Review Article

Prevalence of Pediatric Cataract in Asia: A Systematic Review and Meta-Analysis

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Abstract

Purpose: To conduct a systematic review and meta-analysis for estimating the prevalence of pediatric cataracts across Asia.

Methods: A detailed literature search of PubMed, Embase, Web of Science, Cochrane Library, and Google Scholar databases, from 1990 to July 2021, was performed to include all studies reporting the prevalence of cataracts among children. Two researchers performed the literature search and screening of articles independently, and a third researcher critically reviewed the overall search and screening process to ensure the consistency. The JBI Critical Appraisal Checklist for studies reporting prevalence data was used to assess the methodological quality of the included studies.

Results: Of the 496 identified articles, 35 studies with a sample size of 1,168,814 from 12 Asian countries were included in this analysis. The estimated pooled prevalence of pediatric cataracts in Asian children is 3.78 (95% confidence interval: 2.54–5.26)/10,000 individuals with high heterogeneity (I^2 = 89.5%). The pooled prevalence by each country per 10,000 was 0.60 in Indonesia, 0.92 in Bangladesh, 1.47 in Iran, 2.01 in Bhutan, 3.45 in Laos, 3.68 in China, 4.27 in Thailand, 4.47 in India, 5.33 in Malaysia, 5.42 in Nepal, 9.34 in Vietnam, and 10.86 in Cambodia.

Conclusions: This study utilizes existing literature to identify the prevalence of cataracts in Asian children. Moreover, it highlights the need for more epidemiological studies with large sample sizes from other countries in Asia to accurately estimate the burden of disease.

Keywords: Asia, cataract, meta-analysis, prevalence

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Introduction

A cataract is defined as an opacity of the lens caused by a disruption in the homogeneity of lens structure that obscures the passage of light through the lens to the retina. Cataracts are the leading cause of reversible blindness and visual impairment worldwide, with an estimated 95 million people suffering from impaired vision due to cataracts in 2014.[1] The World Health Organization and its partners in their combined efforts to eliminate avoidable blindness launched the "Vision 2020: The Right to Sight" initiative in 1999 as a response to this global need, intending to reduce the global burden of preventable blindness such as those due to cataracts by the year 2020.[2]

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One of the highest priority objectives under this initiative was to cater to childhood blindness affecting almost 14 million children in the world today.[3] Various studies among the blind have reported pediatric cataracts as one of the leading but treatable causes of childhood blindness. The study by Ezegwui *et al*. in southeastern Nigeria reported that 23.6% of visual abnormalities in children were due to cataracts.[4] Similar studies from Asian populations in Malaysia, Bangladesh, China, and Indonesia have reported that cataracts are responsible for 22.3%, 27.3%, 11.8%, and 15.8% of blindness in children, respectively.[5-8] The global prevalence for pediatric cataracts due to either congenital or developmental factors is estimated

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to range from 2 to 4 individuals/10,000 people.[9] Every year, between 20,000 and 40,000 children are born with congenital cataracts around the globe.[10] Although loss of vision in children due to cataracts is relatively uncommon, children with untreated progressing cataracts are confronted with a lifetime of blindness and severe visual loss with repercussions on the quality of life, education, and employment opportunities. The burden of disability in terms of years spent blind is reported to be 10 million blind persons a year representing a massive social and financial burden for the country and communities.[11]

It is imperative to have reliable estimates of the prevalence and epidemiological nature of pediatric cataracts to develop effective prevention strategies, implementation of public health initiatives, and provision of improved eye care facilities. Asia is the world's largest and most populous continent, with 60% (4.5 billion people) of the current human population.[12] However, there is a scarcity of concrete information regarding the prevalence estimates in Asia since large-scale data collection can be challenging due to logistic and financial constraints. Still segregated studies addressing this concern have been conducted in few Asian countries with a wide range of reported prevalence; this variation may be attributed to differences in the study period, population, and methodology.

Despite numerous related studies published across the world, we were unable to find a comprehensive study to portray the burden of the prevalence of childhood cataracts in Asia. As a result, it is difficult for policymakers and public health officials to get a complete picture of the cataract burden in these countries and formulate appropriate policies. Given the medical, social, and psychological consequences of this disease, there is an urgent need for pertinent information to design plans for screening, early diagnosis, and timely intervention. The goal of this study is to conduct a comprehensive assessment of available literature to arrive at a credible estimate of the frequency and prevalence of cataracts for children residing in Asian countries.

Methods

The electronic databases including PubMed, Embase, Web of Science, and Cochrane Library were searched comprehensively from 1990 to July 15, 2021. Additional databases, including Index Copernicus and Google Scholar, were also utilized to find additional relevant articles. The reference list of included studies and previously published articles was also searched. First, the duplicates were removed, and screening based on title and abstract was conducted for all the retrieved articles. Then, the full text of all the relevant articles was obtained, and articles were selected for inclusion in our study based on the eligibility criteria. Two researchers performed the literature search and screening of articles independently, and a third researcher critically reviewed the overall search and screening process to ensure the consistency. The detailed search strategy was formulated with help from relevant keywords ("cataract," "childhood," "pediatric," "prevalence," "epidemiology," and "Asia") and MeSH (Medical Subject Heading) terms combined with the Boolean operators AND/OR [Table 1]. The Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines were followed for this systematic review and meta-analysis.[13] Since this article is a meta-analysis of published articles, no patient consent or ethics committee or institutional review board approval was required for the research.

Studies that met the following inclusion criteria were included: (1) population-based cross-sectional or cohort studies conducted in Asian countries with data on pediatric population (age ≤18 years), (2) original studies providing data on sample size and directly or indirectly providing data on the prevalence of cataracts, (3) diagnosis of cataract based on the judgment of qualified pediatricians or ophthalmologists, and (4) full-text articles written in English.

However, studies published in languages other than English, published before 1990, studies on Asians residing in non-Asian countries, and publication types other than primary studies such as systematic reviews and meta-analyses, hospital-based epidemiological studies, discussion papers, conference abstracts, case series, and case reports were excluded. In addition, we excluded studies with sample size <1000 since pediatric cataract is a relatively rare disease. Therefore, an adequate sample size is required for population-based studies to reliably estimate the prevalence. We estimated sample size calculated by the formula ($n = Z^2p\ (1\text{-}p)/d^2$), where n is the sample size, Z is the statistic corresponding to level of confidence, p is expected prevalence (obtained from previous meta-analysis by Wu *et al.*), and d is precision limit. For the purpose of our calculation, we utilized Z = 1.96 for a 95% confidence interval (CI), $P = 5.69\%$, d = 1.50%. Therefore, the estimated sample size required is 917, so a cut-off value of 1000 was utilized.

Table 1: Search strategy for PubMed

Search	Query
#1	Cataract[MeSH] OR Lens Diseases[tw] OR Cataract[tw] OR Lens Opacities[tw] OR Lens Opacity[tw] OR visual impairment[tw]
#2	Child[MeSH] OR Pediatric[MeSH] OR Adolescent[MeSH] OR Infant[MeSH] OR Newborn[MeSH] OR Congenital [MeSH] OR Children[tw] OR teenagers[tw] OR juvenile[tw] OR minor[tw] OR young people[tw] OR minor[tw] OR congenital[tw]
#3	Prevalence[MeSH] OR Epidemiology[MeSH] OR Cross-Sectional Studies[MeSH] OR Cohort Studies[MeSH] OR Survey[MeSH] OR Frequency[MeSH] prevalence[All] OR incidence[All] OR epidemiology[All] OR Survey[tw]
#4	Asia[MeSH] OR Asian[tw] OR East Asia[tw] OR South Asia[tw] OR Subcontinent[tw] OR Western Asia[tw] OR Far East[tw] OR Middle East[tw] OR SouthEastern Asia[tw] OR Central Asia[tw]
#5	#1 AND #2 AND #3 AND #4

MeSH: Medical Subject Headings, tw: Text words

Extraction was conducted by two investigators independently using a standardized data collection sheet. Disagreements were resolved through consensus. The following information was extracted from each study: study characteristics such as first author name, publication year, country, number of participants, sampling technique and response rate, participant characteristics like age range, male ratio, study setting, and outcome-related data like the number of cases of cataracts. Only a few studies reported data on the type of cataract, age of diagnosis, and any systemic association. Therefore, we did not extract the relevant data.

The main outcome of interest was the prevalence of cataracts in children (aged ≤18 years) in Asian population.

The articles were critically appraised for quality by two independent authors using the JBI Critical Appraisal Checklist for studies reporting prevalence data.[14] Any disagreements that arose between the reviewers were resolved through discussions, or by further discussion with a third reviewer. This tool assessed studies according to nine questions with a maximum score of 9 possible for each study. If the answer was yes, the question was assigned a score of 1. If the answer was no, unclear, or not applicable, the question was assigned a score of 0. Total quality scores ≤4, 5–7, and ≥8 were regarded as low, moderate, and high quality, respectively.

Statistical analysis

Data analyses were performed using the "meta" package of R version 3.5.2 (R Foundation for Statistical Computing, Vienna, Austria). To minimize the effect of studies with extremely small or extremely large prevalence on the overall estimate, we first stabilized the variance of the study-specific prevalence estimates with the logit transformation and then pooled the data using a random-effects meta-analysis model with the DerSimonian and Laird variance estimator.[15] Heterogeneity between studies was assessed by Cochrane Q and I^2 statistic. $I^2 < 25\%$ indicated low heterogeneity, moderate heterogeneity between 25% and 75%, and high heterogeneity more than 75%. Publication bias was assessed by visual inspection of funnel plot and Egger asymmetry test.[16,17] In the presence of symmetry, one can conclude no publication bias, but in the absence of symmetry, one can expect publication bias. A subgroup analysis was undertaken to estimate the prevalence according to country of study, sample size (< 10,000 or > 10,000 or > 100,000), year of publication (before 2010 or after 2010), study setting (rural versus urban as judged by original authors of the study), and study quality (high versus moderate). Then, a sensitivity analysis was conducted by excluding one study at a time and to further explore sources of heterogeneity and factors associated with prevalence estimation. We conducted a meta-regression analysis on the following covariates: year of study publication, year of data collection, male ratio (%), response rate (%), study quality score, and study sampling method. For all statistical analyses, $P < 0.05$ was considered statistically significant.

Results

The initial search of the electronic databases resulted in 496 citations with an additional 23 articles identified through other resources. After the removal of duplicates, 478 citations were left. An initial screening based on title and abstract was conducted, resulting in 64 articles being selected for full-text evaluation based on eligibility criteria. Finally, 35 articles with 1,160,033 participants were eligible to be included in this meta-analysis. The entire selection process for the relevant studies is illustrated in Figure 1.

The characteristics of the 35 included studies in this systematic review and meta-analysis are shown in Supplementary Table 1. The studies included in this analysis were published between 1997 and 2020 representing data from 12 different Asian countries. There were 12 studies from India, 9 studies from China, 3 studies from Nepal, 2 each from Malaysia and Vietnam, and one each from Bhutan, Tibet, Thailand, Cambodia, Laos, Bangladesh, Bhutan, Iran, and Indonesia.[18-52] All of the included studies were population-based cross-sectional studies by design. Out of the 35 studies, 4 studies used the key informant method of sampling while 31 studies used multistage cluster sampling. The sample size per study ranged from 1084 to 480,574 among the studies, and the total population included in this meta-analysis was 1,160,033 participants, including 183,270 males and 168,885 females. The sum of numbers of males and females does not equal the total number of included participants since a few studies did not provide data on males and females and only provided the total numbers. However, none of the studies reported gender-specific data; therefore, we were unable to investigate how differences in gender affect the cataract prevalence.

The included studies were critically appraised by two independent reviewers using the Joanna Briggs Institute's Checklist for studies reporting prevalence data. We rated 26 studies as high quality and 9 studies as moderate quality. None of the studies were rated as low quality. The results of the methodological quality evaluation are shown in Supplementary Table 2. All studies (100%) clearly described the study participants and performed appropriate statistical analyses, but the sample size was considered inappropriate in 8 studies (23%). Eleven studies (23%) had an inadequate response rate, and seven studies (12%) did not report how all the participants included in the study were examined. Overall, the mean score of the study quality for all the included studies was 8 out of 9 indicating the high quality of studies.

According to the results, 217 cases of childhood cataract were detected from 1997 to 2020 in Asian populations. The prevalence of the included studies ranged from 0.005% to 0.369%. The random-effects pooled prevalence was 3.78 (95% CI: 2.54–5.62)/10,000 children with high risk of heterogeneity ($I^2 = 89.5\%$). Results of country-specific prevalence of childhood cataract revealed the highest

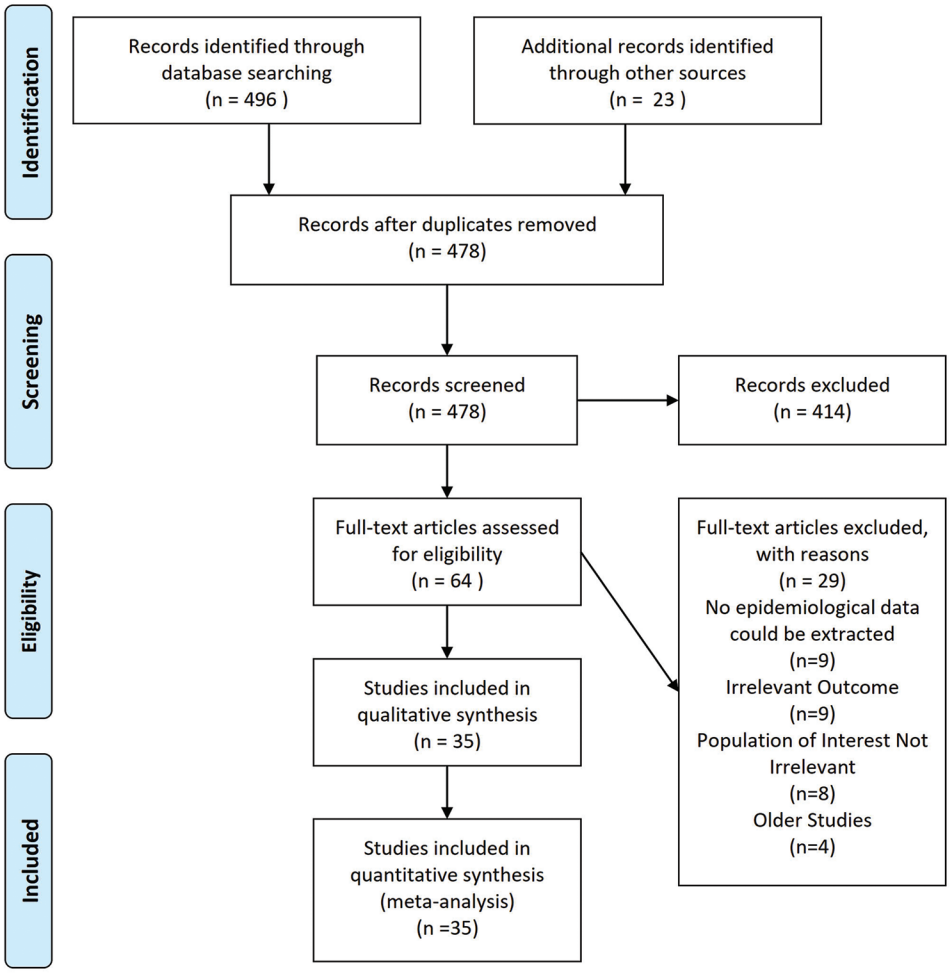

Figure 1: Flowchart of study selection process

prevalence in Cambodia 10.85 (95% CI: 4.88–24.14), followed by Vietnam 9.34 (95% CI: 5.36–12.24) and Nepal 5.42 (95% CI: 1.48–19.81). The lowest prevalence was in Indonesia 0.60 (95% CI: 0.42–0.87), followed by Bangladesh 0.92 (95% CI: 0.30–2.84) and Iran 1.47 (95% CI: 0.37–5.88) [Figure 2 and Supplementary Figure 1]. Since most studies were from China and India, we estimated the regional differences within each country. The highest prevalence within India was reported by Central India 6.20 (95% CI: 2.00–19.21) followed by southern India 6.04 (95% CI: 2.08–12.24) and the lowest in eastern regions of India 1.70 (95% CI: 1.16–2.49). Within China, East China reported the lowest prevalence 0.74 (95% CI: 0.01–2.23) followed by Beijing 1.56 (95% CI: 0.21–3.79) while North-East China 31.19 (95% CI: 8.69–65.70) and West China 25.31 (95% CI: 11.54–43.72) reported high prevalence. Subgroup analysis by sample size shows a decrease in prevalence as the sample size increases. A higher prevalence was observed in studies with sample size ≤10,000, 6.75 (95% CI: 4.64–9.80), while studies with sample size ≥10,000 have a prevalence of 3.16 (95% CI: 1.55–6.46), and studies with larger sample size ≥100,000 have the low prevalence of 0.81 (95% CI: 0.37–1.79) [Figure 3]. The prevalence rates by publication year were similar in studies published before 2010, 4.98 (95% CI: 2.93–8.45) compared to studies published after 2010, 2.93 (95% CI: 1.61–5.36) [Figure 4]. Similarly, urbanization had no effect on the prevalence with an estimated prevalence of 4.31 (95% CI: 2.11–8.80) in rural population and 4.99 (95% CI: 2.38–10.48) in urban population [Figure 5]. Subgroup analysis by study quality demonstrates that higher quality studies report a similar prevalence 4.55 (95% CI: 3.15–6.58) as compared to moderate quality studies 2.39 (95% CI: 0.77–7.40). Further details on the subgroup analysis are provided in Table 2.

A funnel plot for all studies was generated; according to Egger's regression test for funnel plot asymmetry, no significant publication bias was observed (Z value: 0.63; $P = 0.525$) [Figure 6]. Sensitivity analysis of all the studies was conducted by removing each study one by one to test the stability and effect of each study on pooled results. There was no influence on the results with the exclusion of any single study.

We observed significant heterogeneity across the pooled results with high I^2 value 89.5 (86.4–91.9). A meta-regression analysis was conducted to explore this heterogeneity.

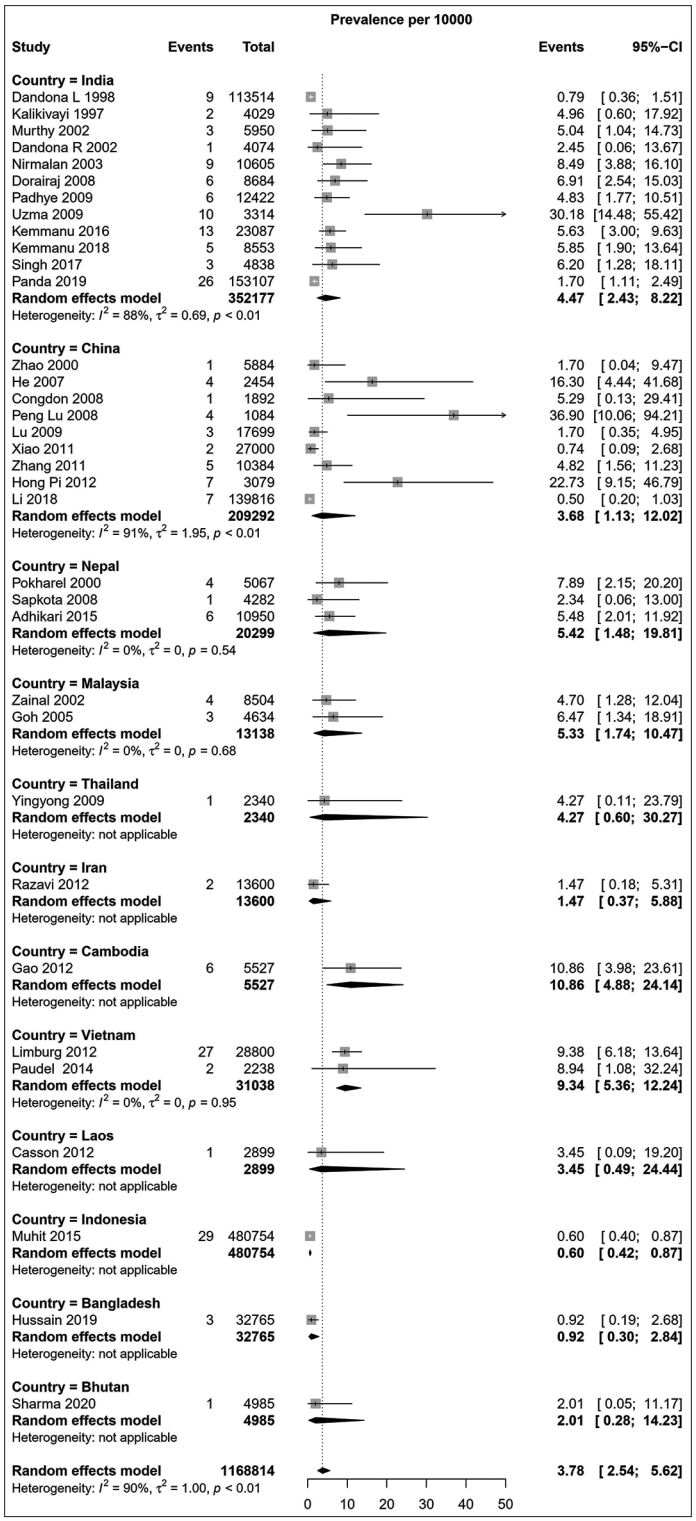

Figure 2: Forest plot for the prevalence of pediatric cataract by country

The analysis reports that sample size (P = 0.008) and sampling method (P = 0.002) were a significant source of heterogeneity [Figure 7]. However, other covariates such as year of publication, year of data collection, male ratio, study quality, and response rate had no significant effect on heterogeneity ($P > 0.05$).

Discussion

This study systematically evaluates the present scientific literature from 12 countries across Asia to provide comprehensive estimates for the prevalence of pediatric cataracts in Asian population from a huge participant

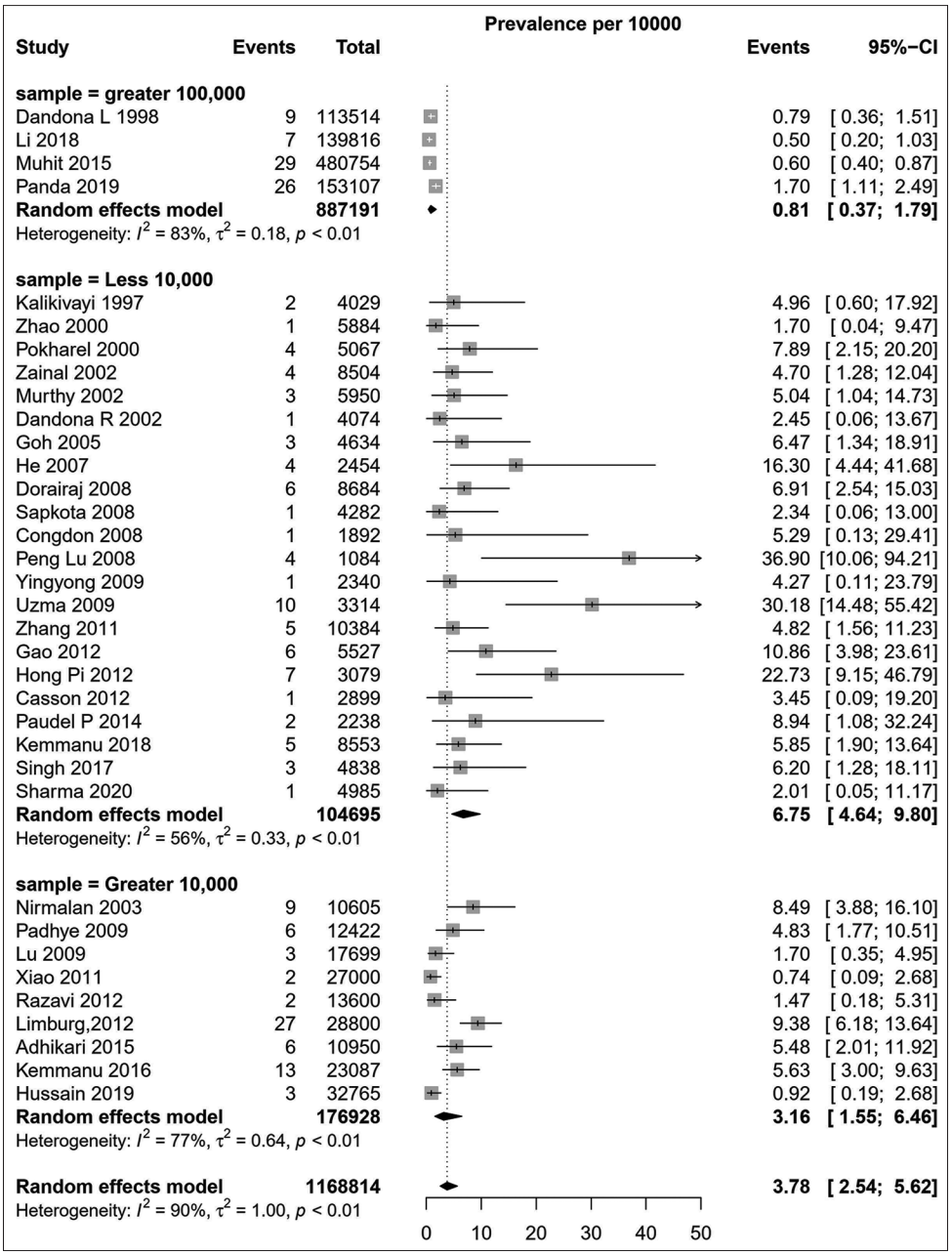

Figure 3: Forest plot for the prevalence of pediatric cataract by sample size

size of 1,160,033 pooled from 35 studies. Our estimated prevalence of pediatric cataract is 3.8/10,000 individuals. There was a difference in prevalence among various Asian countries with prevalence ranging between 0.60/10,000 individuals in Indonesia and 10.86/10,000 individuals in Cambodia.

Pediatric cataract can be clinically classified as either congenital if present at birth or developmental if acquired during early childhood. Proper development of the visual system requires visual stimuli during infancy and early childhood to develop connections between the retina and the brain; however, the presence of cataracts unilaterally or bilaterally can impede the development of such connections, permanently reducing the peripheral and central vision and leading to stimulus deprivation amblyopia.[53,54] Therefore, prompt diagnosis and immediate surgical intervention with appropriate refractive error correction are absolutely essential. Red reflex examination at birth is a simple noninvasive test to screen for congenital cataracts and any suspected cases should be referred to a pediatric ophthalmologist for further examination.[55] For best visual outcomes, surgical intervention is recommended at 6 weeks of age for unilateral cases and before 8 weeks of age or before the appearance of strabismus or nystagmus for bilateral cases.[56] Although most cases of cataracts are due to idiopathic or genetic causes, cataracts due to congenital rubella syndrome from maternal rubella infection continue to be a public health concern in many developing Asian countries such

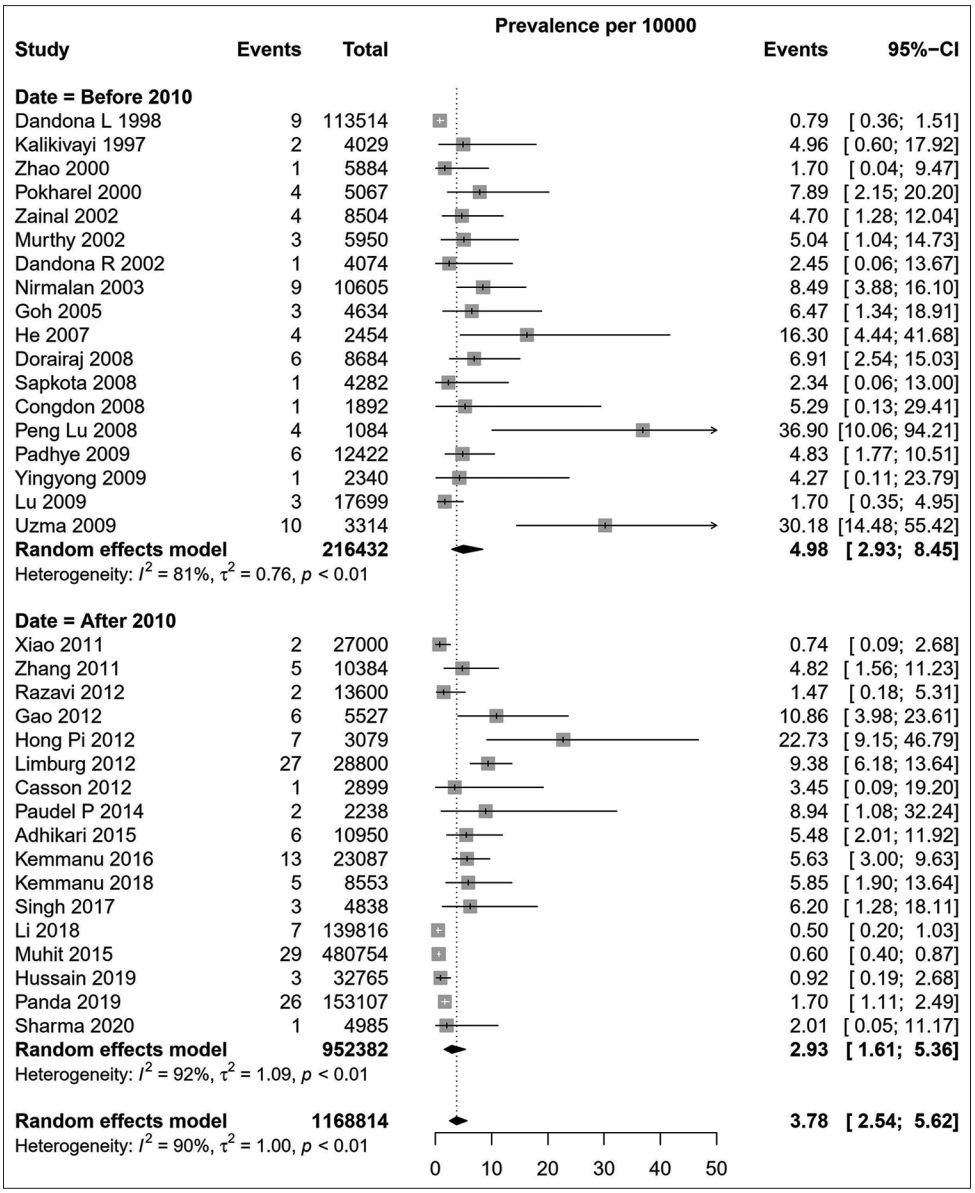

Figure 4: Forest plot for the prevalence of pediatric cataract by publication year

as India where almost 12%–30% of women of childbearing age are susceptible to rubella infection.[57]

For several possible reasons, there was high heterogeneity within the studies addressing the prevalence of pediatric cataracts. First, data were derived from studies with varying study designs and methodological quality, such as study populations, sampling methods, study settings, sample sizes, method of data collection, children's cooperation, and expertise of the examiner.

Second, the age at which a child is diagnosed with cataract can also contribute toward inter-study heterogeneity. The age of participants among the included studies ranged from birth to 18 years, so studies that exclusively screened school-aged children would report a lower prevalence since they would have missed out on cases of congenital cataract, some of which might have been cured by means of successful cataract surgery. Moreover, many studies classified cataract as any lens opacity with a decrease in visual acuity and did not define cataract on any specific grading systems. Finally, the variations among the studies could be attributed to an increase in earlier detection rates in some countries due to increased government-initiated national eye screening programs like those in India and Bangladesh.[58,59]

A previous meta-analysis estimating the global prevalence for pediatric cataracts estimates the prevalence of pediatric cataracts in Asia to be 7.43/10,000.[9] However, those conclusions were based on five epidemiological studies from China, hence not an accurate estimate for the entire Asian region. A similar study by Sheeladevi *et al*. reported the increased prevalence in high-income countries but did not report on the estimates by global regions.[60] Our estimated prevalence in Asian population is reported to be lower than previously reported

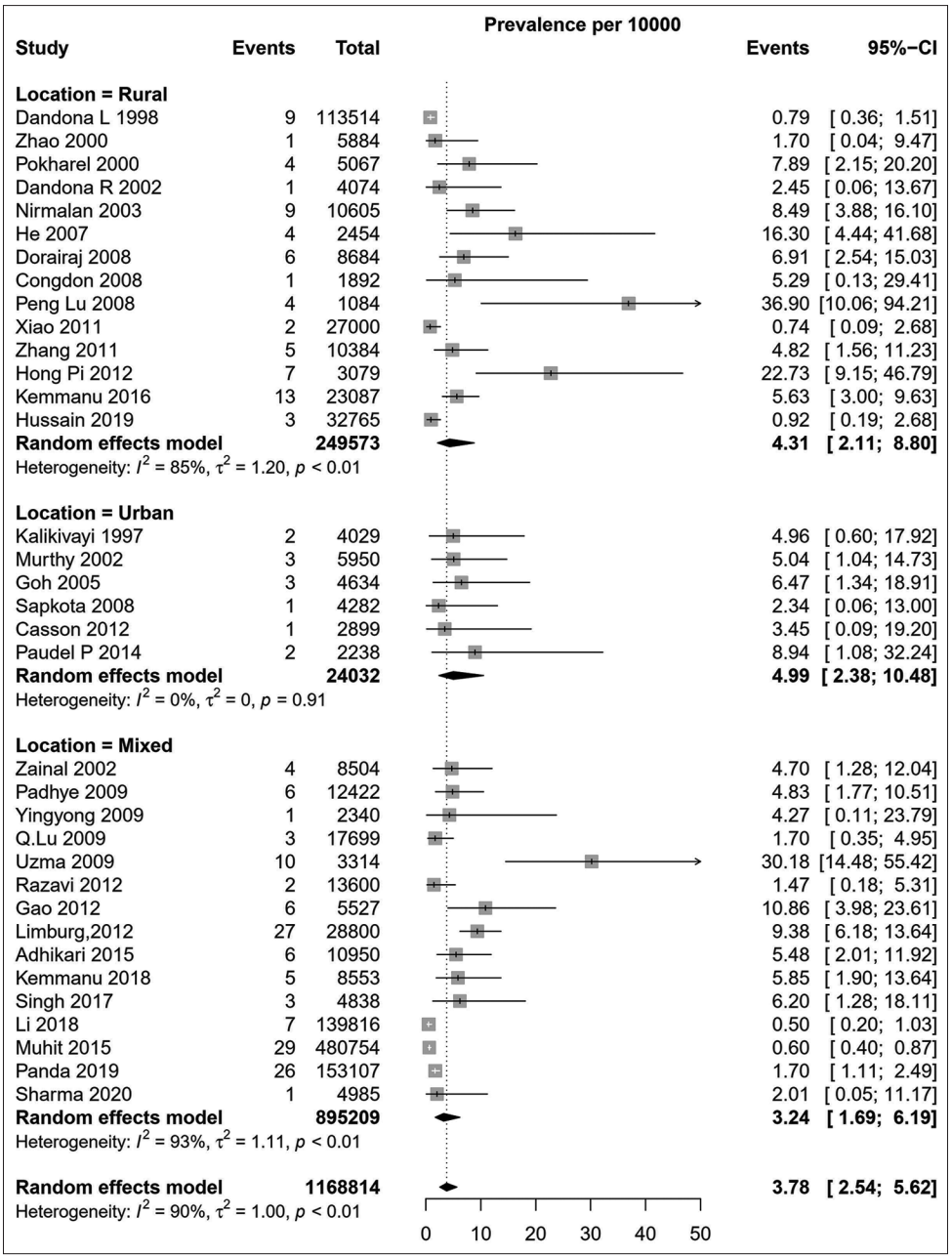

Figure 5: Forest plot for the prevalence of pediatric cataract by study setting

estimates for the American population 4.39/10,000 but similar to the European population 3.41/10,000. However, to make valid comparisons, studies with pooled prevalence based on up-to-date literature from different regions across the globe are required.

A previously published systematic review by Sheeladevi *et al*. explored the economic differences among various countries as a potential source of variation in the rates of prevalence and found that lower income countries have a lower prevalence of pediatric cataracts, while higher income countries have a higher prevalence of pediatric cataracts.[60] However, it is difficult to make a definitive conclusion regarding this observation in this present study since most countries in Asia are low- to middle-income economies. Subgroup analysis by individual countries in meta-analysis study reveals that lower middle-income countries such as Cambodia and Vietnam have reported the highest prevalence while countries with similar economies, for example, Bangladesh and Indonesia have reported the lowest prevalence. The primary reason for the variation is likely due to better identification rates in countries with screening programs, rubella immunization rates, and differing population genetics. The only high middle-income Asian country included in this study was China, with a reported prevalence of 3.68/10,000, but different regions within China revealed a great variation. Studies from Beijing reported a low prevalence 1.56/10,000 while studies from other regions

Table 2: Pooled prevalence and 95% confidence interval by subgroup analysis

Subgroup	Studies	Number of participants	Prevalence (%) per 10,000 people	95% CI	Heterogeneity - I^2 (%) 95% CI
Overall prevalence	35	1,168,814	3.78	2.54-5.62	89.5 (86.4-91.9)
Prevalence by country					
China	9	209,292	3.68	1.13-12.02	90.1 (84.7-94.4)
Nepal	3	20,299	5.42	1.48-19.81	0.0
India	12	352,177	4.47	2.43-8.22	88.3 (81.4-92.60)
Malaysia	2	13,138	5.33	1.74-10.47	0.0
Thailand	1	2340	4.27	0.60-30.27	NA
Cambodia	1	5527	10.86	4.88-24.14	NA
Vietnam	2	31,038	9.34	5.36-12.24	0.0
Laos	1	2899	3.45	0.49-24.44	NA
Bangladesh	1	32,765	0.92	0.30-2.84	NA
Bhutan	1	4985	2.01	0.28-14.23	NA
Indonesia	1	480,754	0.60	0.42-0.87	NA
Iran	1	13,600	1.47	0.37-5.88	NA
Prevalence within India					
Central India	1	4838	6.20	2.00-19.21	NA
West India	1	12,422	4.83	2.17-10.75	NA
East India	1	153,107	1.70	1.16-2.49	NA
South India	8	175,860	6.04	2.08-12.24	89.3 (81.2-93.9)
Delhi	1	5950	5.04	1.63-15.62	NA
Prevalence within China					
Beijing	2	23,583	1.56	0.21-3.79	0.0
Central China	3	144,162	4.49	2.52-22.01	86.7 (61.9-95.4)
West China	2	4163	25.31	11.54-43.72	0.0
East China	1	27,000	0.74	0.01-2.23	NA
North-East China	1	1603	31.19	8.69-65.70	NA
Prevalence by publication year					
Before 2010	18	216,432	4.98	2.93-8.45	80.7 (70.3-87.4)
After 2010	17	952,382	2.93	1.61-5.36	92.2 (88.8-93.2)
Prevalence by sample size					
Greater 10,000	9	175,471	3.16	1.55-6.46	76.9 (56.1-87.9)
Less 10,000	22	95,914	6.75	4.64-9.80	56.1 (29.2-72.8)
Greater 100,000	4	887,191	0.81	0.37-1.79	83.1 (56.7-93.4)
Prevalence by geographic location					
Urban	6	24,032	4.99	2.38-10.48	0.0
Rural	14	240,792	4.31	2.11-8.80	85.5 (77.2-90.8)
Urban/rural (mixed)	15	895,209	3.24	1.69-6.19	93.46 (90.7-95.3)
Prevalence by study quality					
High quality	25	399,734	4.55	3.15-6.58	76.5 (65.9-83.8)
Moderate quality	9	769,080	2.39	0.77-7.40	95.0 (92.4-96.7)

NA: Not available, CI: Confidence interval

such as western China and northeast China. This disparity signifies the range of healthcare services within the country. For instance, Zhang *et al*. reported that in Heilongjiang province, only 4 doctors served a population of 360,600.[36]

In studies published since 2010, a decreasing trend in prevalence has been observed, but it is not statistically significant [Supplementary Figure 2]. This trend is highly encouraging and reflects positively on the implementation and utilization of public health programs as well as government initiatives such as the National Eye Care Plan. For instance, an action plan has been operational in almost all countries in South Asia since 2010.[61] These efforts have resulted in the establishment of better tertiary eye care centers with better trained and equipped personnel, along with the implementation of numerous strategies to control blindness in children such as vision screening in schools, increased public awareness of pediatric eye care, and improved training of frontline health workers with the ability to identify and refer eye problems. These actions have resulted in an earlier detection and subsequent intervention of pediatric cataracts. With newer technology now available for ophthalmologists, such as small incision techniques and readily available cost-effective intraocular

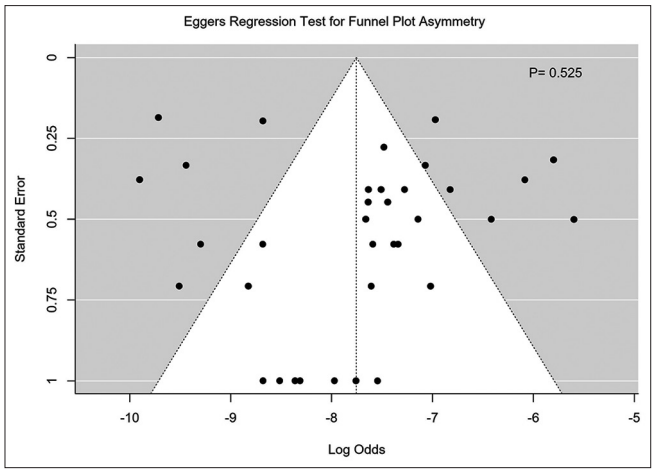

Figure 6: Assessment of publication bias with funnel plot and Egger's regression test

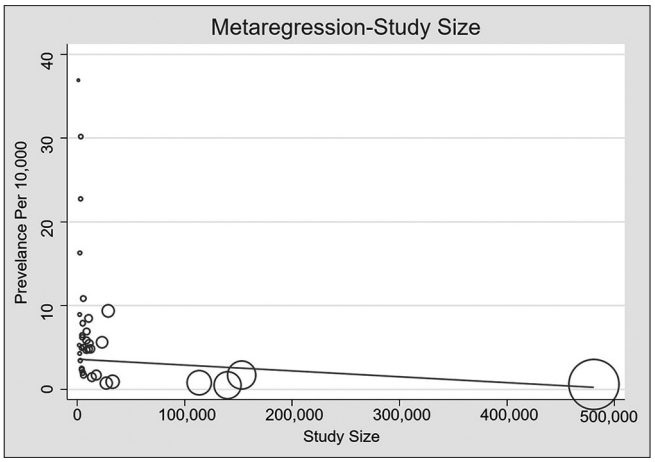

Figure 7: The relationship between the prevalence with study size by means of meta-regression

lenses, there has been a steady increase in cataract surgical rates.[62] The control of childhood blindness due to cataracts and other conditions, especially in low- and middle-income countries in Asia and similar regions, necessitates not only strong strategies but also a well-designed and functional pyramidal system of healthcare delivery, with costs covered either by national eye care subsidies or appropriate health insurance.[62] However, human resources and the fair distribution of competent eye health professionals will always remain the key in reducing the burden of preventable blindness. Since the studies included in this analysis were collected over a wide range of years spanning from 1998 to 2020, it would be interesting to conduct follow-up studies to understand how the degree of development may influence the prevalence.

There are several key strengths of our meta-analysis. A large number of participants from all studies were pooled. Based on strict inclusion criteria, only studies of the highest quality were included, which is why hospital-based prevalence studies were excluded because they frequently overestimate due to their nonrandom sample group. Similarly studies with a smaller sample size <1000 were excluded since pediatric cataract is a rare disease, so studies with a smaller sample size overestimate the prevalence as they are not true representative of population. Our subgroup analysis also confirmed this causality. Although high heterogeneity was reported, we performed meta-aggression and subgroup analysis to explain the discrepancies. However, certain limitations should be considered when evaluating our study. First, the results of this meta-analysis are from only 12 of 50 countries in Asia. Population-based data were not available for many countries located in Central Asia and the Middle East along with other densely populated Asian countries such as Pakistan and Japan; therefore, it cannot be assumed that the contributing studies for the meta-analysis are a true representative of the entire Asian population. Second, because only studies conducted in the English language were included in this meta-analysis, there is a high risk of language bias since English is not the first language in many Asian populations. Third, only a few of the included studies reported data on the laterality of the cataract; therefore, we could not estimate the prevalence of bilateral and unilateral cataracts. Similarly, few studies reported the age of diagnosis of cataract. Hence, we could not explore how the prevalence varied with the age of diagnosis. Given the limitations of this study, several findings should be interpreted with caution.

In conclusion, this systematic review and meta-analysis demonstrates that pediatric cataracts are relatively uncommon in Asia, though its prevalence can vary considerably depending on the country and regions within it. Our study also highlights the urgent need for large-scale multicenter population-based epidemiological studies in various Asian countries in order to accurately estimate the true burden of pediatric cataracts in this part of the world.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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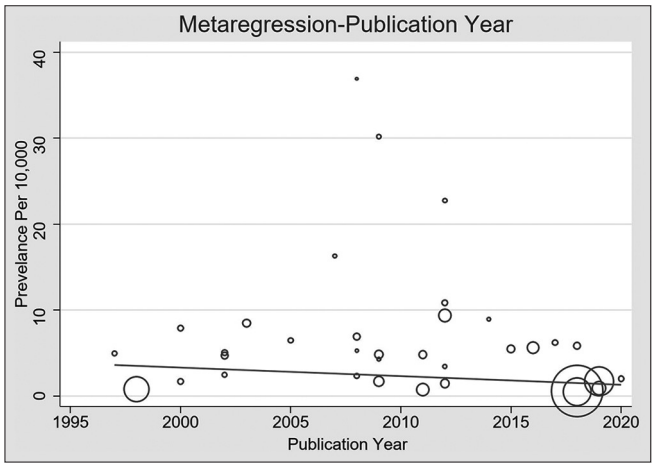
Supplementary Figure 1: Geographical distribution for prevalence of pediatric cataract in Asia with 95% confidence intervals



Supplementary Figure 2: The relationship between the prevalence with publication year by means of meta-regression

Supplementary Table 1: Characteristics of the studies included in this meta-analysis

Author-last name	Publication year	Study period	Country	Study design	Sample size	Cases	Age range (years)	Percentage boys (%)	Response rate (%)	Sampling method	Study quality
Kalikivayi *et al.*	1997	December 1993-March 1995	India	Cross-sectional	4029	2	3-18	58.3	87.2	Cluster	High
Dandona *et al.*	1998	1996	India	Cross-sectional	113,514	9	0-15	NA	NA	Cluster	Moderate
Zhao *et al.*	2000	May 1998-July 1998	China	Cross-sectional	5884	1	5-15	51.1	95.9	Cluster	High
Pokharel *et al.*	2000	May 1998 -July 1998	Nepal	Cross-sectional	5067	4	5-15	56.5	91.7	Cluster	High
Zainal *et al.*	2002	June 1996-March 97	Malaysia	Cross-sectional	8504	4	<15	NA	69	Cluster	High
Murthy *et al.*	2002	December 2000-March 2001	India	Cross-sectional	5950	3	5-15	51.9	92	Cluster	High
Dandona *et al.*	2002	April 2000-February 2001	India	Cross-sectional	4074	1	7-15	51.9	87.3	Cluster	High
Nirmalan *et al.*	2003	July 2002-December 2002	India	Cross-sectional	10,605	9	<15	51.1	94.6	Cluster	Moderate
Goh *et al.*	2005	March 2003-July 2003	Malaysia	Cross-sectional	4634	3	7-15	61.4	83.8	Cluster	High
He *et al.*	2007	April 2005	China	Cross-sectional	2454	4	13-17	51.3	97.6	Cluster	High
Dorairaj *et al.*	2008	NA	India	Cross-sectional	8684	6	<16	63.3	65.5	Cluster	High
Sapkota *et al.*	2008	January 2006-May 2006	Nepal	Cross-sectional	4282	1	10-15	53.2	95.1	Cluster	High
Congdon *et al.*	2008	April-July 2007	China	Cross-sectional	1892	1	<16	48.8	97.3	Cluster	High
Lu *et al.*	2008	March 2006-April 2006	China	Cross-sectional	1084	4	6-14	59.5	96	Cluster	High
Padhye *et al.*	2009	August 2004-July 2005	India	Cross-sectional	12,422	6	6-15	58.4	95.2	Cluster	High
Yingyong *et al.*	2009	October 2008-September 2009	Thailand	Cross-sectional	2340	1	6-12	48.3	NA	Cluster	Moderate
Lu *et al.*	2009	June 2006-July 2004	China	Cross-sectional	17,699	3	3-6	52.2	95.3	Cluster	High
Uzma *et al.*	2009	NA	India	Cross-sectional	3314	10	7-15	47.5	NA	Cluster	Moderate
Razavi *et al*	2010	June-August 2008	Iran	Cross-sectional	13,600	2	<16	NA	NA	Key informant	Moderate
Xiao *et al.*	2011	2009	China	Cross-sectional	27,000	2	<15	NA	NA	Key informant	Moderate
Zhang *et al.*	2011	2008-2009	China	Cross-sectional	1603	5	<15	NA	88.4	Cluster	High
Gao *et al.*	2012	October 2010	Cambodia	Cross-sectional	5527	6	12-14	45.4	89.8	Cluster	High
Pi *et al.*	2012	October 2006-January 2007	China	Cross-sectional	3079	7	6-15	52.5	88.8	Cluster	High
Limburg *et al.*	2012	2007	Vietnam	Cross-sectional	28,800	27	<15	52.2	100	Cluster	High
Casson *et al.*	2012	October 2009-November 2009	Laos	Cross-sectional	2899	1	6-11	49.8	87	Cluster	Moderate
Paudel *et al.*	2014	November 2011-December 2011	Vietnam	Cross-sectional	2238	2	12-15	46.1	77	Cluster	Moderate
Adhikari *et al.*	2015	January 2012-December 2014	Nepal	Cross-sectional	10,950	6	0-10	50.5	93.8	Cluster	High
Kemmanu *et al.*	2016	July 2008-April 2009	India	Cross-sectional	23,087	13	<15	NA	77.4	Cluster	High
Kemmanu *et al.*	2018	August 2012-December 2013	India	Cross-sectional	8553	5	<15	50.5	94.5	Cluster	High
Singh *et al.*	2017	June 2012-August 2014	India	Cross-sectional	4838	3	5-15	49.9	NA	Cluster	High
Muhit *et al.*	2018	January 2015-June 2016	Indonesia	Cross-sectional	480,754	29	0-15	NA	NA	Key informant	Moderate
Li *et al.*	2018	2017	China	Cross-sectional	139,816	7	0-15	NA	NA	Key informant	Moderate
Hussain *et al.*	2019	January 2017-April 2017	Bangladesh	Cross-sectional	32,765	3	<15	50.5	98	Cluster	High
Panda *et al.*	2019	August 2016-July 2017	India	Cross-sectional	153,107	26	5-16	50.8	95.7	Cluster	High
Sharma *et al.*	2020	March-June 2019	Bhutan	Cross-sectional	4985	1	10-15	48.5	98.5	Cluster	High

NA: Not available

Supplementary Table 2: Quality assessment of included studies using Joanna Briggs Institute Critical Appraisal Checklist

Question	Dandona 1998	Kalikivayi 1997	Pokharel, 1998	Zhao 2000	Murthy, 2002	Nirmalan, 2003	Dandona, 2002	Zainal, 2002	Goh, 2005	He, 2007	Dorairaj, 2008	Congdon, 2008	Sapkota, 2008	Peng, 2008	Lu, 2009	Padhye, 2009	Yingyong, 2009	Uzma, 2009
1. Was the sample frame appropriate to address the target population?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Were study participants sampled in an appropriate way?	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear
3. Was the sample size adequate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Unclear	Yes	Unclear	Yes	No	Yes	Unclear
4. Were the study subjects and the setting described in detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Was the data analysis conducted with sufficient coverage of the identified sample?	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Were valid methods used for the identification of the condition?	Yes	Yes	Yes	Yes	Unclear	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Was the condition measured in a standard, reliable way for all participants?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
8. Was there appropriate statistical analysis?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9. Was the response rate adequate, and if not, was the low response rate managed appropriately?	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	No	Yes
Total score	6	9	9	9	8	7	9	8	9	8	8	8	9	8	9	9	7	7

Contd...

Supplementary Table 2: Contd...

Question	Razavi, 2010	Xiao, 2011	Zhang, 2011	Gao, 2012	Casson, 2012	Pi, 2012	Limburg, 2012	Pauduel, 2014	Adhikari, 2015	Kemmanu, 2017	Singh, 2018	Kemmanu, 2018	Muhit, 2018	Li, 2018	Panda, 2019	Hussain, 2019	Sharma, 2020
1. Was the sample frame appropriate to address the target population?	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Were study participants sampled in an appropriate way?	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes
3. Was the sample size adequate?	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear
4. Were the study subjects and the setting described in detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Was the data analysis conducted with sufficient coverage of the identified sample?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Were valid methods used for the identification of the condition?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Was the condition measured in a standard, reliable way for all participants?	No	No	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes
8. Was there appropriate statistical analysis?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9. Was the response rate adequate, and if not, was the low response rate managed appropriately?	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Unclear	Yes	No	No	Yes	Yes	Yes
Total score	6	6	8	9	7	8	9	7	9	8	8	9	6	6	9	9	8

Low quality score <4, Moderate quality score 5-7, High quality>8