

Cataract Hospitalizations in 96 Grade \square A Hospitals in China

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Abstract

Background: To examine the demographic, medical care and financial characteristics of cataract inpatients in China, based on analysis of a large national database.

Design: A multicenter, cross-sectional, 6-year period retrospective study.

Subjects: This study included 185147 inpatients with a principal or secondary diagnosis of cataract, between 2009 and 2014, in China.

Methods: All types of cataract-related hospitalization information from 96 grade IIIA hospitals, over a 6-year period (from 2009 to 2014), were identified and the data from 230250 eyes (185147 inpatients) were retrospectively analyzed statistically.

Main Outcome Measures: Age, sex, location, visit time, hospitalization duration, type of cataract surgery, medical costs.

Result: The male to female sex ratio was 97.66:100, and the mean age was 64.50 ± 16.72 years (56.08% aged 60–79 years). Bilateral cataract accounted for 25.04% and age-related cataract was present in 68.85% of patients. The spatio-temporal distribution of hospitalization was concentrated in the northwest (23.14%) and southwest (25.29%) of China ($P < 0.01$). The estimated hospitalization rate was highest in the northwest (0.23%). Hospitalization peaked biannually, in the summer (27.96%) and winter (27.75%). Phacoemulsification combined with intraocular lens implantation was the most common surgery (97.15%) and was increasingly performed over the study period, doubling within 6 years. The overall average hospitalization stay was 6.72 ± 1.70 days. The average financial cost for treatment was $\text{¥}8861.81 \pm 6818.04$ per person. Specifically, the average operation cost was $\text{¥}2283.00 \pm 2139.14$, while the average medicine cost was $\text{¥}971.53 \pm 2007.69$. All-source social medical insurance covered 52.25% of the hospitalizations.

Conclusion: These findings illustrate the status quo of cataract-related hospitalizations in China and reveal significant regional variations in the prevalence and medical service conditions, based on a population-scale analysis. Cataracts remain an important public health problem in China. Poverty-stricken areas, such as the northwest and southwest regions of the country, face more challenges. Continuing development and implementation of cataract surgery and further improvement of the medical security system and care level are needed to advance blindness prevention programs in China.

Background

Cataract, defined as any opacity of the crystalline lens in the eye that affects clear vision, is a major public health issue and is also the leading cause of blindness worldwide, affecting about 111.74 million individuals in China in 2015.(1, 2) Since 90% of cataracts globally are reported in developing countries, its social, physical, and economic burden cannot be ignored.(3, 4) There is a significantly higher prevalence

of cataracts in China, especially in the rural areas, than in developed countries. It has been estimated that the number of individuals affected by any type of cataract in China will reach 240.83 million by 2050.(1)

Untreated cataract can gradually progress to severe visual impairment and eventually blindness, thereby reducing the vision-related life quality of those patients and accordingly increasing social and family burdens.(5–8) Cataract surgery, an effective technique in resolving crystalline lens opacity, is currently the only available method for restoring vision for those patients. As cataract surgery techniques have advanced and have become more universal, elderly patients suffering from cataract, even those in outlying poverty-stricken areas, have the opportunity to benefit from appropriate intervention. Nevertheless, cataract still remains one of the major socioeconomic and public health burdens in China and poor individuals have limited access to cataract surgery services.(9, 10) In addition, China has a low cataract surgical rate (cataract operations per million population per year) and cataract surgical coverage as compared with other countries in Asia.(11–17)

In this study, we evaluated the epidemiologic and clinical characteristics of cataract and cataract surgery and examined the economic costs for treatments of cataract in China, by performing a multicenter review of cataract inpatients in grade ⅢA hospitals in China over a 6-year period.

Methods

Study Design and Population

Based on the Inpatient Medical Record Home Page databases supported by the Information Center of Logistics support department of the Central Military Commission, this study retrospectively analyzed consecutive case series data from 96 grade ⅢA hospitals for a 6-year period (between October 1, 2008, and September 30, 2014). These hospitals were inside of the information system (IS) in China, and covered most of the provinces and cities in northeast China (13 hospitals), north China (19 hospitals), east China (20 hospitals), south-central China (21 hospitals), northwest China (13 hospitals), and southwest China (10 hospitals) (Fig. 1). Approval from the ethics committee of the Chinese PLA General Hospital (Beijing, China) was obtained. This research has adhered to the guidelines of the Declaration of Helsinki for research involving human subjects. Inpatients were grouped into six geographic regions, which were delineated by the National Bureau of Statistics of China, according to the localization of the hospital that they visited.(1, 18) In the same period, there were 677 grade ⅢA hospitals outside the system (OS) (Table 1). China's population was about 1.34 billion according to the sixth national census in 2010 (www.gov.cn). All hospitals, both inside and outside of the information system, possessed the physical facilities and technological expertise for treating various types of cataract.

Table 1
number of grade IIIA hospitals in the six geographic regions in China

Region	Included provinces	Number of grade IIIA hospitals inside the system	Number of grade IIIA hospitals outside the system
North China	Beijing Municipality, Hebei province, Inner Mongolia Autonomous Region, Shanxi province, Tianjin Municipality;	19	121
Northeast China	Heilongjiang province, Jilin province, Liaoning province;	13	115
Northwest China	Gansu province, Ningxia Hui Autonomous Region, Qinghai province, Shaanxi province, Xinjiang Uyghur Autonomous Region;	13	53
East China	Anhui province, Fujian province, Jiangsu province, Jiangxi province, Shandong province, Shanghai Municipality, Zhejiang province;	20	148
South Central China	Guangdong province, Guangxi Zhuang Autonomous Region, Hainan province, Henan province, Hubei province, Hunan province;	21	183
Southwest China	Chongqing Municipality, Guizhou province, Sichuan province, Tibet Autonomous Region, Yunnan province;	10	57

Data Collection

Data of inpatients diagnosed with “cataract”, according to the *International Classification of Diseases (ICD-9 and ICD-10)*, (19, 20) were collected for statistical analysis; this including information such as age, sex, consultative hospital, arrival time, diagnosis, operation style, preoperative and postoperative length of hospital stay, financial cost, and therapeutic outcomes.

Definitions

The 6-year period was divided into six epochs, which were October 1, 2008, to September 30, 2009, representing year 2009; October 1, 2009, to September 30, 2010, representing year 2010; and so on. The presence of cataract was defined as the existence of any cataract, including age-related, congenital, drug-induced, toxic, traumatic, and complicated cataracts, in at least one eye in an individual. Radiation cataract was classified as one subtype of traumatic cataract. Inpatients with pseudophakia dislocation or aphakia or after-cataract, however, were excluded from this analysis.

Statistical Analysis

All data were collected in an electronic database. Continuous variables were evaluated for normality and homogeneity with ANOVA. One-sample t-tests were performed to assess the significance of differences

between groups. SPSS (version 19) software (IBM SPSS Inc., Chicago, IL, USA) was used for statistical analysis. A $P < 0.05$ was considered to be statistically significant for all tests.

For the purpose of estimating a rough relative “hospitalization rate (HR)” to evaluate the geographical distribution of cataract and investigate the risk factors, we used the following formula:

$$HR = I/P \times (M + L) / M$$

where I is the number of inpatients, P is the population, M is the number of grade \geq A hospitals IS, and L is the number of grade \geq A hospitals OS.

Results

A total of 185147 cataract inpatients (230250 eyes) were included in the present study. Of these, 91479 (49.41%) were male and 93668 (50.59%) were female. Cataract hospitalizations peaked significantly in the summer (51767 cases, 27.96%) and winter (51378 cases, 27.75%), compared to the spring (40909 cases, 22.10%) and autumn (41093 cases, 22.19%) (p value < 0.01) (Fig. 2A). Bilateral cataract occurred in 46351 cases (25.04%); among those with unilateral cataract, the right eye was involved in 70371 cases (38.00%), while the left eye was involved in 68425 cases (36.96%).

The numbers of inpatients with cataract in northwest China (42845 cases, 23.14%) and southwest China (46826 cases, 25.29%) were significantly greater (p value < 0.01) than those in north China (25534 cases, 13.79%), east China (36421, 19.67% cases), south-central China (26076 cases, 14.08%), and, particularly, in northeast China (7445 cases, 4.02%). When considering the vast differences in regional populations and numbers of local hospitals, the estimated “HR” remained highest in northwest China (0.23%) and lowest in northeast China (0.07%) (Fig. 2B).

The age of inpatients with cataract ranged from 1 to 109 years (mean age 64.50 ± 16.72 years). More male than female inpatients in the 0–49-years and 80–109-years age groups visited hospitals, in contrast to the 50–79-year age group (Fig. 2C). No significant difference of morbidity on either eye was found in any age group (p value > 0.01 ; Fig. 2C).

The number of inpatients with age-related cataract (127472 cases, 68.85%) was much higher than that of any other type of cataract. The number of inpatients with traumatic cataract and complicated cataract were 30269 (16.35%) and 27117 (14.65%), respectively (Fig. 3A). Congenital cataract (145 cases, 0.08%) and drug-induced and toxic cataract (145 cases, 0.08%) accounted for the lowest number of cataracts among the different cataract types.

The average length of hospital stays of inpatients ranged from 2.71 to 8.26 days, with an overall average hospitalization stay (AHS) of 6.72 ± 1.70 days. The preoperative and postoperative AHS were 2.41 ± 0.67 days and 4.31 ± 1.04 days, respectively. The congenital cataract inpatients had the shortest AHS, both preoperatively (0.70 days) and postoperatively (2.02 days) (Fig. 3B).

Intracapsular cataract extraction (ICCE), extracapsular cataract extraction (ECCE), and phacoemulsification (Phaco) have been the most common cataract surgeries in China over the past decades. During the study period, 125179 cataract surgeries were performed on 105136 inpatients with any type of cataract, of which Phaco accounted for 97.15% (Fig. 4). The number of Phaco procedures increased markedly, from 12120 to 26596, over the 6-year period. A few ECCE and ICCE procedures were also performed. Intraocular lens (IOL) implantation was subsequently performed on most, but not all, inpatients who underwent cataract surgery.

Among the 185147 inpatients with any type of cataract, 96731 inpatients (52.25%) were covered by social medical insurance (SMI), while another 70966 inpatients (38.33%) without SMI were either covered by their private health-care insurance or paid for their procedures out of pocket, which we termed private medical treatment (PMT). The remaining 17232 (9.42%) inpatients received free medical service (FMS) provided by the state.

The total average medical economic cost (AMEC) per hospitalization increased annually from ¥7871.35 ± 8012.84 (2009) to ¥9555.40 ± 5317.34 (2014). Specifically, the AMEC for one SMI inpatient ranged from ¥7889.26 ± 6449.66 (2009) to ¥9151.11 ± 5315.47 (2014), with a mean of ¥8540.32 ± 6021.88. For PMT inpatients, however, the AMEC ranged from ¥7146.37 ± 5715.19 (2009) to ¥10034.11 ± 4624.87 (2009), with a mean of ¥8860.94 ± 6053.98. FMS inpatients had the highest medical cost (mean, ¥10532.11 ± 11881.49) for treating cataracts. AMEC for an FMS inpatient ranged from ¥9450.02 ± 13841.36, in 2009, to ¥11287.33 ± 12061.18, in 2012 (Fig. 5A).

Interestingly, inpatients who had received treatment in north China needed to pay more, irrespective of whether they were SMI (¥10521.62 ± 8774.50), PMT (¥9985.37 ± 9366.43), or FMS (¥12259.67 ± 15273.38) inpatients. In contrast, SMI and PMT inpatients in south-central China and FMS inpatients in northwest China paid the least for treatment, with an AMEC of ¥6879.70 ± 4092.83, ¥7460.50 ± 6088.05, and ¥8073.01 ± 6459.71, respectively. In sum, the total AMEC per hospitalization was ¥8861.81 ± 6818.04, with the highest in north China (¥10860.01 ± 11107.67) and the lowest in south-central China (¥7373.93 ± 5787.49) (Fig. 5B).

The average operation cost (OC) ranged from ¥2067.05 ± 1182.27 (2014) to ¥2440.77 ± 2414.50 (2012), with a mean of ¥2283.00 ± 2139.14, while the average medicine cost (MC) ranged from ¥846.80 ± 1555.78 (2009) to ¥1201.92 ± 1499.96 (2011), with a mean of ¥971.53 ± 2007.69 (Fig. 5C). The average OC in north China (¥3552.83 ± 3869.59) was markedly higher than in any other regions. Inpatients in northeast China paid the lowest OC (¥1264.63 ± 1024.17), but the highest MC (¥1418.28 ± 2092.27) when compared to any other region. Inpatients in south-central China needed to pay only ¥617.07 ± 1661.21 for MC, which was significantly lower than that in any other region (Fig. 5D). The proportion of the total AMEC accounted for by the OC and MC showed a similar tendency (Fig. 5C, D).

Discussion

This study provided a comprehensive description of the epidemiological and clinical characteristics of cataract and cataract surgery in 96 grade ⅢA hospitals in China, based on a nationally representative database of 185147 participants, over a 6-year study period. Since the 96 grade ⅢA hospitals inside of the information system shared similar medical services, technology, and circumstances with the grade ⅢA hospitals outside of information system, the data reported here should be representative of the status quo of cataract and cataract surgery over the past 6 years in China, in general. However, as the study was conducted in hospitals, we were only able to describe the distribution and clinical characteristics of cataract and cataract surgery based on inpatients with any type of cataract, and could not calculate the actual occurrence and incidence rates. Therefore, we introduced a formula to estimate a rough relative “HR”, which should be helpful in investigating the risk factors for cataract.(21)

Cataract can develop due to various reasons, such as ageing, trauma, or other diseases, resulting in visual impairments. As revealed in our study and other previous studies, the number of cataract inpatients increases markedly with advances in age, indicating the prominent role of ageing as a constant risk factor in cataract development.(22) Age-related cataract inpatients thus occupy the majority of total cataract inpatients. With rapidly ageing populations in China, the number of people with cataract in China will double and redouble in the near future, and the social-economic and medical care issues related to older individuals is an ever-present concern.(23, 24) Congenital cataract continued to have a fairly low prevalence, but is also the primary cause of treatable childhood blindness.(25) We consider that the number of individuals with congenital cataract will gradually decrease in China, due to the national prenatal and postnatal care policy.

In the present study, women were affected slightly more than men, especially in those aged > 50 years and < 80 years; cataracts in these groups were primarily age-related. This result was in accordance with numerous previous population-based studies, which demonstrated a higher prevalence of age-related cataract in women than in men.(1, 26–28) This is not caused by lifestyle-related factors, since men generally have more exposure to ultraviolet B (UVB) and smoking, which are risk factors for cataract, than women. Although the mechanism underlying the sex disparity in cataract formation still remains unclear, a number of previous studies suggested that the estrogens may play a protective role in cataract development. Several studies have indicated that hormone therapy may decrease the risk of cataract and thus hypothesized that the decrease in estrogen at menopause women increased the risk of cataract. more experimental evidence is needed to elucidate the exact mechanism by which estrogens may protect against cataract(29). Additionally, more young men than women are exposed to environments involving physical work, and thus have a higher risk of sustaining eye injuries leading to traumatic cataract.

There were more cataract inpatients who were treated in summer than in other seasons, mainly because of the higher UVB exposure, which is generally considered to be a strong risk factor for age-related cataract.(30) Interestingly, there were also markedly more cataract inpatients in winter than in spring and autumn. Given that China is a largely agricultural country and that most of the population are involved in agriculture, older farmers may prefer to receive treatment after the busy farming seasons, since age-

related cataract is not a medical emergency and does not require immediate care.(31) However, these were opposite to those found in Canada.(32)

Due to the high elevation and UVB exposure, low economic income, educational, and medical care levels, and poor lifestyle, people living in the western region (including northwest and southwest China) were more likely to develop cataract. In contrast, given the higher economic income, educational, and medical care levels, the incidence of cataract in the central and eastern regions, including northeast, east, north, and south-central China, was markedly lower than that in the western region.

Since traumatic, complicated, and drug-induced and toxic cataract are usually associated with injuries or lesions in other ocular parts, inpatients with these types of cataract have a more complex condition than those with age-related and congenital cataract, which require much simpler treatment. These inpatients therefore have a longer AHS and relatively worse prognosis. As disclosed in the present study and previous studies, ICCE and ECCE are now very infrequently used surgical techniques in cataract treatment and have gradually been replaced by Phaco with IOL implantation. A number of previous studies have suggested that ICCE surgeries often have poor visual outcomes and that the visual acuity of patients treated with Phaco was significantly better than that of patients treated with ECCE or ICCE.(17, 33, 34) Nearly all cases in this study received IOL implantation. Previous studies have shown that the use of IOL implantation after cataract extraction increased with economic development.(8, 35, 36) Previous studies also suggested that more precise preoperative IOL power estimation and better postoperative care with correct optometry and spectacle provision helps to maximize surgical benefits.(37)

With the rapid economic development and improvement in the quality of medical services and technology, the mean total cost for cataract surgery has increased year by year. Medical costs were higher in FMS inpatients, who can enjoy better medical conditions without personal costs, than in SMI and PMT inpatients. Interestingly, along with improvements in the standard of living, increasing numbers of inpatients have tended to choose better medical care at their own expense. As the most economically developed region, north China had the highest medical resource consumption in cataract treatment, regardless of the type (FMS, SMI, or PMT) of inpatients. OC accounted for a markedly higher proportion of the total medical cost than did MC, which is reasonable, given that cataract is mainly treated through surgery. It is noteworthy that both OC and MC decreased from 2012. This might be associated with the national New Medical Reform policy that seeks to reduce the medical economic burden for patients through establishing and improving the basic medical and health system covering both urban and rural residents, and providing safe, effective, convenient, and cheap medical and health services for the people. Therefore, cataract patients in areas with relatively poor economic conditions have an equal chance of undergoing cataract surgeries, without being hampered by the expensive cost.(38–40)

There still are several potential limitations in our study. First, the prevalence of cataract could only be estimated based on cataract hospitalization situation. This is far from enough as a small but significant number of cataract patients refuse to receive treatment in hospitals, which might lead to an underestimation in morbidity rate. Second, potential risk factors for cataract, such as smoking and

diabetes, could not be analyzed for the absence of relevant personal information. Considering the above limitations, several analytic results in the present study should be interpreted with considerable caution.

Conclusion

In conclusion, our study provided a comprehensive and up-to-date description and analysis of the epidemiological and clinical characteristics and the economic cost of cataract-related hospitalizations in China, at both the national and regional levels, taking the effects of both demographic and geographic features into account. Cataract and cataract blindness have emerged as a leading public-health issue in China and the cost burden of cataract surgery has increased with the aging population. The results of this study should focus the attention of medical doctors, researchers, and government to this global problem, and lead to the development of more effective cataract prevention strategies.

Abbreviations

IS, inside the system; **OS**, outside the system; **HR**, hospitalization rate; **AHS**, average hospitalization stay; **ICCE**, Intracapsular cataract extraction; **ECCE**, extracapsular cataract extraction; **Phaco**, phacoemulsification; **IOL**, Intraocular lens; **SMI**, social medical insurance; **PMT**, private medical treatment; **FMS**, free medical service; **AMEC**, average medical economic cost; **OC**, operation cost; **MC**, medicine cost.

Declarations

Ethics approval and consent to participate

The study was Approved by the ethics committee of the Chinese PLA General Hospital (No. S2019-326-02) and adhered to the guidelines of the Declaration of Helsinki for research involving human subjects. Informed consent was obtained from the patients.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Zheng Z, YJ, SY, LW obtained the cataract patient data from each center. Zhu Z analyzed and interpreted the data regarding the prevalence and risk factors, and was a major contributor in writing the manuscript. ZY contributed to the conception of the study. All authors read and approved the final manuscript.

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Figures



Figure 1

Geographical distribution of 96 grade ⅠA hospitals in China. There were 96 grade ⅠA hospitals inside the system (IS) and 677 grade ⅠA hospitals outside the system (OS) in the study period. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.'

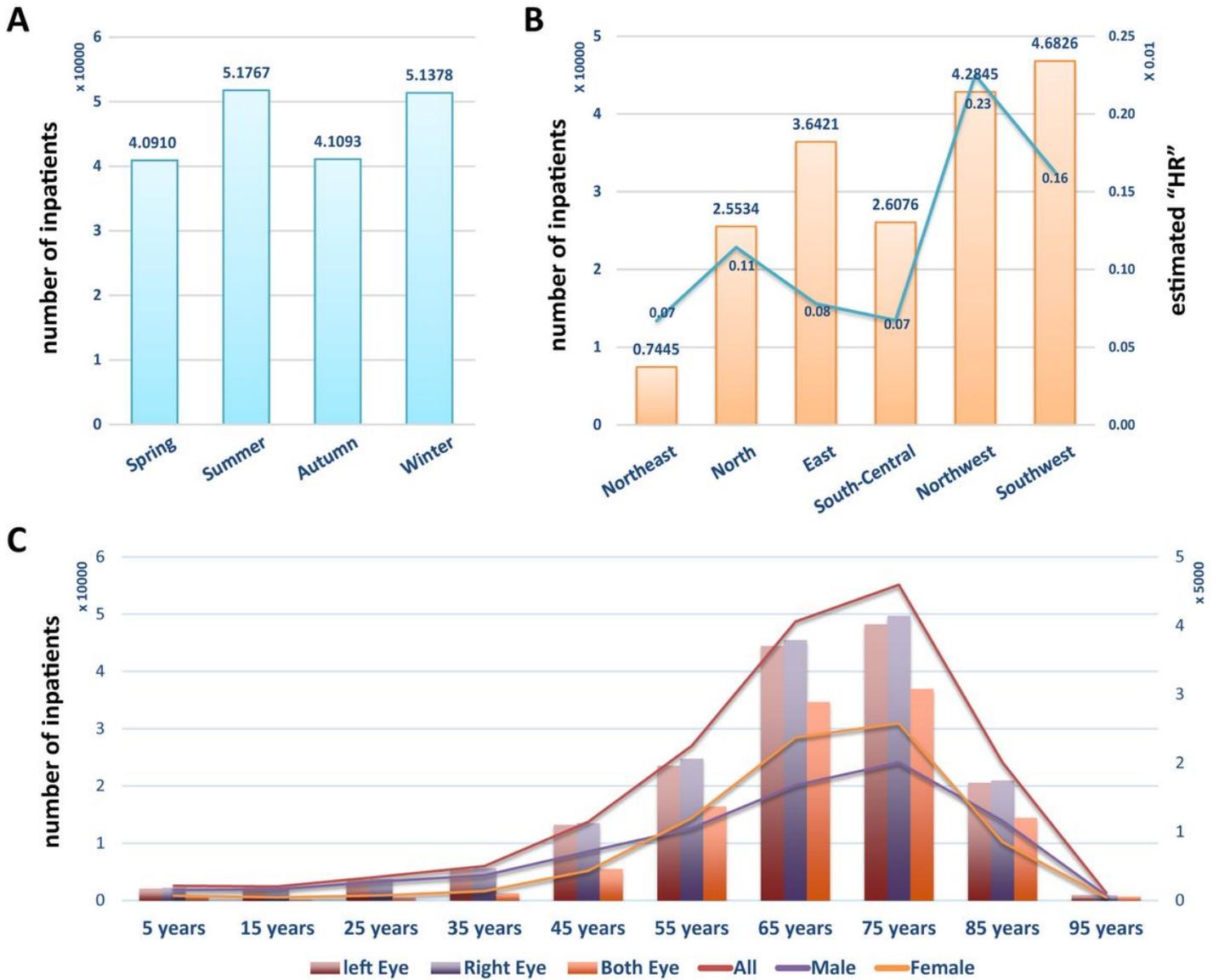


Figure 2

Seasonal, geographical, ocular, and sex distributions of cataract inpatients. (A) Hospitalization peaked in the summer and winter. (B) The number of inpatients with cataract and the hospitalization rate (HR) in northwest and southwest China was much greater than in north, east, south-central, and northeast China. (C) Slightly more women than men were affected, particularly among individuals aged > 50 years and < 80 years. No significant difference in morbidity in either eye was found in any age group.

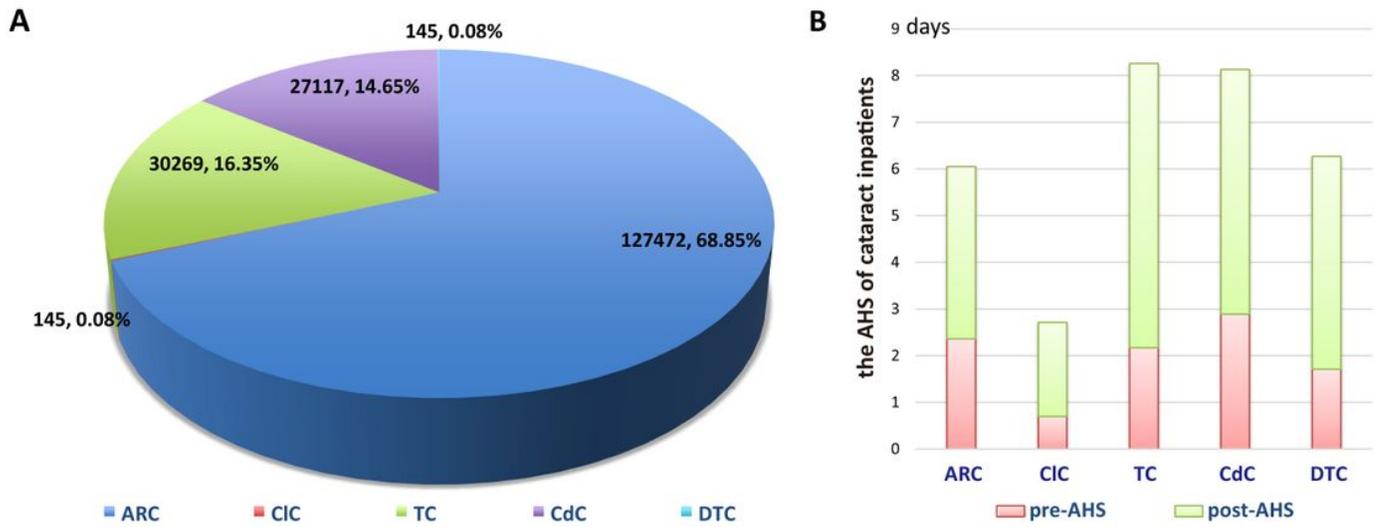


Figure 3

Proportion, average hospital stays, and outcome of each type of cataract. (A) Among all types of cataracts, the number of ARC inpatients was markedly higher, while CIC and DTC inpatients were the least in number. ARC, age-related cataract. CIC, congenital cataract. TC, traumatic cataract. CdC, complicated cataract. DTC, drug-induced and toxic cataract. (B) The CIC inpatients had the shortest AHS, both preoperatively and postoperatively, while the TC had the longest postoperative AHS. AHS, average hospitalization stay.

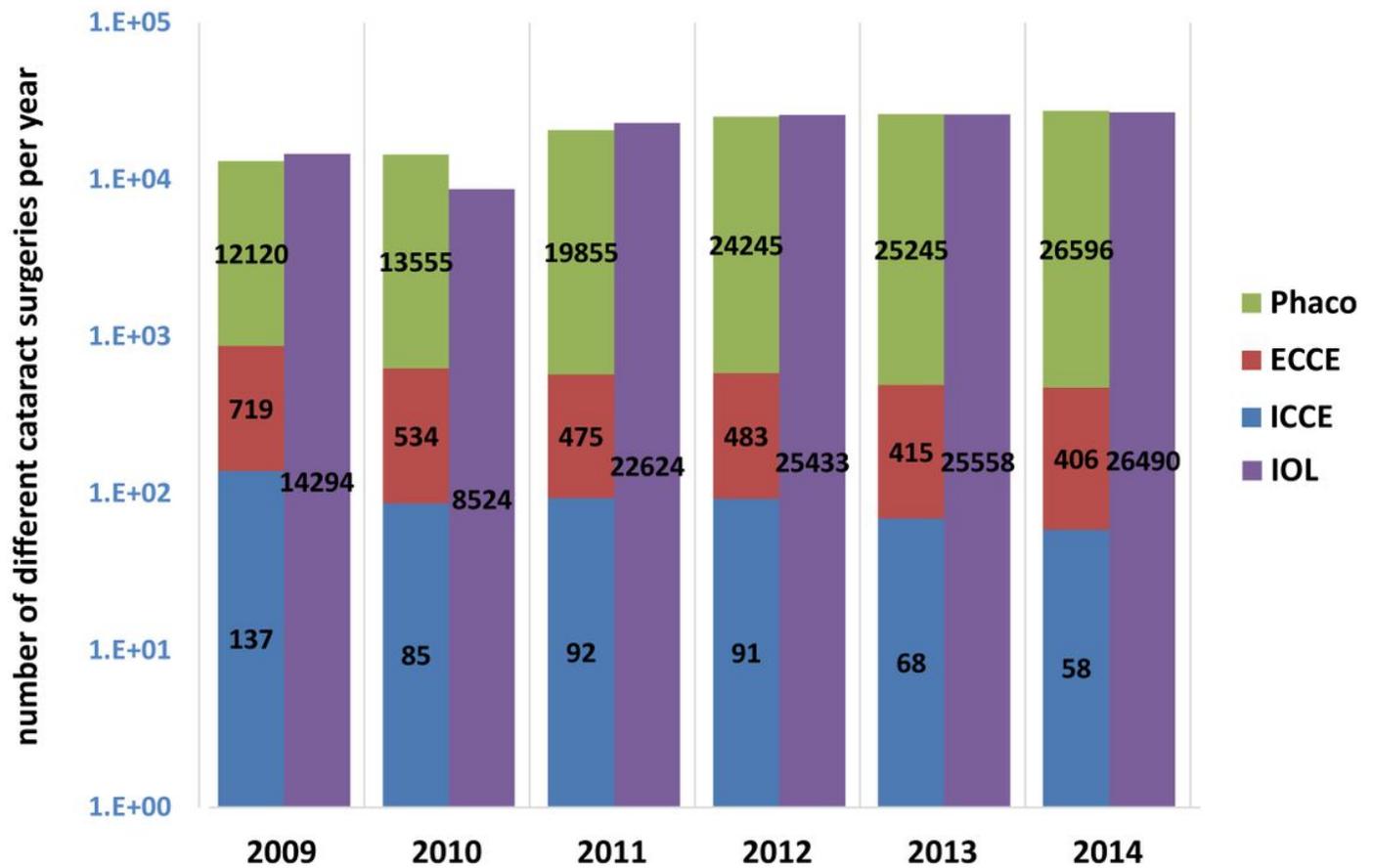


Figure 4

Number of cataract surgeries and intraocular lens (IOL) implantation during the 6-year period. A total of 125179 cataract surgeries were performed on 105136 inpatients with any type of cataract in the present study, of which phacoemulsification procedures accounted for 97.15%.

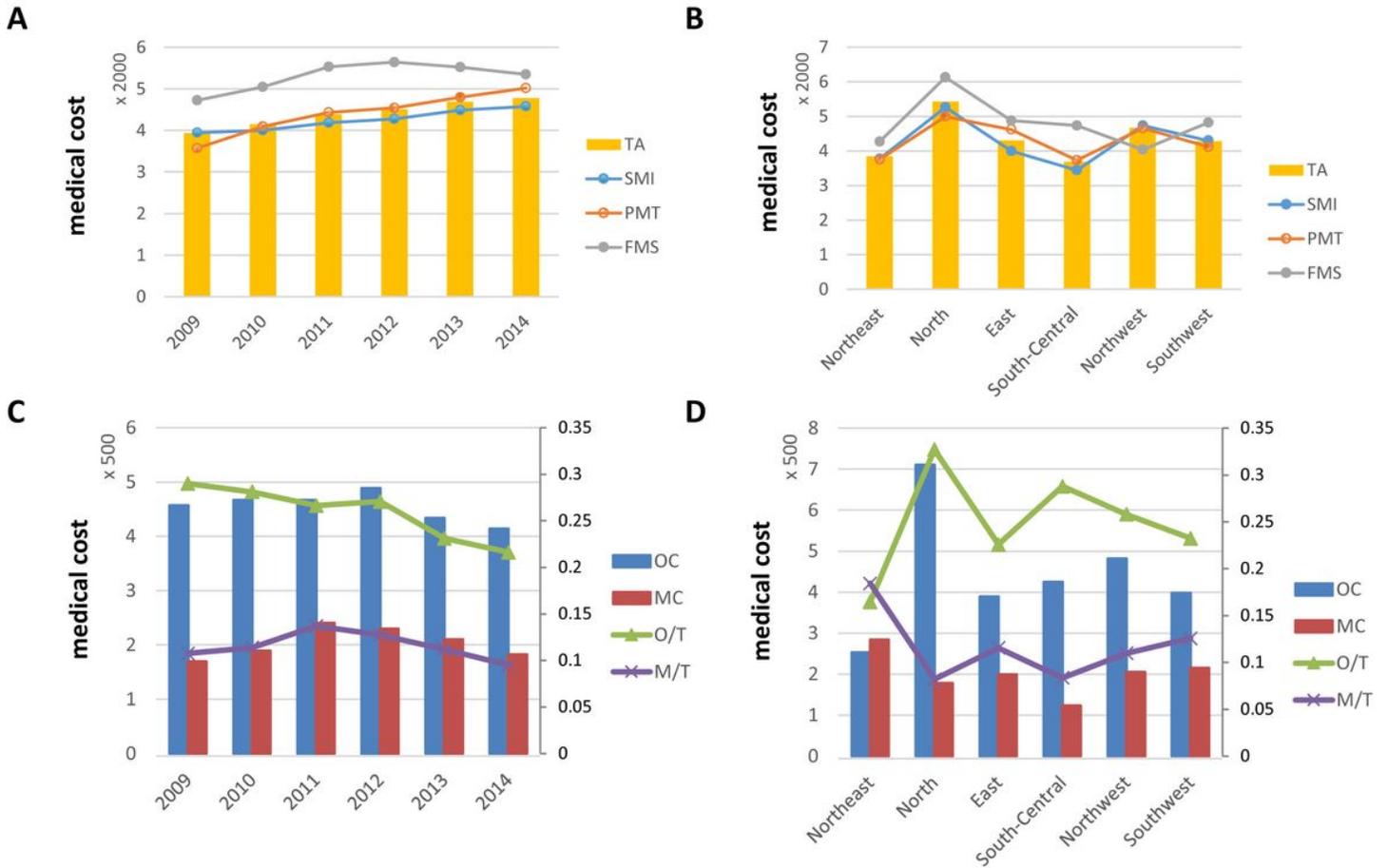


Figure 5

Economic cost of cataract treatment. (A) the TA per hospitalization increased annually. The medical cost for cataract treatment of FMS inpatients was higher than for SMI and PMT inpatients. TA, total average medical economic cost. SMI, social medical insurance. PMT, private medical treatment. FMS, free medical service. (B) Inpatients in north China needed to pay more than those in any other regions. Inpatients in south-central China spent the least on cataract treatment. (C) The OC was markedly higher than the MC. OC, operation cost. MC, medicine cost. O/T, operation cost/total medical cost. M/T, medicine cost/total medical cost. (D) Inpatients in northeast China paid the lowest OC, but the highest MC, as compared to any other region.