

Prevalence of cataract and cataract surgery in urban and rural Chinese populations over 50 years old: a systematic review and Meta-analysis

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Abstract

• **AIM:** To summarize the data of epidemiological studies on cataract prevalence over 50 years old in urban and rural areas of China from 2000 to 2020, and to analyze the prevalence of cataract and operation rate in China.

• **METHODS:** By searching PubMed, EMBASE, Web of Science, Wanfang Data and CNKI, Chinese and English literatures on the prevalence of cataract in China were retrieved, and the relevant characteristic data were extracted. Then, Stata v15SE software was used for Meta-analysis and heterogeneity test. According to the results of heterogeneity, the corresponding effect models were selected to combine the extracted data.

• **RESULTS:** A total of 20 studies were included in this study, with a total of 111 434 cases. Meta-analysis showed heterogeneity. According to the random effect model, the overall prevalence of cataract in Chinese people over 50 years old was 27.45%, that in rural was 28.79%, and that in urban was 26.66%. The overall coverage rate of cataract surgery was 9.19%.

• **CONCLUSION:** The prevalence of cataract is high in China, and there is still room for improvement in surgical coverage, so it is very important to promote cataract screening and prevention.

• **KEYWORDS:** cataract; prevalence; surgical coverage; Meta-analysis

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INTRODUCTION

Cataract was one of the main causes of blindness which remained a major public health problem worldwide^[1]. The prevalence of cataract in developing countries was higher and the age of onset was earlier, Asia contributed the majority particularly^[2]. In China, cataract was the leading cause of low vision and blindness^[3]. Cataract were the primary causes of visual impairment in adults over 60 years old, despite the continuous efforts of public health to improve the cataract surgery rate^[4-5]. In terms of economic burden, most countries faced serious economic burden and global health progress in cataract was accompanied by widening inequality, with cataract burden being more concentrated in countries with lower socioeconomic status^[6]. China also endured a huge economic burden based on the number of patients. This made the cost of medical treatment and social impact caused by cataract blindness lead to serious damage to the economy all over the world. Although cataract was not fatal, it still had a negative influence on the quality of life in cataract patients.

The most common cause of cataract was the denaturation of protein which led to the opacity in lens. It was commonly observed in people over 50 years old, and the morbidity increases with age^[7]. Its occurrence was linked to the degeneration of metabolism in the elderly. So cataract had a profound impact on the quality of life of the elderly in pace with age^[8]. Figuring out a way to investigate the prevalence of cataract and further guide cataract screening to improve the quality of life will be one of the urgent challenges which China needs to face. Since the 1990s, Chinese researchers had started to survey and analyze the prevalence of cataract in many areas^[9-10], and the results explained that cataract was still the main cause of blindness. With the increasing proportion of the elderly in the population, the number of cataract patients in China would increase year by year, and the increasing

Table 1 Quality assessment criteria of literatures proposed by Khambalia and Seen^[11]

Scoring criteria for literature quality	Score
National epidemiological report with random sampling and large sample size ($\geq 10\,000$)	1
Provincial epidemiological report with random sampling and large sample size (≥ 1000)	2
Epidemiological reports of random sampling but investigation in a limited number of specific units (such as 2 or 3 county-level cities or research institutes)	3
Reports that are not random sampling but have a large sample size (≥ 1000)	4
Reports that are not random sampling and have a small sample size (< 1000)	5

economic burden caused by cataract was an inevitable problem. The prevalence of cataract and cataract surgical coverage has significant disparities among different regions and nationalities. However, the research on the prevalence and cataract surgical coverage in China has not been integrally analysed, which also limited the extensive cataract screening and popularization of cataract surgery in the future.

In order to further analyses the prevalence of cataract and reduce the economic burden, it was necessary to investigate the epidemiology of cataract. The purpose of this study was to summarize and analyses the research on the prevalence of cataract in China, expecting to get a preliminary assessment of the prevalent trend and provide a theoretical evidence for further cataract screening.

SUBJECTS AND METHODS

Search Strategy We searched PubMed, EMBASE, Web of Science, Wanfang Data, and CNKI for literature about the prevalence of cataract in China. In order to cover comprehensive related literature as much as possible, the search terms were set as “cataract” or “cataracts” and “prevalence” or “epidemiology” or “incidence” and “China” or “Chinese”. The time of publication was limited from July 2000 to July 2020, and the language of publication was English.

The literature was collected and screened by Endnote X9, then the related literature was screened according to the inclusion and exclusion criteria. After that, titles and abstracts of the remaining studies would be independently scanned by three authors (Du YF, Liu HR and Zhang Y). In this step, literature was selected subjectively in order to judge whether it is related to this Meta-analysis. These selected literatures would be compared, and inconsistent problems were solved through negotiation. Then we read the full text of the remaining studies to determine whether they met our inclusion criteria, but studies that were not available for the full text would be excluded. Finally, according to Chinese urban and rural classification standards (Chinese administrative divisions, the scale of county and above was urban, and the scale of village and township was rural), the literature was divided into urban and rural categories.

Inclusion Criteria The inclusion criteria were as follows: 1) The purpose of these literature was to investigate the

1. Lens opacification, including vacuoles, hydrocephalus, lamellar separation, wheel width opacification, wedge opacification, nuclear opacification and posterior subcapsular opacification, does not include a few punctate opacification which has no effect on vision.
2. The small hole visual acuity is less than 0.7, and the visual acuity decrease caused by other reasons is excluded.
3. Patients with aphakia and intraocular lens (previous cataract) are included as cataract.

Figure 1 Diagnostic criteria for cataract in included studies.

prevalence of cataract in China, and the cases included were consecutive; 2) The sampling method should be random sampling, and subjects were healthy people in a stationary region; 3) The subjects were aged 50 or above, and were stratified according to different age groups; 4) The diagnosis method of cataract was reasonable and met the standard (Figure 1); 5) The prevalence of cataract can be directly extracted or can be calculated from the original data.

Exclusion Criteria The exclusion criteria were as follows: 1) Research method was cohort study, or the study type was “comments”, “letter”, “review”, “case report”, *etc.*; 2) Repetitive articles or duplicate studied population from the identical area; 3) Had tendency when select the studied population; 4) Research data were incomplete.

Quality Assessment The quality of included studies was evaluated using the quality assessment criteria of literature proposed by Khambalia and Seen^[11]. Then the included literature was scored and summarized according to these criteria (Table 1).

Data Extraction We extracted the basic data of the final qualified literature, including the author, publish year, study region, regional category, age, sample size, literature quality score, *etc.* And research data were extracted from the literature include the number of samples older than 50y, the number of cataract patients and the prevalence.

Other data: We also collected and collated the other data of some literature in this Meta-analysis, including the prevalence of cataract in urban and rural areas respectively, the prevalence of cataract in different age groups, and the cataract surgical coverage.

Statistical Analysis Meta-analysis was performed by Stata v15SE (StataCorp, College Station, TX, USA) in this study. According to the prevalence of cataract in these literatures, the

Table 2 Extraction and summary of basic data from included cataract epidemiological studies

Author	Publish year	Study region	Regional category	Age (y)	Sample (n)	Cataract patients (n)	Prevalence (n)
Zhao J ^[14]	2001	Beijing	Urban	≥50	5084	1185	23.31%
Liu CL ^[15]	2002	Chengdu, Sichuan	Urban	≥60	279	60	21.51%
Liu CL ^[15]	2002	Chengdu, Sichuan	Rural	≥60	737	218	29.58%
Li ZQ ^[25]	2004	Tianjin	Rural	≥40	1776	294	16.55%
Chen L ^[32]	2004	Shenzhen, Guangdong	Urban	≥50	3428	1016	29.64%
Li L ^[16]	2006	Nantong, Jiangsu	Urban	≥60	3040	1060	34.87%
Li Z ^[26]	2011	Harbin, Heilongjiang	Rural	≥50	5058	1529	30.23%
Huang XB ^[17]	2009	Shanghai	Urban	≥60	3851	1535	39.86%
Tang B ^[22]	2011	Chongqing	Urban	≥50	2583	792	30.66%
Li FR ^[18]	2012	Beijing	Urban	≥50	5118	797	15.57%
Guan HJ ^[19]	2012	Qidong, Jiangsu	Urban	≥50	5141	1098	21.36%
Yi JL ^[20]	2012	Ji'an, Jiangxi	Urban	≥50	5010	1158	23.11%
Duan XR ^[24]	2013	Handan, Hebei	Rural	≥30	6544	1362	20.81%
Cai N ^[33]	2013	Luxi, Yunnan	Rural	≥50	5151	1154	22.40%
Jiao WZ ^[31]	2013	Shandong	Rural	≥50	17816	4938	27.72%
Luan L ^[21]	2014	Wuxi, Jiangsu	Urban	≥50	6150	1785	29.02%
Xiang W ^[30]	2015	Tongxin, Ningxia	Rural	≥50	4812	1682	34.95%
Zhou J ^[23]	2017	Nantong, Jiangsu	Rural	≥60	1305	376	28.81%
Wu XL ^[29]	2019	Ningbo, Zhejiang	Urban	≥50	5448	1265	23.22%
Zhang KY ^[27]	2019	Hainan	Urban	≥50	2243	787	35.09%
Bai LN ^[28]	2019	Jiayang, Sichuan	Urban	≥50	20860	7460	35.76%

pooled prevalence of cataract in Chinese population over 50 years old was calculated. Subgroup analysis was conducted according to the types of regions, different age groups and cataract surgical coverage. Effect size (ES, the ratios in all eligible studies were combined, which called pooled ratio) with 95%CI was evaluated and the forest map was drawn according to the results. And the homogeneity test was also used, which set I^2 to quantitatively determine the level of heterogeneity when $\alpha=0.1$ ^[12]. The included studies were considered to be homogeneous when $P \geq 0.10$ and $I^2 \leq 50\%$, and the fixed effect model was selected for Meta-analysis; On the contrary, if $P < 0.1$ and $I^2 > 50\%$, it is considered that there was heterogeneity among the included studies, and the random effect model (REM, a generalization of the classical linear model) was selected for Meta-analysis^[12]. While the publication bias was analysed by Eggers' test^[13].

RESULTS

Retrieval Results of Literature Totally 20 studies were finally included for Meta-analysis through literature screening^[14-33]. The detailed screening process was shown in Figure 2. The total number of participants in all studies contained in this Meta-analysis was 111 434, and 31 551 were cataract patients. Among these studies, the minimum sample size was 279, and the maximum sample size was 20 860, of which the median was 5010, and the interquartile range was 2413-5300. The epidemiological investigations involved in these studies were

distributed in the urban and rural areas of 15 provinces or cities, including Beijing, Zhejiang, Guangdong, Hainan, Hebei, Heilongjiang, Jiangsu, Jiangxi, Ningxia, Shandong, Shanghai, Sichuan, Tianjin, Yunnan, and Chongqing^[14-33]. The median prevalence of cataract was 28.81%, the lowest was 15.57%, the highest was 39.86%, and the interquartile range was 21.96%-32.77%.

Data Extraction and Quality Assessment of Literatures In this study, the data were extracted on the basis of prescribed process, which the details were shown in Table 2. Quality assessment was based on the quality assessment criteria proposed by Khambalia and Sen^[11], and the results of quality score were as follows: 2 papers scored 1, 7 papers scored 2, 9 papers scored 3, 1 paper scored 4, and 1 papers scored 5 (Figure 3).

Meta-Analysis of Cataract Prevalence Over 50 Years Old in China Heterogeneity analysis showed that the prevalence of cataract was statistical heterogeneity among these studies ($I^2=99.2\%$, $P < 0.01$), so the random effect model was used in Meta-analysis. The results showed that the prevalence of cataract over 50 years old in China was 27.45% (95%CI: 24.38%-30.52%). Forest map was shown in Figure 4.

Difference of Cataract Prevalence Between Urban and Rural Areas The median prevalence of cataract was 28.97% in rural areas, and the lowest was 22.40%, the highest was 34.95%. Heterogeneity test showed that there was statistical

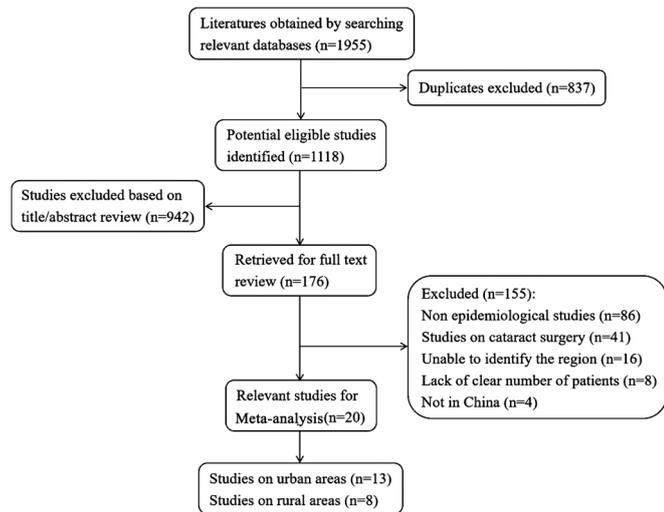


Figure 2 Process and results of literature screening.

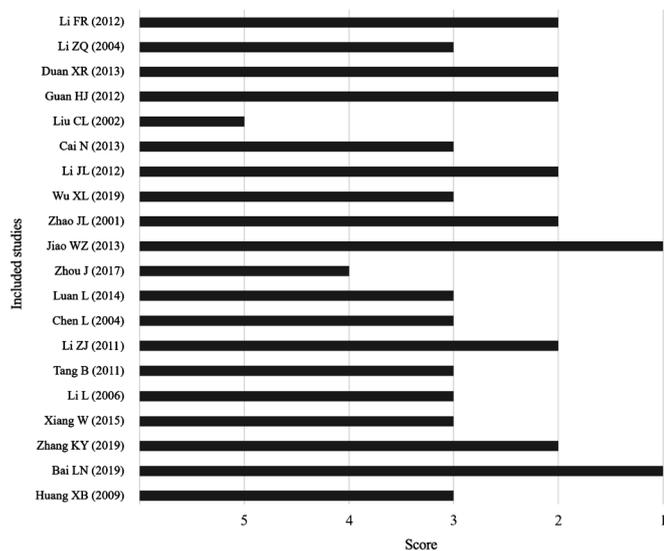


Figure 3 Quality assessment and summary results of these studies.

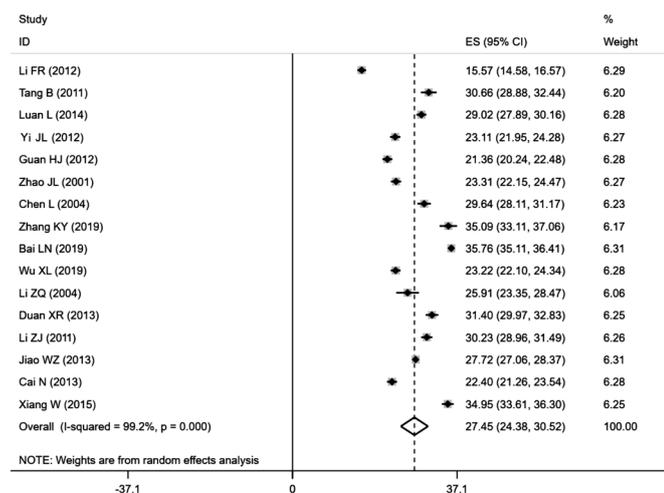


Figure 4 Forest map for Meta-analysis of cataract prevalence in China over 50 years old.

difference between the included studies ($I^2=97.8\%$, $P<0.01$), so the random effect model was used for Meta-analysis. The results showed that the prevalence of cataract in rural areas was

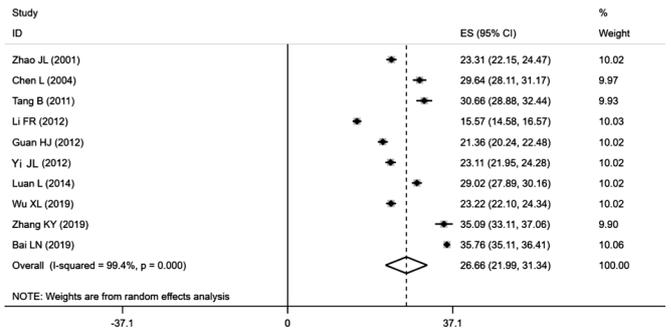


Figure 5 Forest map for Meta-analysis of cataract prevalence in urban Chinese areas.

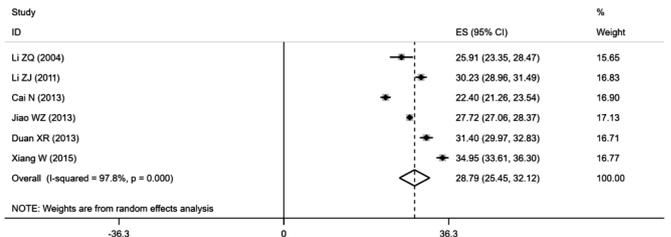


Figure 6 Forest map for Meta-analysis of cataract prevalence in rural Chinese areas.

28.79% (95%CI: 25.45%-32.12%). The median prevalence of cataract was 26.17% in urban areas, and the lowest was 15.57%, the highest was 35.76%. Heterogeneity test showed that there were statistical differences among these studies ($I^2=99.4\%$, $P<0.01$). Meta-analysis showed that the prevalence of cataract in urban areas was 26.66% (95%CI: 21.99%-31.34%). Forest maps were shown in Figures 5 and 6.

Prevalence of Cataract in Different Age Groups The prevalence of cataract in different age groups was statistically analysed base on the length of 10y. Results showed that the median prevalence of cataract in 50-59 age group was 5.23%, the lowest prevalence was 2.39%, and the highest prevalence was 16.81%. The heterogeneity test showed that there was statistical difference between the included studies ($I^2=98.8\%$, $P<0.01$). Meta-analysis using random effect model showed that the prevalence of cataract in the age group of 50-59y was 7.88% (95%CI: 5.59%-10.18%). The median prevalence of cataract in 60-69 age group was 25.37%, the lowest was 10.90%, and the highest was 42.14%. Heterogeneity test showed that there was statistical difference between the included studies ($I^2=99.1\%$, $P<0.01$). So Meta-analysis showed that the prevalence of cataract was 24.94% (95%CI: 20.28%-29.60%). The median prevalence of cataract in 70-79 age group was 50.72%, the lowest was 41.47%, and the highest was 69.44%. Heterogeneity test showed that there was statistical difference between the included studies ($I^2=97.4\%$, $P<0.01$). Meta-analysis showed that the prevalence of cataract in 70-79 years old was 51.74% (95%CI: 45.75%-57.72%). The median prevalence of cataract over 80 years old was 82.42%, the lowest was 64.84%, and the highest was 85.71%.

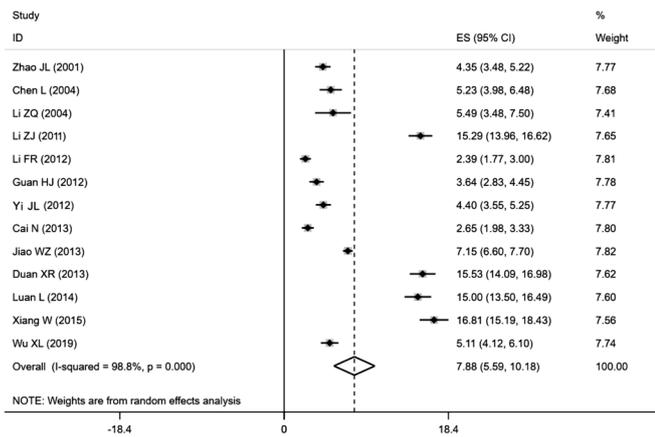


Figure 7 Forest map for Meta-analysis of cataract prevalence in 50-59 age groups in China.

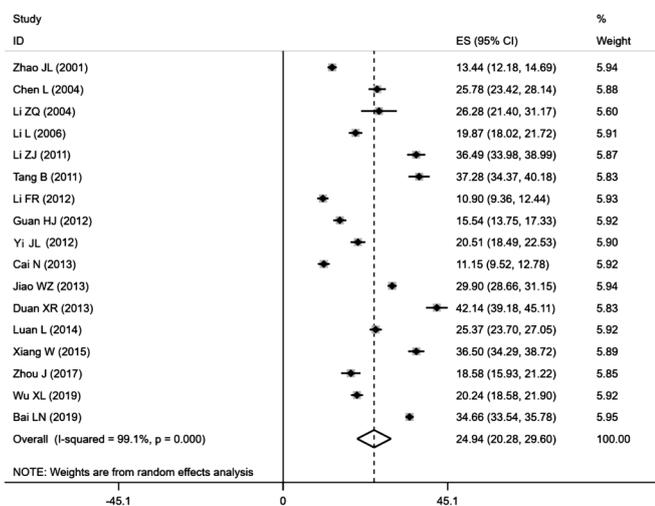


Figure 8 Forest map for Meta-analysis of cataract prevalence in 60-69 age groups in China.

Heterogeneity test showed that there was statistical difference between the included studies ($I^2=87.3%$, $P<0.01$). So Meta-analysis showed that the prevalence of cataract over 80 years old was 78.43% (95%CI: 74.02%-82.83%). Forest maps were shown in Figures 7-10.

Analysis of Cataract Surgical Coverage Cataract surgical coverage represents the coverage of cataract surgery among cataract patients. It reflects the popularity of cataract surgery in study area, but do not distinguish the types of surgery and regions in this Meta-analysis. The results showed that the median of cataract surgical coverage in China was 7.18%, the lowest was 3.47%, and the highest was 17.69%. Heterogeneity test showed that there was statistical difference between the included studies ($I^2=97.1%$, $P<0.01$). Meta-analysis after using random effect model showed that the cataract surgical coverage in China was 9.19% (95%CI: 7.16%-11.22%). Forest map was shown in Figure 11.

Analysis of Publication Bias The publication bias of this study was analysed by Eggers' test. Results of Eggers' test showed that $t=-0.22$, $P=0.826$, $P>0.05$, so there was no

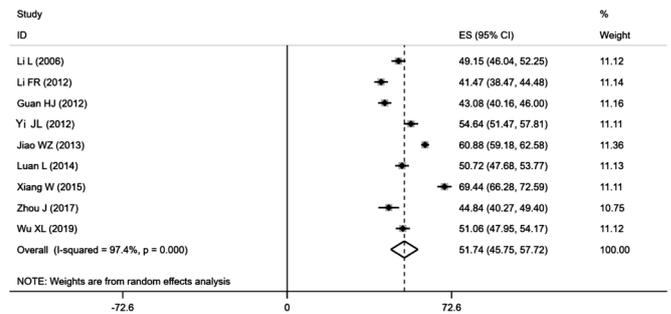


Figure 9 Forest map for Meta-analysis of cataract prevalence in 70-79 age groups in China.

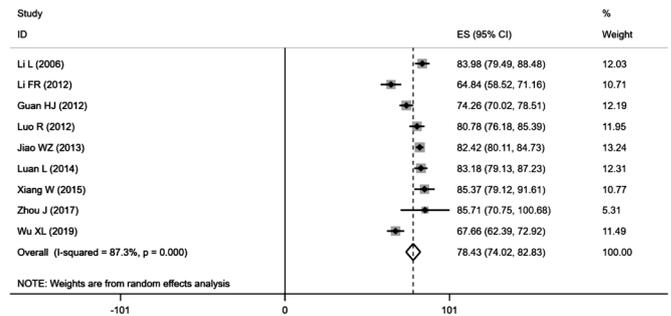


Figure 10 Forest map for Meta-analysis of cataract prevalence in China over 80 years old.

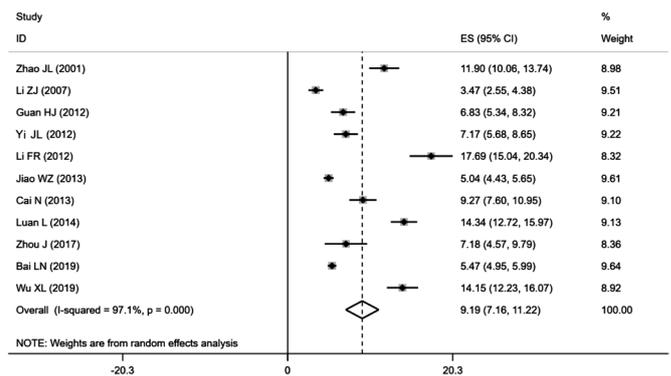


Figure 11 Forest map for Meta-analysis of cataract surgery coverage in China.

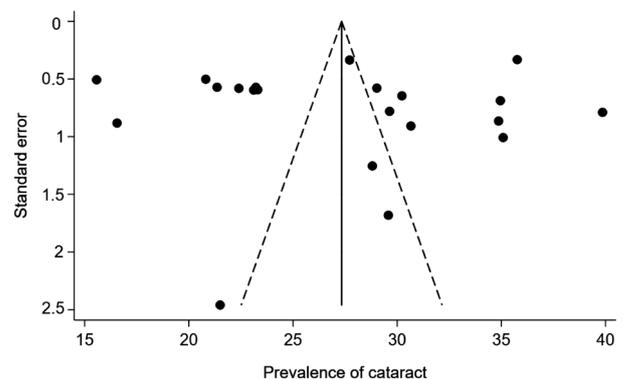


Figure 12 Funnel chart of publication bias test of cataract epidemiological studies in China.

significant publication bias. Funnel plot of publication bias was shown in Figure 12.

DISCUSSION

Cataract was one of the main causes of blindness in the world,

Table 3 Meta-analysis of epidemiological studies on cataract

Content of Meta-analysis	Number of studies	Sample (n)	Heterogeneity test	Analysis model	Pooled prevalence	95%CI (%)
Total	16	99074	$I^2=99.2\%$, $P<0.01$	Random effect model	27.45%	24.38-30.52
Region						
Urban	10	61065	$I^2=99.4\%$, $P<0.01$	Random effect model	26.66%	21.99-31.34
Rural	6	38009	$I^2=97.8\%$, $P<0.01$	Random effect model	28.79%	25.45-32.12
Age (y)						
50-59	13	32455	$I^2=98.8\%$, $P<0.01$	Random effect model	7.88%	5.59-10.18
60-69	17	35520	$I^2=99.1\%$, $P<0.01$	Random effect model	24.94%	20.28-29.60
70-79	9	10548	$I^2=97.4\%$, $P<0.01$	Random effect model	51.74%	45.75-57.72
≥ 80	9	2979	$I^2=87.3\%$, $P<0.01$	Random effect model	78.43%	74.02-82.83
Surgical coverage	11	22745	$I^2=97.1\%$, $P<0.01$	Random effect model	9.19%	7.16-11.22

Table 4 Prevalence of cataract in other countries of the world recent 10y (over 60 years old)

Author	Country	Year	Age	Sample size	Number of cataract patients	Prevalence of cataract
Vashist <i>et al</i> ^[43]	India	2011	≥ 60	5871	3241	55.20%
Hashemi <i>et al</i> ^[44]	Iran	2017	≥ 60	645	208	32.24%
Park <i>et al</i> ^[45]	Korea	2014	≥ 60	7297	3588	49.17%
Mahdi <i>et al</i> ^[46]	Nigeria	2014	≥ 60	629	270	42.92%
Rauf <i>et al</i> ^[47]	United Kingdom	2013	≥ 60	922	651	70.60%
Pan <i>et al</i> ^[48]	Singapore	2013	≥ 60	5768	2279	39.51%
Germano <i>et al</i> ^[49]	Brazil	2017	≥ 60	377	50	13.26%
Singh <i>et al</i> ^[50]	India	2019	≥ 60	4331	2588	59.75%
Yoshikawa <i>et al</i> ^[51]	Japan	2019	≥ 60	490	200	40.81%
Current study	China	2022	≥ 60	46359	18752	40.45%

which accounts for about half of the entire blind people^[34]. But the prevalence of cataract in China varies markedly due to regional distribution and examination methods^[35]. Meta-analysis was still developing in the world for a short time, when there were not enough time or funds to do a national survey, we can make a Meta-analysis of the results from the existing local epidemiologic surveys to increase the sample size and the diagnostic efficiency, make the research results have statistically significant^[36-37]. This Meta-analysis showed that the pooled prevalence of cataract in China was 27.45% (95%CI: 24.38%-30.52%), which was similar to the results of most previous epidemiological studies in the world^[38-39]. And with the increase of age, the prevalence of cataract increased significantly. Based on the large number of cataract patients in China, the cataract surgical coverage still has room for improvement compared with many countries and regions (Table 3).

The results from this study showed that the prevalence of cataract was 26.66% (95%CI: 21.99%-31.34%) in urban areas and 28.79% (95%CI: 25.45%-32.12%) in rural areas. The prevalence of cataract in rural areas is higher than that in urban areas. Due to the difference of economy and education between rural and urban areas, the awareness of disease and the desirability of treatment are relatively low in rural areas. This suggests that cataract screening to popularize the knowledge

of cataract and the latest research progress are an effective method to reduce the prevalence of cataract in rural areas, and carry out cataract surgery camps in the local area could be a safe and effective way to reduce cataract cases^[40-42]. Compared with the prevalence of cataract in other countries all over the world, we found that the prevalence of cataract in China stayed at an intermediate level (over 60 years old)^[41-49]. But the prevalence of cataract was still nearly 40%, together with Chinese population, these would easily make China become one of the countries with heavy burden of visual impairment by cataract in the world, which should arouse our attention. So comprehensive screening of cataract and popularization of cataract knowledge is one of the necessary measures. The specific results of other countries in the world were shown in Table 4^[43-51].

The prevalence of cataract varies evidently among different age groups. The results of this study show that the prevalence of cataract in the age group of 50-59 years old is 7.88%, the prevalence of cataract in the age group of 60-69 years old is 24.94%, and the prevalence of cataract in the age group of 70-79 years old has increased to 51.74%, while the prevalence of cataract in more than 80 years old is 78.43%. This can be found that with the increase of age, the prevalence of cataract also showed a significant growth trend. The increase of age can lead to the decline of metabolic capacity in lens, and

eventually lead to the occurrence of cataract^[52], which was the main cause of cataract. Cataract usually begins to occur at the age of 40, but most of them are over 50 years old when slit lamp examination can detect or cause visual impairment. Therefore, it also indicates that the prevalence of cataract increases rapidly after 50 years old, and with the accumulation of cases, the prevalence of cataract in each age group increases significantly. But with the accumulation of systemic diseases, some risks would be brought for the elderly cataract patients to choose surgical treatment, and the growth of age will bring other eye diseases, even the choice of cataract surgery may not be able to achieve satisfactory results. So, the recognition and timely selection of surgical treatment are the first choice to ensure the vision and quality of life.

Phacoemulsification combined with intraocular lens implantation was one of the most effective surgical methods for cataract, but the cost of surgery and intraocular lens was still difficult for part of the population to afford^[53]. The outcomes of this Meta-analysis show that the cataract surgical coverage in China is 9.19% (95%CI: 7.16%-11.22%). Although the popularity of cataract surgery in some economically developed areas has been relatively high, which even can reach the level of developed countries. But there is still room to improve the cataract surgical coverage in China^[54-55]. Economic burden may be one of the main factors that affect the treatment of cataract. In addition, lack of the concept of cataract and the backward way of thinking still restrict the selection of treatment for some people with poor education. Due to the lack of concrete classification in this study, the Meta-analysis cannot be carried out in terms of operation rate. However, we speculate that the operation rate of cataract in rural areas will be less than that in urban areas due to the above reasons. Jongsareejit *et al*^[56] have found that small incision cataract surgery was a more effective surgical method than cataract phacoemulsification. And the improvement of the medical treatment level has gradually simplified the implementation of cataract surgery, which could relieve the economic burden of cataract blindness.

There are still some limitations in this study: 1) The existence of heterogeneity is one of the main reasons to limit the credibility of the results. We believe that this heterogeneity is mainly due to different regions, ethnic minority, diagnostic criteria and other factors, but the concrete factors that may affect the prevalence of cataract need further research; 2) Although this study has covered most areas of China comprehensively, it still cannot fully reflect the prevalence of cataract in all regions of China; 3) The epidemiological investigation involved in this study has a fixed period of time (2000-2020), and the prevalence of cataract could change with time which will inevitably affect the results; 4) Due to the difference of examination instrument in many regions, the

diagnosis and definition of cataract may be different, which also leads to the bias of the prevalence; 5) Other factors such as publication bias (published articles tend to have significant positive results), selection bias (the process of screening articles and the population involved in the epidemiological survey) will also affect the results of this study^[57].

In conclusion, this Meta-analysis showed that the prevalence of cataract in China was still at a high level, due to the lack of awareness of cataract and cataract surgery, the promotion of cataract surgery still needs to be further improved, and the decline of quality of life caused by cataract is worthy of attention. So, it's obviously that the opportunistic treatment to find cataract was not enough. Cataract blindness and severe visual impairment have become serious public health problems. Therefore, health institutions should play the leading role to integrate social resources, and implement intervention on cataract blindness and severe visual impairment through regular screening of cataract. And cataract surgery rate may be increased by involving non-government organizations (NGO)^[58]. We should propagate the knowledge of cataract and develop more cataract surgical training, so as to solve the economic burden caused by cataract.

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