9	114.9	5,811.0	800.9	84.0	49.2	108.5	250.0	5.0	1,297.7	7,108.7
Highest	3,988.4	1,491.6	129.7	5,609.8	2076.3	144.4	190.8	168.6	537.5	313.7	3,431.3	9,041.1

* Abbreviations: NCMS, new cooperative medical scheme; UEBMI, urban employee basic medical insurance; URBMI, urban resident basic medical insurance; GMI, government medical insurance; CMI, commercial medical insurance.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6-7
		(b) Describe any methods used to examine subgroups and interactions	6-7
		(c) Explain how missing data were addressed	/
		(d) If applicable, describe analytical methods taking account of sampling strategy	/
		(e) Describe any sensitivity analyses	/
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	/
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	/
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	/

		(b) Report category boundaries when continuous variables were categorized	15-17
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	18-19
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	/
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Burden of visual impairment associated with eye diseases: an exploratory survey of 298 Chinese patients

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2 **1 Burden of visual impairment associated with eye diseases: an exploratory**
3
4 **2 survey of 298 Chinese patients**
5

6 3

7 4 Xiaodong Guan,^{1,2} Mengyuan Fu,¹ Fanghui Lin,² Dawei Zhu,^{2,3} Daniel Vuillermin,⁴ and Luwen
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20 15

21 16

22 17 **Keywords:** economic burden, catastrophic healthcare expenditure, quality of life, visual
23 18 impairment
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1
2 **Abstract**

3
4 **Objectives** To explore the economic burden, prevalence of catastrophic healthcare
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6
7
8 expenditure (CHE) and the quality of life (QoL) of Chinese patients with visual impairment
9
10 (VI) associated with eye diseases.

11
12 **Design** A questionnaire survey from March to May 2016 by structured face-to-face interviews
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14
15 of patients with VI.

16
17 **Participants** 302 patients who were diagnosed with moderate VI or worse in both eyes
18
19
20 (VA<6/18) were included and 298 patients (98.7%) completed the survey questionnaires were
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22
23 eligible for the study.

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25 **Outcome measures** The economic burden was estimated by calculating participants' direct
26
27
28 costs covered in 2015 and the definition of CHE was out-of-pocket costs exceeding 30% of
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30
31 annual household income. QoL was weighed by health utility value using time-trade-off
32
33
34 valuation techniques.

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36 **Results** Annual average direct costs per patient caused by VI were US\$6988.6±10834.3 and
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38
39 70.3% were direct medical costs of which only 26.9% were reimbursable by medical
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41
42 insurance. 32.2% of households suffered from CHE, in particular, less wealthy patients with
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44
45 VI living in rural areas and without medical insurance. The health utility value was rated at
46
47
48 0.65 on average and VI patients aged 51-57, living alone and insured by commercial medical
49
50
51 insurance had relatively less QoL.

52
53 **Conclusion** Our study explored the economic burden and QoL of visual impairment
54
55
56 associated with patients with eye diseases in China, indicating a substantial economic burden
57
58
59 and poor quality of life. Preferential medical insurance policies should be designed in relation
60
61
62 to people with VI to further reduce the health inequalities, avoid CHE and promote QoL.

1
2 45 **Article Summary**

3
4 46 **Strengths and limitations of this study**

5 47 1. To our knowledge, this is the first study to explore the prevalence of CHE and QoL of
6 Chinese patients with VI associated with eye diseases.

7 48
8 49 2. The face-to-face interviews were conducted in two tertiary general hospitals in Beijing,
9 which might result in potential sample selection bias.

10 50
11 51 3. There could have been recall bias because the data were self-reported by the patients.
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For peer review only

54 INTRODUCTION

55 With a large rapidly-aging population in mainland China, visual impairment (VI) is
56 emerging as a significant public health concern [1]. According to the World Health Survey
57 (2003), one in five adults reported some degree of far visual difficulty [2]. In 2015, the number
58 of people with moderate VI or worse was estimated to be 253 million globally [3]. More than
59 80% of the global total of VI occurs in developing countries [4], and 26.5% of the total of VI
60 occurs in China [5]. The prevalence of VI in China is 0.94% yet, for the people older than 50,
61 this figure rises to 5.8%. In Tibet, one of the highest and harshest human habitations on earth,
62 the prevalence is 13.2% [6-8].

63 The main impact of VI is a diminished ability to perform daily activities, which often results
64 in high health expenditures and the loss of independence [9]. The total financial cost of VI
65 worldwide was estimated to be \$3 trillion in 2010 or \$4,030 per person who is visually
66 impaired [10]. In addition to the economic burden, VI also has extensive social ramifications in
67 terms of participation in society, employment and quality of life (QoL). The World Health
68 Organization (WHO) estimated that 1% of the total global burden of disease measured as
69 Disability-Adjusted Life Years (DALY) attributable to VI increased by 47% from 12.9
70 million DALYs in 1990 to 18.8 million DALYs in 2010 [11, 12].

71 The burden of VI has been well researched in countries such as the United States, Australia
72 and some European countries [12-14]. However, little is known about the economic burden and
73 QoL of patients with VI associated with eye diseases in China. Therefore, we undertook an
74 explanatory survey to: quantify the economic burden; identify the prevalence of catastrophic
75 healthcare expenditure (CHE); and describe the QoL of Chinese patients with VI associated
76 with ocular diseases. The results will provide primary information for policy-makers when
77 allocating limited public insurance financial resources in mainland China.

79 METHODS

80 Questionnaire design

81 We conducted a questionnaire survey by structured face-to-face interviews of patients with
82 VI. The study questionnaire included standardized items developed by reviewing related
83 research as well as items developed by consulting ophthalmologists and pharmacists. The
84 survey questionnaire included four parts: 1. sociodemographic information; 2. clinic-related
85 information; 3. economic burden; 4. Quality of life.

86 *Sociodemographic information*

87 Age, gender, ethnicity, educational level, occupation, marital status, living status, current
88 living place, medical insurance, personal income, household size and household income were

1
2 89 included.

3
4 90 ***Clinic-related information***

5 91 Healthcare service utilization, treatment history and level of visual impairment were
6 92 included. The level of VI was divided into three categories based on the WHO visual acuity
7 93 (VA) categorization principles: 1. moderate VI ($6/60 < VA < 6/18$); 2. severe VI
8 94 ($3/60 < VA < 6/60$); 3. Total blindness ($VA < 3/60$)^[15]. Causes of VI were noted using standard
9 95 WHO methodology for surveys on VI^[16].

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12
13
14 96 ***Economic burden***

15 97 Economic burden was estimated by calculating participants' direct costs related to the
16 98 diagnosis, treatment and follow up care of eye diseases leading to VI and the expenses related
17 99 to the vision loss/inability to see in the year 2015. Direct costs included direct medical costs,
20 100 which were further divided into insurance covered and out-of-pocket parts, and direct non-
21 101 medical costs.

22
23
24 102 ***Quality of life***

25 103 The time trade-off (TTO) valuation technique is a commonly used QoL measurement,
26 104 which is understood by the majority of patients and shows good reproducibility^[17]. In our
27 105 study, TTO determined the length of lifetime the respondent would be willing to forego to
28 106 live in perfect health by asking, "Assuming you will only live for 10 years, what is the
29 107 maximum amount of that time, if any, you would be willing to trade for a return to permanent
30 108 perfect vision (1.0) during the years that remain?"^[18]

31 109 The questionnaire was designed and optimized by ophthalmologists and clinical
32 110 pharmacists in Beijing, China. After conducting a pilot field research study in a tertiary
33 111 hospital in Beijing, all of the experts agreed that the questionnaire was valid. The items and
34 112 descriptions of survey questionnaire were shown in **Appendix 1**.

35 113

36 114 **Recruitment and sampling**

37 115 Two tertiary hospitals in Beijing were recruited based on the volume of ocular outpatient
38 116 visits using convenience sampling methods. Participants were eligible for inclusion in the
39 117 study if they were diagnosed with moderate VI or worse in both eyes ($VA < 6/18$) and were
40 118 physically and mentally able to participate in the survey and agreed to participate in the study.
41 119 We excluded participants who were pregnant, had a concomitant malignant disease or an
42 120 inability to complete the questionnaire. Given the time required for each face-to-face
43 121 interview and the volume of VI patient visits in the both sample hospitals per day, we aimed
44 122 to collect data from approximately 300 patients.

45 123

124 **Data collection and quality control**

125 A questionnaire survey was conducted from March to May 2016 by structured face-to-face
126 interviews of outpatients admitted in ophthalmic department in Peking University Third
127 Hospital and Beijing Hospital. These two hospitals accept most ocular outpatient visits in
128 Beijing. All of the investigators were trained for standard processes via a workshop before
129 implementation of the survey to minimize performance bias. In order to control ascertainment
130 bias, the investigators read all the contents of the questionnaire during the face-to-face
131 interviews to establish that patients with VI could hear and understand the questions. The
132 interviews lasted approximately 0.5-1 hours to collect detailed information. The researchers
133 emphasized to participants that only vision-related costs were to be included after reading
134 through every question in the economic burden section to ensure accurate recording of
135 economic burden. Survey data were recorded on paper forms and translated using Epidata3.1.
136 All patients were de-identified into a unique project sequence number during data analysis to
137 ensure anonymity and control analysis bias.

139 **Outcome measures**

140 *Catastrophic healthcare expenditure*

141 CHE was defined as out-of-pocket (OOP) for healthcare over a year that exceeded a certain
142 proportion of a household's income. This threshold had been defined in many ways. One of
143 the most common definitions was OOP costs exceeding 30% of annual household income^[19].

144 *Quality of life*

145 Answers to the time trade-off questions were converted to utility value.

$$146 Z = (10 - N) / 10$$

147 Z was the health utility value; N was the number of years that the respondents were willing
148 to trade for a return to permanent perfect vision. Utility values were anchored on a scale
149 between 0 (the preference for death rather than living in the patient's current state of health)
150 and 1 (a perception of perfect health)^[17].

152 **Statistical analysis**

153 Costs and income were assessed in Chinese Yuan (CNY) and converted into United States
154 dollars (USD) uniformly based on exchange rates on June 1, 2016 (1 USD=6.5889 CNY) to
155 make the results more comparable to other published studies.

156 STATA 14.0 was applied to conduct the following statistical analysis: 1. descriptive
157 analysis of the participants' demographic information, healthcare service utilization,
158 insurance reimbursement rate, expenditures, CHE prevalence and QoL; 2. bivariate chi-square

1
2 159 test on the difference of CHE prevalence and QoL value between subgroups. The level of
3
4 160 statistical significance was $p < 0.05$ (two-sided).

5 161

7 162 **Ethics Statement**

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9 163 Ethics committee approval obtained from Peking University Institution Review Board (No.
10 164 IRB00001052-16003). All participants were informed by an information sheet and have
11
12 165 signed the declaration of consent to participate in the study.

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14 166

16 167 **Patient and public involvement**

17 168 There were no patients and public involved in the development of the research
18
19 169 questionnaire, the outcome measures, the design, recruitment and implementation of the study.
20
21 170 The results will be disseminated through scientific journals.

22
23 171

24 172 **RESULTS**

26 173 **Description of demographic characteristics**

27
28 174 A total of 302 patients were included and 298 completed questionnaires were eligible for
29
30 175 this study, yielding a response rate of 98.7%. Patients' demographic data are shown in **Table**
31 176 **1**. The mean age in sample was 65.4 and there were slightly fewer males (47.7%). Most of the
32
33 177 participants were married (85.2%), living with family (94.6%) and in urban areas (71.8%).
34
35 178 41.3% of the participants were covered by Urban Employee Basic Medical Insurance
36 179 (UEBMI), 23.8% by New Cooperative Medical Scheme (NCMS), 14.1% by Government
37
38 180 Medical Insurance (GMI), and 13.4% by Urban Resident Basic Medical Insurance (URBMI).

39
40 181 Of the visual-related health conditions reported, 58.4% had moderate VI, 28.9% had severe
41 182 VI, and 12.8% were blind. 71.8% of the participants had been suffered from VI for more than
42
43 183 one year. 26.8%, 11.7% and 9.1% of the participants' VI were caused by cataract, AMD and
44
45 184 vascular retinopathy separately, while 26.5% by multiple ocular diseases. The annual
46
47 185 personnel income and household income of the participants were US\$6,266.4±10,403.2 and
48
49 186 US\$13,457.8±16,711.9, respectively.

50 187

52 188 **Healthcare service utilization**

53
54 189 As shown in **Table 1**, the average number of healthcare service utilization due to VI within
55
56 190 1 year was 9.7 outpatient visits, ranging from 4.8 visits (cataract) to 16.7 visits (glaucoma).
57
58 191 Average number and length of inpatient hospital visits were 0.6 visit within 1 year and 2.7
59
60 192 days of hospital staying per visit.

193

194 **Direct costs**

195 The total direct medical costs were US\$6,988.6±10,834.3 in 2015, including direct medical
196 costs of US\$4,909.8±8,981.7 (70.3%) and direct non-medical costs of US\$2,078.8±4,430.6
197 (29.7%).

198 As shown in **Table 2**, of the direct medical costs, outpatient fees represented the largest
199 costs at US\$3,408.5 (69.4%), followed by inpatient costs at US\$1,369.5 (27.9%). Except
200 outpatient and inpatient costs, the participants also purchased drugs by themselves in retail
201 pharmacies (2.7%). Only 10.6% of the outpatient costs, 24.4% of the inpatient costs and 2.6%
202 of the self-purchased drug costs were covered by the medical insurance. Average total OOP
203 costs per patient were US\$4211.6 (85.8%).

204 Direct non-medical costs occurred mostly due to long-term home care at US\$1,216.6
205 (58.5%). Nutrition or assistive devices, food and accommodation, escort, transportation, and
206 home modifications costs accounted for 13.3%, 8.5%, 7.7%, 7.2% and 4.7% respectively.

207 The specific costs among different groups were shown in the **Appendix 2**.

209 **Insurance reimbursement rate**

210 As shown in **Table 3**, 28.1%, 9.5%, 2.7% and 26.9% of the outpatient, inpatient, self-
211 purchased drugs and total direct medical costs caused by VI were reimbursable. However, the
212 reimbursement rate decreased with the severity of VI (moderate VI 28.1%, severe VI 27.0%,
213 blind 21.4%) and increased with patient's economic status (lowest 15.0%, lower 25.4%,
214 middle 28.7%, higher 31.7% and highest 39.3%). Rural patients received a lower
215 reimbursement rate (13.9%) as most of their medical insurance scheme was NCMS which has
216 much lower reimbursement rate than other insurance schemes. The reimbursement rate of
217 different diseases ranged from AMD (23.9%) and glaucoma (24.8%) to cataract (26.7%) and
218 multiple ocular diseases (32.1%).

220 **Prevalence of CHE**

221 Patients with VI paid in direct medical costs an average amount equal to 111.5% of their
222 individual annual income and 51.9% of their household's annual income. As shown in **Table**
223 **3**, 32.2% households suffered from CHE caused by VI. The prevalence of CHE was generally
224 correlated with the severity of VI (moderate VI 28.2%, severe VI 31.4%, blind 52.6%; $p<0.05$).
225 Patients living in rural areas generally had greater risk of CHE compared with urban residents
226 (47.6%, 26.2%; $p<0.001$). Of all of the different types of medical insurances, the CHE
227 prevalence of patients without medical insurance and insured by NCMS ostensibly
228 outweighed those insured by GMI and CMI (none 50.0%, NCMS 47.9%, GMI 16.7%, CMI

229 21.4%; $p<0.01$). In relation to the patients' economic status, the less wealthy patients (those
230 with lower or the lowest economic status) were much more likely to encounter CHE than
231 wealthier patients ($p<0.01$). Patients with AMD (51.4%) and glaucoma (24.8%) had much
232 higher risk of CHE than those with cataract (17.5%, $p=0.01$).

234 QoL

235 As shown in **Table 3**, the value of QoL was 0.65 on average and correlated with the severity
236 of VI (moderate VI 0.69, severe VI 0.65, blind 0.49; $p<0.01$). Middle-aged patients (51-70)
237 had the poorest life quality (0.58; $p<0.001$) and patients living alone had relatively poorer
238 QoL than living with family (0.58, 0.68; $p<0.01$). Of all of the different types of medical
239 insurances, the health utility values of patients insured by CMI were significantly lower than
240 those insured by URBMI (0.49, 0.81; $p<0.01$). Patients with multiple ocular diseases (0.56)
241 had relatively poorer QoL than those with cataract (0.76) and AMD (0.72, $p<0.001$).

243 DISCUSSION

244 This study provided primary information for the economic burden and QoL of Chinese
245 patients with VI associated with ocular diseases, indicating a substantial burden of VI, with
246 considerable variation among the different level of VI, type of medical insurance and
247 economic status.

248 In our study, annual direct medical costs per VI patient associated with ocular disease were
249 US\$4,093.1 for moderate VI, US\$6,321.8 for severe VI and US\$5,453.9 for blindness, which
250 were much lower than several previous studies in the US, which reported mean annual direct
251 medical expenses per patient to be US\$12,175-14,029 for moderate VI, US\$13,154-16,321
252 for severe VI and US\$14,882-24,180 for blindness^[12]. This was understandable as the gross
253 domestic product per capita of China was much lower than the United States in 2015 (China
254 (US\$8,033.4), US (US\$56,803.5))^[20]. Direct medical costs occurred mostly due to outpatient
255 visits, which was inconsistent with formal findings in the United States and Australia that
256 direct medical costs occurred mostly due to hospitalization^[12]. As for different diseases, AMD
257 and glaucoma reported highest average annual direct medical costs in our study (US\$8,821.8,
258 US\$7,414.8), which were higher than studies of AMD in Thailand (US\$3,604),^[21] and
259 glaucoma in Germany (€814-€1195), UK (€457-1065), France (€313-€1002) and Italy (€153-
260 €791).^[14,22] Previous studies demonstrated that even mild visual impairment had a significant
261 and independent impact on vision-specific functioning^[23] and diminished ability to perform
262 activities of daily living alone, which led to long-term care for patients. Therefore, it was not
263 surprising that the highest direct non-medical costs came from long-term home care (58.5%).

1
2 264 A possible explanation for high nutrition or assistive devices costs (13.3%) in our study was
3
4 265 that people in China were keen on buying nutrition or devices that usually advertised in the
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6 266 media,^[24] especially those visually impaired patients who rarely went out and had no other
7
8 267 choices but to listen to TV for entertainment.

9 268 Our research showed that Chinese patients with VI had a relatively-high financial burden,
10
11 269 resulting in 32.2% households suffered from CHE. Patients with VI paid in direct costs an
12
13 270 average amount equal to 111.5% of their individual annual income and 51.9% of their
14
15 271 household's annual income, which indicated that the patients themselves are clearly unable to
16
17 272 meet such substantial costs and the exorbitant burden was too costly for even the entire
18
19 273 household to maintain. In particular, for households that have a lower economic status, the
20
21 274 discrepancy between costs and income was greater, which made them more vulnerable facing
22
23 275 the CHE. Medical insurance plays a vital role in preventing patients from CHE by assisting
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25 276 to cover patients' medical expenses. However, our results showed that the average insurance
26
27 277 reimbursement rate of Chinese VI patients was low (26.9%), and varied greatly between
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29 278 different insurance schemes. Patients without medical insurance recorded the highest CHE
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31 279 prevalence and patients insured by NCMS, with the relatively lowest reimbursement rate ^[25],
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33 280 had substantially higher CHE prevalence than those with the highest reimbursement rate (GMI
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35 281 and CMI). Patients living in rural areas, who usually had a relatively low economic status and
36
37 282 were insured by NCMS ^[26] were ostensibly at greater risk of CHE. This was the result of the
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39 283 "urban-rural dual structure" of medical insurance system in China, ^[27] which showed a
40
41 284 significant difference in coverage reimbursement scope, payment level, funding level, etc.^[28]
42
43 285 Besides, our study found that higher severity level of VI caused higher direct costs, but
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45 286 received a lower reimbursement rate, which resulted in dramatically increased risk of CHE
46
47 287 with the severity of VI. Furthermore, patients with AMD and glaucoma with a relatively low
48
49 288 reimbursement rate had a heavier economic burden and were more likely to incur catastrophic
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51 289 spending. This result may largely due to the high price of AMD treatment therapy, ^[29] which
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53 290 also explain the highest fraction of outpatient costs of AMD patients and limited drug covered
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55 291 by medical insurance. This situation was alleviated after the national pricing negotiations on
56
57 292 two innovative but expensive medicines (Razumab and Conbercept) in 2017, which
58
59 293 eventually reached an average price discount of 18.74% by the pharmaceutical companies and
60
294 70% public medical insurance reimbursement rate by Chinese government. ^[30] Recommended
295 management of glaucoma which requires regular attendance of follow-up clinic visits ^[31] may
296 explain the highest number of outpatient visit, inpatient visit, the longest stay per inpatient
297 visit as well as the high costs.

298 In addition to the economic burden posed by VI, our study also suggested that VI had a

1
2 299 substantial negative effect on health-related QoL. Moreover, the life quality of patients with
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4 300 VI (0.65) in our study was worse than patients with cancer (0.92), mild stroke (0.9), gout
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6 301 (0.86), heart failure (0.78) and HIV/AIDS (0.70)^[32]. This may largely due to the significant
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8 302 association between VI and mental stress such as anxiety,^[33] depression^[9] and cognitive
9
10 303 functions.^[34] Among the study population, the utility value decreased dramatically with
11
12 304 perceived total loss of vision, which was consistent with a study in rural Africa^[35]. Previous
13
14 305 studies have suggested that the utility values most highly correlated with the visual acuity in
15
16 306 the better seeing eye, and as the vision in the better seeing eye decreased, the corresponding
17
18 307 utility value decreased.^[36] Patients with cataract reported the highest TTO utility value (0.76)
19
20 308 than those with other diseases especially multi ocular diseases (0.56). One of the reasons for
21
22 309 this is that cataract can be effectively treated by surgery, which is a disability-preventing and
23
24 310 highly cost-effective intervention,^[37] and patients' TTO utility value could improve
25
26 311 significantly after cataract surgery.^[38] Besides, living with family could slightly enhance the
27
28 312 life quality rather than living alone because family members were often called on to provide
29
30 313 physical and emotional support.^[39] However, unlike CHE, the life quality of visual impaired
31
32 314 patients was not associated with their wealth and patients with one of the highest
33
34 315 reimbursement rate insurance (CMI) had the poorest life quality in our study. Thus, efforts
35
36 316 are needed to promote the access to adequate and effective treatment for visual impaired
37
38 317 patients to alleviate their diseases and recover their sight. Moreover, the government should
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40 318 evade the inconvenience with daily living of the visual impaired patients by consciously
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42 319 redesigning the built environment, public facilities and services.

43
44 320 We spent 3 months in two tertiary hospitals to interview 298 individuals. Due to the
45
46 321 limitation of movement for patients with VI in China several limitations to this study should
47
48 322 be noted. First, the study population is not fully representative of all the patients with VI in
49
50 323 mainland China. Second, the face-to-face interviews were conducted in tertiary general
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52 324 hospitals in Beijing, which might result in a sample with higher education levels, income,
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54 325 treatment costs, better health insurance, more serious disease than the average level of all the
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56 326 patients with VI in China. Third, there could have been recall bias because the data were self-
57
58 327 reported by the patients.

59 328

60 329 **CONCLUSION**

61 330 Our study provided primary information for the economic burden and QoL of visual
62
63 331 impairment associated with eye diseases of patients in China, indicating that compared with
64
65 332 people who were sighted, people with VI experienced greater difficulties with daily living,
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67 333 higher economic burden, greater chance of CHE and poorer QoL. The findings in this study

1
2 334 suggested that preferential medical insurance policies should be designed of VI to further
3
4 335 reduce the health inequalities, avoid the CHE and enhance the QoL.

5
6 336

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15
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17
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19
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27
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29
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31
32 351 sheet and have signed the declaration of consent to participate in the study.

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34
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36
37 354 prof. Luwen Shi, shiluwen211@163.com. In order to ensure full anonymity, confidentiality
38
39 355 and data protection for the participants, the full survey data cannot be made accessible to the
40
41 356 public.

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458 **Table 1** General characteristics of sample visual impaired patients in 2015.

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)
Total	298	9.7	0.6	2.7	13,457.8
Age					
19-50 years old	39 (13.1)	11.4	1.1	3.5	12,696.0
51-70 years old	125 (41.9)	10.8	0.6	2.6	13,452.4
71-90 years old	134 (45.0)	8.1	0.4	2.5	13,684.4
Gender					
Male	142 (47.7)	10.7	0.6	2.7	14,408.2
Female	156 (52.3)	8.8	0.5	2.7	12,592.6
Ethnicity					
Han	278 (93.3)	9.4	0.6	2.7	12,788.9
Minority	20 (6.7)	13.9	0.7	2.1	22,755.0
Educational level					
Primary and below	71 (23.8)	9.3	0.5	1.9	6,945.0
Middle and high school	159 (53.4)	9.9	0.6	2.7	13,853.7
College and above	68 (22.8)	9.6	0.7	3.3	19,332.0
Occupation *					
Management personnel	32 (10.7)	12.1	0.8	2.3	15,623.8
Professional personnel	81 (27.2)	9.0	0.6	2.5	16,599.2
General staff	89 (29.9)	10.1	0.6	2.2	14,206.2
Farmer	56 (18.8)	6.9	0.4	2.0	4,707.6
Other professions	11 (3.7)	14.0	0.5	2.9	28,215.5
Unemployed	29 (9.7)	7.7	1.0	3.1	11,295.3
Marital status					
Unmarried	44 (14.8)	5.0	0.8	2.4	12,740.7

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)
Married	254 (85.2)	10.5	0.5	2.7	13,582.0
Living status					
Alone	16 (5.4)	7.9	0.6	5.6	6,304.6
With family	282 (94.6)	9.8	0.6	2.5	13,863.6
Current living place					
Urban	214 (71.8)	9.7	0.6	2.7	15,792.0
Rural	84 (28.2)	9.6	0.6	2.6	7,511.1
Medical insurance †					
None	8 (2.7)	18.1	1.4	3	18,299.2
NCMS	71 (23.8)	9.8	0.6	2.3	15,099.4
URBMI	40 (13.4)	8.1	0.4	1.8	11,345.5
UEBMI	123 (41.3)	10.2	0.5	3.6	6,333.6
GMI	42 (14.1)	7.9	0.5	1.8	31,936.8
CMI	14 (4.7)	5.5	1.5	1.4	4,249.6
level of VI					
Moderate VI	174 (58.4)	9.7	0.4	1.8	15,021.5
Severe VI	86 (28.9)	9.6	0.7	3.5	12,308.5
Blind	38 (12.8)	10.0	1.2	4.7	8,898.5
Duration of VI ‡					
3-6 months	36 (12.1)	4.6	0.4	1.3	12,948.3
6-12 months	48 (16.1)	7.5	0.5	2.8	9,755.8
More than 12 months	214 (71.8)	11.1	0.6	2.9	14,373.8
Cause of VI					
Cataract	80 (26.8)	4.8	0.3	1.5	10,898.1
AMD	35 (11.7)	12.1	0.3	1.4	12,185.9
Vascular retinopathy	27 (9.1)	8.9	0.9	2.1	14,326.4

Characteristics	n (%)	Outpatient visit	Inpatient visit	Hospital stay per visit (days)	Household income (USD)
Glaucoma	17 (5.7)	16.7	1.2	6.2	17,850.1
Other eye diseases	60 (20.1)	10.1	0.6	2.6	11,511.3
Multiple ocular diseases	79 (26.5)	12.0	0.7	3.8	16,849.5
Economic status §					
Lowest	59 (19.8)	10.0	0.6	2.3	2,445.9
Lower	59 (19.8)	7.7	0.8	3.9	6,464.2
Middle	60 (20.1)	8.3	0.5	3.3	10,890.3
Higher	60 (20.1)	14.2	0.5	1.4	15,481.5
Highest	60 (20.1)	8.4	0.6	2.4	32,134.7

* Occupation included current profession of unretired participants and former profession for the retired. Professional personnel were professional and technical personnel, i.e. teachers, doctors, lawyers, engineer among others.

† Public insurance included new cooperative medical scheme in rural area (NCMS), urban employee basic medical insurance (UEBMI), urban resident basic medical insurance (URBMI) and Government medical insurance (GMI). NCMS was insurance for rural residents, UEBMI was for urban employees of urban enterprises, and URBMI was for those who were not employed or flexible employees and children with urban household registration, students of urban schools, and rural migrants who worked in cities. GMI, also called publicly-funded free medical care, was insurance for some of the civil servants and personnel at public institutions. Commercial medical insurance (CMI) was supplements of public medical insurance, purchased by respondents' employers or by themselves from insurance company.

‡ Duration of VI was defined by the period from the time which the participants became their current visual impaired level.

§ Economic status was divided into five equal intervals based on household income per capita of the study participants. Lowest US\$[60.7, 1274.9]; Lower US\$[1365.9, 2428.3]; Middle US\$[2529.5, 4097.8]; Higher US\$[4249.6, 6677.9]; Highest US\$[7183.8, 37942.6].

Table 2 Annual direct costs of Chinese patients with visual impairment associated with ocular diseases.

Characteristics	Mean (USD)	Median (USD)	Max (USD)	Min (USD)	Proportion (%)
Direct medical costs *					70.3
Outpatient costs					69.4
Total	3,408.5	607.1	68,296.7	0.0	
Drug	2,352.7	215.5	54,637.3	0.0	
Out-of-pocket	3,048.5	324.8	68,296.7	0.0	
Inpatient costs					27.9
Total	1,369.5	0.0	31,871.8	0.0	
Drug	408.8	0.0	12,748.7	0.0	

Out-of-pocket	1,034.8	0.0	31,871.8	0.0	
Self-purchased drugs costs					2.7
Total	131.8	0.0	4,553.1	0.0	
Out-of-pocket	128.3	0.0	4,553.1	0.0	
Total direct medical costs	4,909.8	1,517.7	70,573.2	0.0	100.0
Direct non-medical costs					29.7
Long-term home care	1,216.6	0.0	28,836.4	0.0	58.5
Transportation	149.8	15.2	5,463.7	0.0	7.2
Food or accommodation	176.8	0.0	9,106.2	0.0	8.5
Escort †	161.1	15.2	6,677.9	0.0	7.7
Nutrition or assistive devices	277.1	0.0	4,629.0	0.0	13.3
Home modifications	97.5	0.0	6,070.8	0.0	4.7
Total direct non-medical costs	2,078.8	440.1	33,237.7	0.0	100.0
Total direct costs	6,988.6	2,281.8	101,079.1	45.5	100.0

* Direct medical costs measured the cost of resources used for treating a particular illness and consisted of outpatient costs, inpatient costs and self-purchased drugs costs. Outpatient costs were vision-related medical costs during outpatient visits, including registration fee, medical service fee, treatment fee, examination fee, drug expenses, medical supply expenses, etc. Inpatient costs were vision-related medical costs during hospitalization, including medical service fee, treatment fee, examination fee, surgery fee, drug expenses, medical supply expenses, etc. Expenditures of medicine prescribed and purchased during outpatient and inpatient visits in hospitals were included in outpatient and inpatient drug costs, respectively. The cost of self-purchased drugs was the expense of the drugs that patients bought in pharmacies (not in hospitals) for their ocular disease treatment after the initial diagnosis.

† Cost of escort were meals, transport and accommodation costs encountered by patients' escorts during all outpatient or inpatient visits.

Table 3 Reimbursement rate, proportion of CHE and QoL by related characteristics.

Characteristics	Reimbursement rate (%)*				CHE		QoL	
	Outpatient	Inpatient	SPD	Total	Proportion (%)	<i>p</i>	Mean	<i>p</i>
Total	28.1	9.5	2.7	26.9	32.2		0.65	
Level of VI								
Moderate VI	29.9	6.4	2.9	28.1	28.2	0.014	0.69	0.001
Severe VI	26.9	14.8	2.9	27.0	31.4		0.65	
Blind	22.2	11.7	1.4	21.4	52.6		0.49	
Cause of VI								
Cataract	29.5	4.3	2.3	26.7	17.5	0.010	0.76	0.000
AMD	26.9	7.6	0.6	23.9	51.4		0.72	

Characteristics	Reimbursement rate (%)*				CHE		QoL	
	Outpatient	Inpatient	SPD	Total	Proportion (%)	<i>p</i>	Mean	<i>p</i>
Vascular retinopathy	24.8	9.4	1.7	25.2	37.0		0.67	
Glaucoma	32.4	19.7	0.0	24.8	41.2		0.64	
Other eye diseases	22.2	6.8	5.1	23.5	31.7		0.59	
Multiple ocular diseases	31.7	15.5	3.2	32.1	35.4		0.56	
Current living place								
Urban	30.9	15.0	5.9	33.5	26.2	0.000	0.67	0.450
Rural	27.9	9.2	2.5	26.5	47.6		0.62	
Medical insurance								
None	0.0	0.0	0.0	0.0	50.0	0.008	0.64	0.003
NCMS	14.2	4.9	2.3	13.9	47.9		0.63	
URBMI	24.2	6.9	4.3	21.6	25.0		0.81	
UEBMI	35.7	11.3	2.1	33.5	30.9		0.63	
GMI	38.5	14.5	2.6	38.0	16.7		0.66	
CMI	26.8	15.4	7.1	31.4	21.4		0.49	
Economic status								
Lowest	15.0	4.7	3.1	14.7	54.2	0.001	0.59	0.559
Lower	25.4	12.2	2.5	23.3	33.9		0.66	
Middle	28.7	8.3	2.9	31.3	26.7		0.68	
Higher	31.7	7.0	0.0	27.2	21.7		0.73	
Highest	39.3	15.4	4.9	38.0	25.0		0.62	

* Medical insurance reimbursement rate in our study was the percent of the whole year costs that is covered by insurance.

† Abbreviations: SPD, self-purchased drugs costs; CHE, catastrophic healthcare expenditure; QoL, quality of life; NCMS, new cooperative medical scheme; UEBMI, urban employee basic medical insurance; URBMI, urban resident basic medical insurance; GMI, government medical insurance; CMI, commercial medical insurance.

Supplementary File

Burden of visual impairment associated with eye diseases: an exploratory survey of 298 Chinese patients

Appendix 1 The items of the survey questionnaire.

Variable name	Description
Sociodemographic information	
age	[19,50], [51,70], [71,90]
gender	Male, Female
ethnicity	Han, Minority
educational level	Primary and below, Middle and high school, College and above
Occupation *	Management personnel, Professional personnel, General staff, Farmer, Other professions, Unemployed
marital status	Unmarried, Married
living status	Alone, With family
current living place	Urban, Rural
medical insurance †	None, NCMS, URBMI, UEBMI, GMI, CMI,
personal income	Continuous
household size	Continuous
household income	Continuous
Clinic-related information	
level of visual impairment	moderate VI , severe VI , blind
Duration of visual impairment ‡	3-6 months, 6-12 months, More than 12 months
Cause of visual impairment	Cataract, AMD, Vascular retinopathy, Glaucoma, Other eye diseases, Multiple ocular diseases
Outpatient visit	Continuous
Inpatient visit	Continuous
Hospital stay per visit	Continuous
Economic burden	
Direct medical costs §	
Outpatient costs	Continuous
Outpatient drug costs	Continuous
Outpatient out-of-pocket costs	Continuous
Inpatient costs	Continuous
Inpatient drug costs	Continuous
Inpatient out-of-pocket costs	Continuous
Self-purchased drugs costs	Continuous
Self-purchased drugs out-of-pocket costs	Continuous
Direct non-medical costs	
Long-term home care costs	Continuous
Transportation costs	Continuous
Food or accommodation costs	Continuous
Escort costs	Continuous
Nutrition or assistive devices costs	Continuous
Home modifications	Continuous
Quality of life	Continuous

* Occupation included current profession of unretired participants and former profession for the retired. Professional personnel were professional and technical personnel, i.e. teachers, doctors, lawyers, engineer, etc.

† Public insurance included new cooperative medical scheme in rural area (NCMS), urban employee basic medical insurance (UEBMI), urban resident basic medical insurance (URBMI) and government medical insurance (GMI). Commercial medical insurance (CMI) was supplements of public medical insurance purchased by respondents' employers or by themselves.

‡ Duration of VI was defined by the period from the time which the participants became their current visual impaired level.

§ Direct medical costs measured the cost of resources used for treating a particular illness, consisted of outpatient costs, inpatient costs and self-purchased drugs costs. Expenditures for medicine prescribed and purchased during outpatient and inpatient visits in hospitals were included in outpatient and inpatient drug costs, respectively. The cost of self-purchased drugs was the expense of the drugs that patients bought in pharmacies (not in hospitals) for their ocular disease treatment after the initial diagnosis.

|| Cost of escort were meals, transport and accommodation costs encountered by patients' escorts during all outpatient or inpatient visits.

Supplementary File

Burden of visual impairment associated with eye diseases: an exploratory survey of 298 Chinese patients

Appendix 2 Annual direct costs of different visual impaired patients in China.

Characteristics	Direct medical costs (USD)				Direct non-medical costs (USD)							Total direct costs (USD)
	Outpatient	Inpatient	Self-purchased drugs	Total	Long-term home care	Transportation	Food or accommodation	Escort	Nutrition or assistive devices	Home modifications	Total	
Total	3,408.5	1,369.5	131.8	4,909.8	1,216.6	149.8	176.7	161.1	277.1	97.5	2,078.8	6,988.6
Age												
19-50 years old	2,009.3	3,572.4	211.5	5,793.2	1,269.1	248.1	407.7	249.6	77.8	43.2	2,295.5	8,088.7
51-70 years old	3,479.0	1,062.6	156.3	4,697.9	963.7	161.1	216.6	178.5	226.3	75.3	1,821.6	6,519.6
71-90 years old	3,749.9	1,014.6	85.8	4,850.3	1,437.2	110.6	72.4	119.1	382.4	134.0	2,255.7	7,106.0
Gender												
Male	3,321.3	1,860.7	98.6	5,280.6	1,069.2	130.7	132.7	179.2	300.4	118.4	1,930.6	7,211.2
Female	3,487.8	922.4	162.0	4,572.3	1,350.8	167.2	216.9	144.6	255.8	78.5	2,213.8	6,786.0
Ethnicity												
Han	3,404.2	1,325.0	130.2	4,859.4	1,039.7	135.5	166.1	167.0	250.6	86.5	1,845.5	6,704.8
Minority	3,468.1	1,988.2	154.7	5,611.0	3,675.2	348.7	324.7	78.2	645.0	250.4	5,322.3	10,933.2
Educational level												
Primary and below	2,924.6	991.6	85.3	4,001.6	2,331.9	173.9	138.3	96.1	146.7	51.3	2,938.2	6,939.8
Middle and high school	3,894.0	1,440.2	174.5	5,508.7	887.0	134.9	163.0	210.6	237.4	117.8	1,750.8	7,259.6
College and above	2,778.4	1,598.7	80.5	4,457.7	822.8	159.4	248.9	113.2	505.8	98.3	1,948.5	6,406.2
Occupation												
Management personnel	5,325.1	2,859.9	131.6	8,316.6	840.4	125.8	115.9	149.4	274.8	38.4	1,544.7	9,861.3
Professional personnel	3,924.7	1,129.7	137.3	5,191.6	1,035.5	182.0	281.2	207.9	503.9	111.5	2,322.1	7,513.7
General staff	2,751.8	1,414.9	97.5	4,264.1	1,592.0	156.1	136.3	97.0	211.6	109.5	2,302.4	6,566.5
Farmer	3,246.6	483.0	137.8	3,867.3	1,036.3	128.3	141.2	147.0	127.0	32.6	1,612.5	5,479.8
Other professions	2,467.8	2,635.3	146.8	5,249.9	2,731.9	172.9	242.8	226.6	531.3	275.9	4,181.6	9,431.4
Unemployed	2,536.8	1,487.3	204.9	4,229.1	758.8	100.0	119.8	242.1	40.4	144.4	1,405.7	5,634.8
Marital status												
Unmarried	869.9	1,715.0	172.2	2,757.1	1,922.0	78.0	59.7	71.5	120.7	79.4	2,331.4	5,088.5
Married	3,848.2	1,309.6	124.8	5,282.7	1,094.4	162.2	197.0	176.6	304.2	100.6	2,035.1	7,317.8
Living status												
Alone	1,546.6	1,218.0	138.6	2,903.2	1,015.9	82.9	39.2	126.8	158.1	95.8	1,518.7	4,422.0
With family	3,514.1	1,378.1	131.4	5,023.6	1,228.0	153.6	184.6	163.0	283.8	97.6	2,110.6	7,134.3

Characteristics	Direct medical costs (USD)				Direct non-medical costs (USD)							Total direct costs (USD)
	Outpatient	Inpatient	Self-purchased drugs	Total	Long-term home care	Transportation	Food or accommodation	Escort	Nutrition or assistive devices	Home modifications	Total	
Current residence												
Urban	3,463.3	1,411.9	105.2	4,980.5	1,347.2	143.6	176.7	136.5	319.9	111.6	2,235.7	7,216.1
Rural	3,268.7	1,261.5	199.5	4,729.8	883.8	165.5	176.9	223.8	167.8	61.5	1,679.8	6,409.1
Medical insurance												
None	298.9	4,249.6	202.1	4,750.5	4,078.8	192.6	147.0	180.2	154.5	151.8	4,905.0	9,655.5
NCMS	3,488.4	1,208.2	209.3	4,905.9	881.5	156.2	173.2	233.0	96.9	42.8	1,583.8	6,489.6
URBMI	3,258.8	359.3	65.0	3,683.1	1,061.2	71.0	23.5	86.2	103.0	25.0	1,370.0	5,053.1
UEBMI	3,351.3	1,658.9	123.1	5,133.3	1,251.4	181.4	225.9	115.2	326.5	112.1	2,212.4	7,345.7
GMI	3,924.8	1,368.5	92.1	5,385.3	1,585.7	128.4	183.4	252.0	500.4	195.1	2,845.0	8,230.3
CMI	4,160.8	888.9	85.7	5,135.4	311.7	104.2	197.8	130.1	653.7	130.1	1,527.6	6,663.0
level of VI												
Moderate VI	3,120.7	853.8	118.6	4,093.1	916.4	142.4	138.5	125.9	222.0	65.3	1,610.4	5,703.5
Severe VI	4,479.9	1,694.5	147.5	6,321.8	1,793.8	158.7	226.7	128.2	293.3	137.0	2,737.6	9,059.5
Blind	2,301.6	2,995.5	156.8	5,453.9	1,284.8	163.9	238.9	396.6	492.7	155.8	2,732.6	8,186.5
duration of VI												
3-6 months	1,574.8	503.8	225.0	2,303.6	1,643.7	103.1	89.4	110.6	308.8	123.5	2,379.2	4,682.7
6-12 months	2,182.5	1,070.6	70.9	3,324.0	429.4	152.8	282.8	104.2	104.5	85.4	1,159.1	4,483.0
More than 12 months	3,992.0	1,582.2	129.8	5,703.9	1,321.3	157.0	167.6	182.4	310.4	95.9	2,234.6	7,938.6
Cause of VI												
Cataract	1,236.9	583.9	27.5	1,848.3	790.1	55.1	67.7	48.4	63.2	19.4	1,043.7	2,892.0
AMD	8,162.3	524.7	134.8	8,821.8	346.9	189.3	172.0	174.6	480.9	0.0	1,363.7	10,185.5
Vascular retinopathy	4,151.1	2,270.9	249.9	6,671.9	930.5	139.1	84.9	141.1	237.9	194.2	1,727.8	8,399.7
Glaucoma	4,909.7	2,297.1	208.0	7,414.8	380.0	78.6	100.9	102.7	118.7	35.7	816.6	8,231.4
Other eye diseases	1,656.8	2,350.2	180.2	4,187.1	1,781.2	278.0	414.6	203.0	145.3	76.4	2,898.5	7,085.7
Multiple ocular diseases	4,255.0	1,286.8	142.7	5,684.5	1,882.8	149.8	156.4	256.8	550.9	216.2	3,212.9	8,897.5
Economic status												
Lowest	3,662.3	1,342.8	177.1	5,182.2	1,523.5	254.6	315.7	294.5	173.4	36.0	2,597.8	7,780.0
Lower	1,996.4	1,738.2	95.0	3,829.6	479.0	174.2	295.0	158.1	200.8	54.9	1,362.1	5,191.7
Middle	2,614.7	1,345.7	142.5	4,102.9	1,196.1	94.0	37.3	77.9	220.6	76.1	1,702.0	5,804.9
Higher	4,761.2	934.9	114.9	5,811.0	800.9	84.0	49.2	108.5	250.0	5.0	1,297.7	7,108.7
Highest	3,988.4	1,491.6	129.7	5,609.8	2076.3	144.4	190.8	168.6	537.5	313.7	3,431.3	9,041.1

* Abbreviations: NCMS, new cooperative medical scheme; UEBMI, urban employee basic medical insurance; URBMI, urban resident basic medical insurance; GMI, government medical insurance; CMI, commercial medical insurance.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6-7
		(b) Describe any methods used to examine subgroups and interactions	6-7
		(c) Explain how missing data were addressed	/
		(d) If applicable, describe analytical methods taking account of sampling strategy	/
		(e) Describe any sensitivity analyses	/
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	/
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	/
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	/

		(b) Report category boundaries when continuous variables were categorized	15-17
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	18-19
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	/
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.