Incidence and Cumulative Risk of Childhood Cataract in a Cohort of 2.6 Million Danish Children

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PURPOSE. To determine the incidence and cumulative risk of childhood cataract in Denmark during 1980 to 2000.

METHODS. A cohort of 2,616,439 Danish children born between 1962 and 2000 was followed from 1980 or from the day of birth, whichever occurred later, until their 18th birthday, death, emigration, or diagnosis of cataract, whichever occurred first. Cases were ascertained from the Danish National Register of Patients (NRP) and validated by reviewing the medical records. They were divided into four groups: congenital/infantile (CI) cataract, traumatic cataract, complicated cataract, and “other” types of cataract.

RESULTS. After diagnostic validation, 1,311 children with cataract (59% with CI cataract) were included in the study. During 1995 to 2000 the overall cumulative risk of childhood cataract was 108 per 100,000 children. There was no significant difference in incidence between girls and boys or over time (1980 to 2000) for CI, complicated, and “other” types of cataract. In contrast, the incidence of traumatic cataract was significantly higher among boys. It remained increased during the entire study period despite a 23% decrease per 5 years among boys. Sixty-six percent of the children diagnosed with CI cataract below 2 years of age underwent surgery within 1 year.

CONCLUSIONS. The stable incidence during a 20-year period of CI cataract and complicated cataract indicates that risk factors for these conditions have remained unchanged, whereas the marked drop of traumatic cataract among boys most likely reflects changed behavior and an increased focus on preventive measures. (Invest Ophtalmol Vis Sci. 2004;45: 1316–1320) DOI:10.1167/iovs.03-0635

Although being a rare disease, cataract is a major cause of childhood blindness worldwide.¹ Most of what is known about the distribution of childhood cataract is restricted to studies of congenital and/or infantile cataract. The occurrence of these types has been reported to vary between 12 and 136 cases per 100,000 children.²⁻⁶ However, there is uncertainty about the robustness of the reported figures due to limited sample size and varying study designs. Furthermore, little is known regarding trends in the incidence over time for the various types of cataract.

Some cases of childhood cataract are associated with other ocular or systemic diseases or are a result of trauma. Approximately half of the cases traditionally referred to as congenital or infantile cataract are of unknown etiology⁷⁻⁻¹⁰ and another 20%–35% are believed to be genetically based.¹¹⁻¹³,¹⁶ It is unknown to what extent changes in lifestyle and environment in recent decades may have influenced the risk of cataract.

The unique Danish population-based registers formed the basis of the study of the cumulative risk and the age-specific incidence of childhood cataract during the past 20 years with respect to age, sex, type of cataract, and calendar period.

METHODS

Since 1968, Danish citizens have been assigned a personal 10-digit identification number by the Civil Registration System (CRS).¹⁷ Attached to this CRS number is continuously updated information on vital status, emigration status, family relation, and place of birth and living. Other national registries also use the CRS number as their person-identification key, thus allowing the different registries to be linked. Based on information from the CRS registry, a cohort of all persons who were born in Denmark and who were between 0 and 17 years old at some time during the period 1980 to 2000 was established. Totally, this included all children born between 1962 and 2000 (n = 2,616,439). In Denmark newborn children are routinely examined at delivery by a pediatrician. Healthcare is cost-free in Denmark, and during the first year of life all children are seen regularly by a general practitioner for health checks and vaccinations. A visiting nurse performs additional health checks.

Cases of cataract within the cohort were ascertained from the Danish National Register of Patients (NRP). Since 1977 the NRP has registered discharge diagnoses for all patients admitted to public hospitals (inpatients) in Denmark. In addition, surgical procedures are registered. Since January 1, 1995, the diagnoses for outpatients and for patients seen in emergency wards at hospitals have also been registered. Inpatients and outpatients are coded differently in NRP, making it possible to differentiate between the two ways of handling the patient. For the purpose of this study the date of the first registered cataract diagnosis of a particular case was considered to be the date of occurrence of cataract.

During the study period 1980 to 2000, two versions of the International Classification of Diseases (ICD) were used, namely versions 8 (1980 to 1993) and 10 (1994 to 2000). Cases of cataract were identified as codes 74.439 and 37.400 to 37.409 in ICD-8 and as codes Q120 and Q12, H25.2, H25.8, H25.9, H26.6, H26.8, H26.9, H27, H27.8, H27.9, H28.8, H28.2 in ICD-10.

To validate the diagnoses, all medical records of cases with a discharge diagnosis of cataract were thoroughly reviewed, the only exception being children who were solely registered with traumatic cataract or complicated cataract. For these diagnoses a stratified random sample was selected, making up 40 medical records out of 286 registered cases with traumatic cataract, and 30 medical records out of 120 registered cases with complicated cataract. Whenever a case was...
registered with two different cataract diagnoses (e.g., traumatic and complicated cataract, or infantile and complicated cataract), the medical record was reviewed for proper classification of the case.

Subsequently, the cases of cataract were grouped into four categories: congenital/infantile (CI) cataract, traumatic cataract, complicated cataract, and “other” types of cataract.

CI cataract included hereditary cataracts and cataracts in association with syndromes (e.g., Down and Marfan syndromes), and/or congenital ocular abnormalities (e.g., congenital ectopia lentis, aniridia, persistent hyaloid artery, persistent hyperplastic primary vitreous, posterior lenticous). Furthermore, if no obvious etiology or association was present, nuclear/zonular cataract and anterior or posterior polar cataract were considered to be congenital morphologies.

Early cataracts associated with retinopathy of prematurity and cataracts associated with uveitis and Coats’ disease were included in the group of complicated cataracts. Cataract developed after intraocular surgery was also classified as complicated cataract.

Traumatic cataract was defined as cataract occurring after blunt or perforating trauma to the eyeball. The “other” types of cataract is a mixture of small subgroups, each considered too rare to constitute an independent group. Subgroups consist of drug-induced cataract (n = 25), which includes cataracts caused by steroid therapy, diabetic cataract (n = 12), cataract of other specified etiology (n = 14), and cases whose medical records were not found and whose primary diagnosis did not fit into the main groups (n = 4).

Surgery rates were based on the registered diagnoses of surgery on the lens coded as 17,000 to 17,490 (all included) in ICD-8 and as groups (7,18). Furthermore, if no obvious etiology or association was present, nuclear/zonular cataract and anterior or posterior polar cataract were considered to be congenital morphologies.

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Surgery rates were based on the registered diagnoses of surgery on the lens coded as 17,000 to 17,490 (all included) in ICD-8 and as KJDB-KCIW99 (all included) in the ICD-10 nomenclature.

Permission to receive data from the national registries was obtained in accordance with the Ethical Committees for Copenhagen and Frederiksberg (KF) 01-253/00, and it adhered to the tenets of the Declaration of Helsinki.

Statistics Analyses
Age-specific incidence rates were estimated as the number of cases divided by the amount of person-years at risk in each age category. Person-years at risk were calculated by assuming that children were at risk from January 1, 1980, or from the day of birth, whichever occurred later, until the first diagnosis of cataract, or until death, emigration, 18th birthday, or December 31, 2000, whichever occurred first. Statistical tests and estimation of sex ratios and time trends in incidence rates per 5 years were performed using log-linear Poisson regression with the number of cases as the dependent variable, and with age, calendar period (1980 to 1984, 1985 to 1989, 1990 to 1994, 1995 to 2000) and sex as the independent variables, and the logarithm of person-years at risk as offset. The age groups used for congenital/infantile cataract were 0–2 months, 3–5 months, 6–8 months, 9–11 months, and 1, 2, 3, 4–6, 7–9, 10–13, and 14–17 years. The age groups for traumatic and for complicated cataract were 0–3, 4–6, 7–9, 10–13, and 14–17 years.

The cumulative risk during childhood, either overall or for a specific sex in a specific period, was estimated as 1-exp (-Λ), where Λ was the cumulative incidence rate overall or for the specific sex in the specific period. The cumulative incidence rate was determined as a weighted sum of the age-specific incidence rates with the above-mentioned age groups and with weights equal to the number of years in the age categories.

RESULTS
Validation and Distribution of Cases
Overall, 1424 children aged 0 to 17 years were registered with a diagnosis of cataract during 1980 to 2000. A random sample of 40 out of 286 medical records of cases registered with traumatic cataract was reviewed, and all cases fulfilled our criteria for being traumatic. We further validated 30 out of 120 medical records of cases registered with complicated cataract. Of these, 63% (19/30) of the validated cases fulfilled our definition of complicated cataract. Of the remaining 11 cases, six were reclassified as “other” types of cataract, four as congenital/infantile (CI) cataract, and one case as traumatic cataract.

All medical records of the remaining 1018 cases registered with a diagnosis of cataract were reviewed. Of these, 113 did not have cataract (90 had erroneously been given a classification code indicating cataract, and the remaining 23 had been given an observational diagnosis of cataract that was dropped at a subsequent evaluation). Of the 905 remaining medical records, 85% were CI cataract, 5% traumatic, 5% complicated, and 5% belonged to the group of “other” types of cataract. Overall, 20 medical records were not available for evaluation. For this small subgroup we chose to accept the originally registered diagnosis.

A total of 1311 children with cataract remained in the study. There were 779 boys (391 with CI, 266 with traumatic, 93 with complicated, and 29 with “other” types of cataract) and 532 girls (379 with CI, 61 with traumatic, 68 with complicated, and 24 with “other” types of cataract).

Inpatients 1980 to 2000
Table 1 shows the cumulative risk (i.e., the cumulative risk at the 18th birthday) of childhood cataract divided into CI, traumatic, complicated, and “other” types. Because cataract in childhood is a rare disease, the cumulative risk corresponds to the cumulative incidence. During 1980 to 2000, the overall cumulative risk of childhood cataract among inpatients was 92.4 per
100,000 children, 107.9 for boys and 76.2 for girls per 100,000 children.

Throughout the study period there was no significant difference in incidence between boys and girls regarding CI [boys/girls ratio = 0.99 (95% confidence interval, CI, 0.85–1.15)], complicated [boys/girls ratio = 1.34 (95% CI, 0.97–1.84)], or “other” types of cataract [boys/girls ratio = 1.08 (95% CI, 0.61–1.88)]. With respect to traumatic cataract the incidence was significantly larger among boys than among girls, however with a decrease over time in the boy/girl ratio, from 4.44 (95% CI, 2.77–7.11) in 1980 to 1984 to 2.32 (95% CI, 1.29–4.15) in 1995 to 2000. In boys with traumatic cataract the incidence significantly with age (P-trend < 0.0001), whereas there was no such trend among girls (P-trend = 0.12). The incidence of complicated childhood cataract also increased significantly with age (P-trend < 0.0001).

### Inpatients and Outpatients 1995 to 2000

From 1995 both inpatients and outpatients were registered in the Danish NRP. Of the 401 children with cataract registered in 1995 to 2000, 101 were outpatients. In Tables 1 and 2 the cumulative risks and age-specific incidences of childhood cataract among inpatients and outpatients during 1995 to 2000 are included. The resulting cumulative risk of childhood cataract including both inpatients and outpatients was 108.4 per 100,000 children, corresponding to 119.2 per 100,000 children among boys and 97.0 per 100,000 children among girls.

The percentage of children (0 to 17 years of age) who underwent surgery of the lens within 1 year after being diagnosed with cataract was 55.0% for CI, 79.2% for traumatic, 61.4% for complicated, and 69.3% for “other” types of cataract. However, the percentage of children below 2 years of age with CI cataract who underwent surgery within 1 year after being diagnosed with cataract was 65.7%.

### DISCUSSION

Based on the nationwide registration of all types of hospital patients in 1995 to 2000, 108.4 per 100,000 Danish children were diagnosed with cataract before their 18th birthday. Over
a 20-year period, the risk of CI, complicated, and “other” types of cataract remained stable, whereas there was a dramatic drop of traumatic cataract among boys.

The literature is sparse regarding comprehensive studies of the incidence and distribution of childhood cataract. Most knowledge derives from studies performed on subgroups of childhood cataract in certain age groups, usually based on surveys of patients from selected hospitals. In contrast to most previous reports our population surveys of patients from selected hospitals. In contrast to most childhood cataract in certain age groups, usually based on knowledge derives from studies performed on subgroups of citizens. This allowed a cohort of all Danes born between 1962 and 2000 to be established and followed until their possible diagnosis of early cataract.

The cataract cases in this study were identified by the hospital discharge diagnoses as coded and registered in the NRP, which is based on mandatory registration of an entire population. During the entire period, 1980 to 2000, all childhood cataract cases that required hospitalization were registered (inpatients). In the most recent period, 1995 to 2000, the diagnoses for outpatients and patients seen in emergency wards at hospitals were also registered, but with codes identifying these as outpatients. The use of hospital registers may thus lead to an underestimation of the incidence. In the period 1980 to 1994, some of the milder cases of cataract may have been missed. In 1995 to 2000, however, milder cases were also registered as hospital outpatients. Cases remaining are those few that originally may have been seen by a private ophthalmologist. However, it is normal practice that children with cataract are examined at an eye department to evaluate the need and timing of surgery, and/or at a pediatric department for evaluation of possibly underlying disease. Furthermore, due to the Danish citizens’ free access to healthcare, it is reasonable to assume that the referral pattern is free from bias caused by socioeconomic status. We therefore believe that the risks and incidences for the 1995 to 2000 subgroup including both inpatients and outpatients are reliable estimates of the risk and incidence of childhood cataract in the Danish population.

Age at first diagnosis of “incident” cataract was determined as the date of the first registration of a cataract diagnosis in the Patient Registry. This method was chosen to permit comparison of the incidence rates of different types of cataract, as some of the medical records were not reviewed. Consequently, the figures presented are based on the date at which a cataract case was first admitted to the hospital and not on the date at which the cataract actually arose. This might give a slightly distorted picture of the age-specific incidence rates, since some of the registered cases have had their cataract developing for some time before registration. The consequence would be that the incidence rates in the lowest age groups are in fact higher than shown here and lower in the higher age groups.

In our study the group of complicated cataract included a few cataracts regarded as a result of a postnatally developed retinopathy of prematurity, cases associated with uveitis, and cataract as a complication of Coats’ disease. Cataract formation after intraocular surgery for congenital glaucoma was equally classified as complicated cataract. When reviewing the medical records, it became obvious that our definition of complicated cataract did not completely match the definition used by many clinicians. Therefore, only 63% of the validated cases were classified as complicated cataracts according to our definition. However, our final number of complicated cataracts included reclassified cases. It can be estimated that 80% of the cases included in this group were complicated cataracts also according to our definition. As a result, the figures for complicated cataract are likely to be slightly overestimated.

The validation of the random sample of the medical records of children with traumatic cataract disclosed that 100% conformed to our definition of traumatic cataract. The reviewed medical records in this group eventually also contained cases from other groups that had been revised and reclassified. All the medical records of the cases with CI cataract and “other” types of cataract were reviewed. The group of “other” types of cataract was thought to be too small and heterogeneous from which to draw conclusions. The estimated number of CI cataract cases hidden in the nonvalidated part of complicated cataract would constitute < 2% of the cases, and a misclassification of this magnitude could have caused only a marginal underestimation of the number of CI cataract cases.

The risk of CI cataract among inpatients appeared similar among boys and girls and remained stable during the past 20 years, indicating that risk factors for this disease have remained largely unchanged. The stable incidence is consistent with the only other published study of a similar nature which, based on a smaller sample size (n = 136), describes trends over a 16-year period of congenital cataract in four Swedish counties.25 In contrast to the Swedish study, we calculated the risk estimates on the basis of person-years at risk, thus ensuring a correct measure of the denominator throughout the period under study.

Most previous studies have reported lower risk estimates for CI cataract than the 72.0/100,000 children found in the present Danish study, the exception being a United States birth cohort study of children born between 1959 and 1965 giving a cumulative incidence of 136/100,000 children.26 Some of the discrepancy between the two studies can be explained by differences in vaccination coverage. Whereas most of the mothers giving birth to children in the Danish study would have immunity to rubella, the number was lower in the older US cohort. Excluding cases with known prenatal rubella exposure, the authors of the US study estimated 112/100,000 children with cataract. The difference may partly also be explained by differences in population composition (e.g., the US population being more heterogeneous than the Danish), or they could reflect a true reduction in cases of infantile cataract from the 1960s to the 1980s.

The only type of cataract that showed changes in the incidence over time in the present study was traumatic cataract, where the incidence was reduced by > 50% among inpatients, though only in boys. A Finnish study from the late 1970s reported a decreasing percentage of eye injuries compared to earlier decades, and the severity of the accidents had decreased.27 The decrease seen in our study might be due to increased focus on the necessity of using protective equipment (e.g., when lighting fireworks and in sports). Among girls the risk of eye injury has been reported to be stable at all ages.28–31 In other studies the boys/girls ratio is 4 to 6 in children with traumatic cataract21–25 which is in accordance with the ratio found in our study regarding the period 1980 to 1984. However, more recently the ratio has decreased markedly due to the recent significant decrease in incidence among boys.

The Patient Registry does not include information on the long-term follow-up regarding visual function after a diagnosis of childhood cataract. Information on surgery rates revealed that 66% of children diagnosed with CI cataract before 2 years of age had surgery within a year. There are presently no data in the literature to which this figure can easily be compared. Whereas very early surgical intervention removes the likelihood of according to normal visual development, recent studies have found high long-term complication rates of glaucoma development.24–26 Thus it remains to be investigated whether the present surgery practice is optimal in relation to the long-term prognosis of the patient’s vision.

In conclusion, this nationwide study of 2.6 million children provided incidence figures for childhood cataract in a developed country. The stable incidence of CI cataract in recent
decades indicates that risk factors for this disease have remained largely unchanged. In contrast, preventive measures or changed lifestyles are likely to be responsible for the dramatic drop in the incidence of traumatic cataract.

References