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Epidemiology of blindness in Nepal*

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This report presents the major findings of the Nepal Blindness Survey, the first nationwide epidemiological survey of blindness, which was conducted in 1979–80. The survey was designed to gather data that could be used to estimate the prevalence and causes of blindness in the country. Ancillary studies were conducted to obtain information on socioeconomic correlates and other risk factors of blinding conditions and patterns of health care utilization.

The nationwide blindness prevalence rate is 0.84%. Cataract is the leading cause of blindness, accounting for over 80% of all avoidable blindness. Trachoma is the most prevalent blinding condition, affecting 6.5% of the population. Very few cases of childhood blindness were detected.

The implications of the survey findings for programme planning, health manpower development, and health education are discussed.

The Nepal Blindness Survey was a multipurpose, interdisciplinary study of the prevalence and causes of blindness in Nepal. Conducted under the auspices of the Ministry of Health of His Majesty's Government and WHO's programme for the prevention and control of blindness, the survey was the first activity of the Nepal Blindness Prevention and Control Project. The survey was designed to gather data on a large sample of the approximately 15 million Nepalese population, from which one could estimate the prevalence and causes of blindness for the entire country as well as for certain geographical, demographic and community subgroups of the population. Several ancillary studies were also conducted as part of the survey to investigate specific diseases in more detail.

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METHODS

A two-year period from late 1978 to 1980 for planning, design, pretesting, and standardization preceded the field-work. The design of the survey was based on consultations with ophthalmologists, administrators, survey research specialists, health planners, epidemiologists, and others. A feasibility study in five villages was conducted in March 1979, and an international advisory meeting of ophthalmologists, epidemiologists, and survey researchers was held in San Francisco, CA, USA, in December 1979 to review the proposed survey protocols. Preparation of pro formas, protocols, operational guidelines, and other survey materials was carried out for eight months in 1980. Pretests of the survey protocols, including ophthalmic examinations, were conducted on nearly 3000 persons located in ten sites covering different parts of the country.

A stratified two-stage probability sample of persons in 105 sites in Nepal was selected for the survey. Fig. 1 shows the distribution of the sample sites. From mid-December 1980 till the end of April 1981, ten ophthalmologists (from Nepal and four other countries) examined 39 887 persons in all 14 administrative zones and all five development regions, according to the standardized survey protocols. Three basic activities were conducted in each of the sites. First, a complete list of all households and

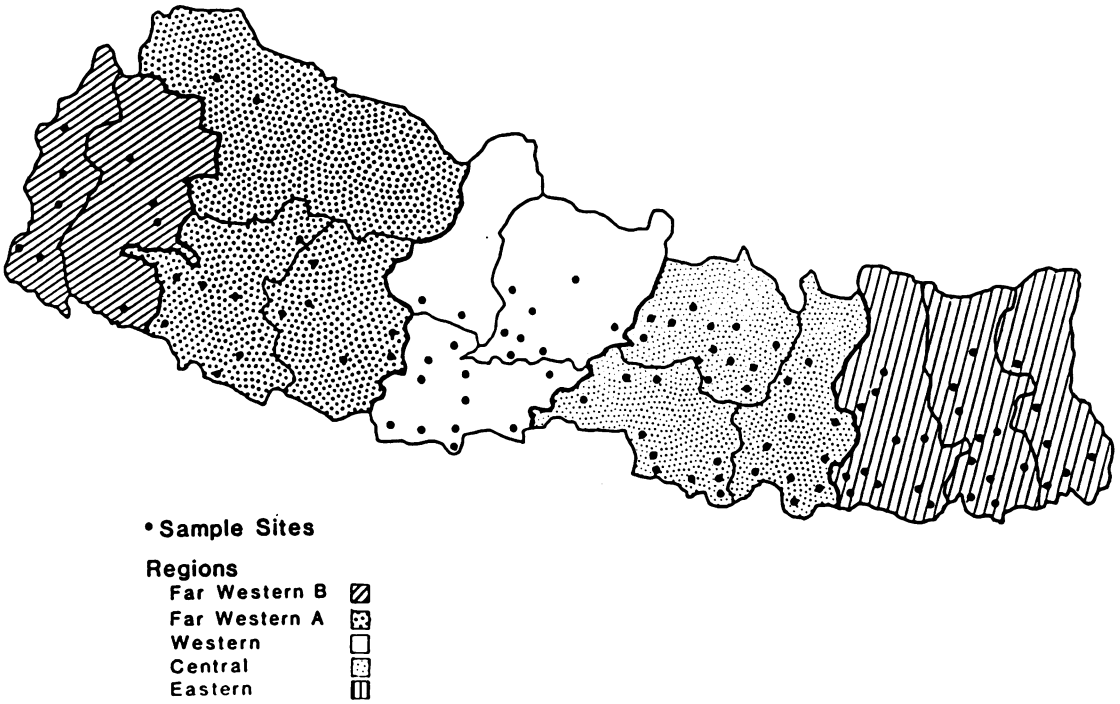

Fig. 1. Map of Nepal showing 5 regions, 14 zones and 105 sample sites visited in the blindness survey.

persons was prepared for each survey site to serve as a register against which the coverage of examinations could be assessed. Enumeration of 80–90 households and 450–500 persons was accomplished by advance teams of two to four enumerators who canvassed the site several days prior to the arrival of the examination team. The enumeration team was responsible for preparing the list and for the collection of background data about the site, households, and persons (including information about caste, religion, ethnic group, water supply, migration history, health services utilization, and other characteristics of the household) which could be used later in the epidemiological analyses.

The second basic activity was the eye examinations. A team consisting of an ophthalmologist, a medical officer, and an ophthalmic assistant arrived after the enumeration activities were completed. With the assistance of the enumerators, a centralized location was organized in the site and the subjects were brought in for examination. The name, age, sex, and other identifying information for each person had been recorded on a household register, and all persons in a household had been issued a "ticket" identifying the household in which they had been enumerated. As the subjects came forward for their eye examination, they were registered by an enumerator who checked the name and other information on the household register.

The ophthalmic examination protocol involved three basic steps. First, the ophthalmic assistant measured visual acuity using a simplified procedure designed to meet the range of climatic and environmental conditions expected in Nepal. Each ophthalmic assistant was provided with a piece of rope with knots tied at one, three, and six metre distances from one end. The examinee was seated, and one eye was covered by a locally hired assistant, usually using the palm of the hand. The ophthalmic assistant stood at a distance of six metres holding a plastic-coated E-type card with 6/18 optotype displayed. The examinee was asked to indicate the direction of the "fingers" of the E optotype, and the optotype was rotated five times. If the direction was correctly identified in at least four out of five times, the visual acuity was recorded as 6/18 and the visual acuity examination was ended. If

the identification was not correct, optotypes for 6/60, 3/60 (at three metres), and 1/60 (at one metre) were attempted until a successful result was obtained. If the examinee could not see the optotype at a distance of even one metre (i.e., counting fingers at one metre), the ophthalmologist recorded the subject's perception of light or assessed the ability to fix and follow a focused light source during the ophthalmic examination.

Persons unable to see at least 6/18 had a pinhole correction applied, and pinhole improvement to 6/18 was noted. All subjects were tested using the best available correction (i.e., pinhole or eyeglasses), and those with visual impairment (i.e., less than 6/18 vision) were questioned about the onset of visual impairment. The E optotype was always displayed in full sunlight, and the subjects were seated either in the shade or with their backs to the sun.

Once the visual acuity measurement was completed, an eye examination was carried out by the ophthalmologist. Subjects were seated in front of the ophthalmologist in a darkened room. Using equipment provided by the survey (a standard head-mounted 2.5 × loupe and a battery-powered, focused light source), the ophthalmologist examined the anterior segment of the eye. The lids of all subjects were flipped during this examination of the anterior segment to inspect the tarsal conjunctiva for signs associated with trachoma. If the subject's visual acuity was less than 6/18, the pupil was dilated using a single drop of 10% phenylephrine solution. A supplementary examination of the posterior segment of the eye was then conducted using an ophthalmoscope. The ophthalmologist then recorded his diagnosis of the cause of any visual impairment and the etiology of any ocular disorders.

The third basic activity of the survey was a series of ancillary studies conducted by the examining ophthalmologist, by a medical officer, or by an enumerator. The studies included two matched-pair case-control studies of xerophthalmia and keratomalacia (250 case-control pairs matched by place of residence, age, and sex), a study of operated and unoperated cataract patients (103 operated and 285 unoperated), a study of a random sample of persons from trachomatous areas (280 persons), and a study of persons with a history of signs of eye trauma (336 persons). Much consideration was given to quality control both before and during the survey, e.g., special training in data collection for all levels of survey staff, continuous field supervision by several levels of supervisory staff, several office reviews and editing of all completed forms, and a special study of inter-observer variability. Inter-observer agreement was good or excellent for most survey measures (*1*).

Once the data collection was completed, data management and analysis activities were based on more than four million bytes (units) of information gathered during the survey. Data management had two phases, the first in Kathmandu, Nepal, and the second in the USA at the University of Michigan in Ann Arbor, Michigan. In Nepal, the forms were coded, the results keypunched and verified, the keypunched cards converted to magnetic tape storage, and the data tape subjected to a series of edits, range checks, and consistency checks before a duplicate copy of the tape was carried to Ann Arbor. In Ann Arbor, several additional checks and edits were conducted, datasets were created, and analytic tabulations produced. The final report was written by survey staff from the Seva Foundation, the Departments of Epidemiology and Ophthalmology,

Table 1. Distribution of visual acuity (best eye) by WHO categories of visual impairment in Nepal, 1981

WHO impairment category	Visual acuity	Size of sample (*n*)	Estimated number of cases	Prevalence (per 100)
0	⩾ 6/18	38 478	13 680 142	97.31
1	⩾ 6/60	546	192 746	1.37
2	⩾ 3/60	192	67 142	0.48
3	⩾ 1/60	135	47 655	0.34
4	PL, PLP	165	57 340	0.41
5	NPL	35	12 628	0.09
Subtotal		39 551	14 057 653	100.0
Missing data[a]		336	115 429	
Total		39 887	14 173 082	100.0

[a] Missing data refer to individuals who were enrolled in the survey, but for whom certain ophthalmic or demographic measures were not known.

Table 2. Distribution, estimated cases, and prevalence of blindness in Nepal, 1981

	Size of sample (*n*)	Estimated number of cases	Percentage of total population
Sighted both eyes	38 547	13 703 500	97.5
Blind in one eye	661	233 612	1.7
Blind in both eyes	335	117 623	0.8
Subtotal	39 543	14 054 735	100.0
Missing data[a]	344	118 346	
Total	39 887	14 173 081	100.0

[a] Missing data refer to individuals who were enrolled in the survey, but for whom certain ophthalmic or demographic measures were not known.

Table 3. Prevalence, estimated cases, and distribution of blindness by age group in Nepal, 1981

Age group (years	Size of sample (*n*)	Estimated number of cases	Prevalence (per 100)	Percentage of total blind population
0-4	5 793	329	< 0.01	0.3
5-9	6 350	1 743	0.08	1.5
10-19	8 436	4 209	0.14	3.6
20-39	10 345	10 018	0.26	8.5
40-59	6 162	28 456	1.30	24.3
⩾ 60	2 443	72 456	8.58	61.8
Subtotal	39 529	117 211	0.83	100.0
Missing data[a]	358	412		
Total	39 887	117 623	0.84	100.0

[a] Missing data refer to individuals who were enrolled in the survey, but for whom certain ophthalmic or demographic measures were not known.

and the Survey Research Center at the University of Michigan. It was then reviewed and edited by the programme staff in Nepal and New Delhi.

RESULTS

Visual acuity and blindness

Table 1 shows the results of visual acuity testing in Nepal. Of the 39 887 people examined in the survey, 335 were found to be blind[a] by the WHO criterion of visual acuity less than 3/60 in the better eye. Table 2 presents distributions of blindness in Nepal. It has been estimated that there are 117 623 persons blind in both eyes in Nepal (0.84 per 100 population), and an additional 223 612 persons blind in one eye (1.66 per 100 population).

The major determinant of blindness in Nepal, as elsewhere, is age because a high percentage of blindness is due to cataract, a disease whose prevalence increases markedly with age. The prevalence of blindness increases from less than 0.01 per 100 in preschool-age children to 8.58 per 100 persons over the age of 60 (Table 3).

A blindness prevalence rate above 1.0% is a widely quoted indicator of a public health problem. Because of differences in the age structure of the population in different areas, this indicator rate is not very useful unless it is first age-adjusted.

When the blindness prevalence rates were age-sex

[a] In this article, the terms "blind" and "blindness" refer to the WHO definition: visual acuity less than 3/60 in the best eye, which implies persons blind in both eyes. Persons blind in one eye are referred to as unilaterally blind, or blind in one eye.

standardized to the overall Nepal age distribution, two geographical areas had rates above 1.0%. One of these areas, in the Eastern and Central terai (plains), contained about one-third of the blindness cases in Nepal. The other area, in the Far Western hills and mountains, had a high blindness prevalence rate but a low population density and contained about one-sixth of the nation's blind. The major reason for the high prevalence of blindness in the terai is the higher cataract prevalence rate in this area. As much as 92% of the blind in Nepal reside in the rural areas of the country.

Major ocular disorders

Of the 39 887 persons examined in the survey, 6855 (16.5%) had one or more ocular disorders, representing an estimated 2 338 742 persons in the total population. The most prevalent potentially blinding ocular disorder in Nepal is trachoma, which was considered to be the primary etiology in an estimated 848 759 cases of ocular disorder and a secondary problem in an additional 61 075 cases. In total, there are an estimated 909 834 Nepalese with trachoma (6.5% of the population). Of these, an estimated 58 329 persons have trichiasis or entropion, the lid deformities resulting from active trachoma. The second most prevalent condition was cataract which was the primary disorder in an estimated 312 720 cases, and a secondary disorder in an additional 61 544 cases. There were 22 941 additional cases of cataract in whom the lens had been surgically removed (aphakia) or dislocated (by the traditional practice called "couching") or who suffered from "aftercataract" or other surgical complications. In total, an estimated 397 205 Nepalese have some degree of cataract (2.8% of the population).

Causes of blindness

The causes of blindness affecting both eyes are shown in Table 4. Out of an estimated 117 623 blind, cataract accounts for two-thirds (66.8%), an estimated 78 605 cases. The "sequelae" of cataract account for another 6195 cases (5.3%). Retinal diseases follow with an estimated 3849 cases (3.3%), glaucoma with 3820 cases (3.2%), infections (other than trachoma) with 3305 cases (2.8%), trauma with 2853 cases (2.4%), trachoma with 2822 cases (2.4%), smallpox with 2610 cases (2.2%), amblyopia with 1476 cases (1.3%), and signs consistent with nutritional blindness 1095 cases (0.9%). Seen another way, cataract and its sequelae account for 84 800 cases of blindness in Nepal, nearly three-quarters (72.1%) of the estimated total of blind cases.

Of the estimated 233 612 persons blind in one eye, cataract accounts for an estimated 79 886 (34.2%) and cataract sequelae for another 15 098 cases (6.5%). Trauma is the second leading cause of unilateral blindness, accounting for 31 870 estimated cases (13.6% of the total). The remaining causes of unilateral blindness are: infection other than trachoma (22 920 cases, 9.8% of all unilateral blindness), corneal scars (13 039 cases, 5.6%), phthisis of undetermined origin (11 731 cases, 5.0%), trachoma (9453 cases, 3.9%), and smallpox (10 089 cases,

Table 4. Causes of blindness by Mutually Exclusive Cause of Bilateral Blindness (MECOBB),[a] Nepal, 1981

Rank	Cause of blindness	Number of blind detected in survey	Estimated cases of blindness in Nepal	Percentage of all blindness in Nepal
1	Cataract	225	78 605	66.8
2	Iatrogenic sequelae of cataract	17	6 195	5.3
3	Retinal disease	11	3 849	3.3
4	Glaucoma	11	3 820	3.2
5	Infections other than smallpox/trachoma	9	3 305	2.8
6	Trachoma	9	2 822	2.4
7	Trauma	8	2 853	2.4
8	Smallpox	7	2 610	2.2
9	Amblyopia	4	1 476	1.3
10	Nutritional etiology	3	1 095	0.9
	Miscellaneous combinations	25	8 841	7.5
	Undeterminded	6	2 152	1.8
Total		335	117 623	100.0

[a] For an explanation of how the cause of blindness was assigned, see *The report of the Nepal blindness survey*, WHO/Government of Nepal Blindness Prevention Project, Kathmandu (in press).

4.3%). Nutritional blindness was a relatively rare cause of unilateral blindness (2124 estimated cases, 0.9%).

Blindness is not evenly distributed between men and women in Nepal. The prevalence of blindness is much higher in women (0.99 per 100 women) compared to men (0.68 per 100 men). The number of women who are blind is thus 1.5 times the number of blind men. Major differences were found between males and females with respect to the causes of blindness. Of the 78 605 cataract blind, 63.8% are women. Nearly half (44.8%) of all the blind persons from all causes in Nepal are women blinded by cataract or its sequelae. It is noteworthy that although, during the survey, only 9 people blind in both eyes from trachoma were found, all were female (a population estimate of 2822 for the whole country). With the exception of certain signs of xerophthalmia such as Bitot's spots, females have a higher prevalence than males for nearly all ocular disorders.

The number of cases of childhood blindness detected in the survey was fortunately very few; 11 cases of blindness detected in children under the age of 15 years (a total population estimate of 4033), of whom 6 were under the age of 10 years (an estimated 2072 in Nepal). Under the age of 10 years, congenital cataract was the leading cause of blindness. For children between birth and 15 years, three diseases were nearly equal as causes of blindness: infections other than trachoma (21.3%), nutritional blindness (17.9%), and congenital cataract (16.3%). It must be stressed, however, that these percentages are based upon very few cases of each type of blindness for children under the age of 15. Caution is urged in using these figures to compare the causes of childhood blindness beyond a general estimate of orders of magnitude.

Cataract

Cataract is the leading cause of blindness in Nepal, accounting for more than two-thirds of blindness and more than 80% of all avoidable blindness[b] in nearly every geographical and demographic group. Approximately 20% of cataract cases are blind. Of the 39 887 Nepalese examined in the survey, 1137 were found to have at least one lenticular opacity or evidence of prior cataract surgery. For the entire country, the estimated 397 205 cataract cases (2.8% of the population) are unevenly distributed. Age-sex standardized cataract prevalence rates ranged from less than 0.5% in one mountain village to 7.5% in one terai village. The Central terai had nearly three times the prevalence of the Eastern and Far Eastern hills (about 4.5% compared to 1.4%), suggesting a need for hospitals in the terai and mobile eye camps in the hills. Fig. 2 shows the age-sex standardized prevalence rates

[b] The term "avoidable blindness" is used here to refer to blindness which is either preventable (e.g., xerophthalmia) or curable (e.g., cataract).

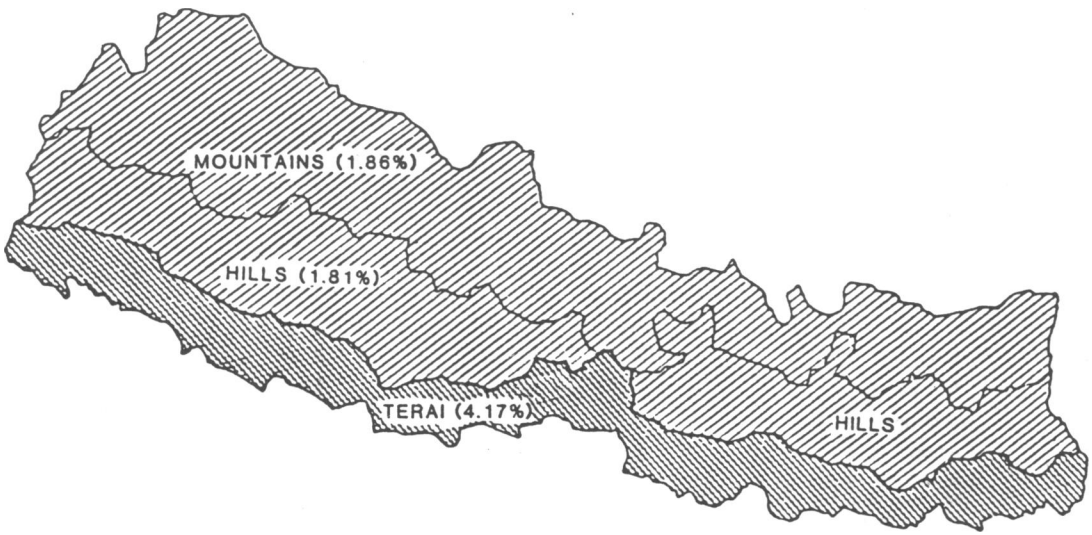

Fig. 2. Age-sex standardized prevalence rate of cataract (%) due to old age or undetermined etiology among life-long full-time residents of 97 rural villages, by terrain, in Nepal, 1981.

for senile cataract by terrain, emphasizing the difference between hills and plains.

The results of previous cataract surgery have been inconsistent. Over one-half (56%) of eyes operated on for cataract are functionally blind today, mostly because the spectacles which may have been distributed after surgery have not been replaced after loss or breakage. Distribution of spectacles to people who have already been operated on and who need glasses is a priority because these people not only can have their sight significantly improved, but they are currently poor advertisements to others of the value of surgery. In addition, the surgical complication rate itself is high; 17% of those operated on for cataract (aphakics) are now irreversibly blind. Post-operative results are similar for Nepali patients operated in Nepal or India (where one-third of cataract operations on Nepalis have been carried out).

The major risk factors for cataract identified in the Nepal Blindness Survey are increased age, female sex, and increased exposure to sunlight. Age is the most important factor. More than one-third of those over the age of 65 have cataract. The average age of those blinded by cataract is nearly 60 years old. Females are 1.35 times more likely to have cataract than males. People living in a village exposed to more than 11 hours of daily sunlight were nearly three times as likely to have cataract, compared with people living where there was less than 8 hours of sunshine. Preliminary analysis suggests that sunlight exposure may account for approximately one-third of the geographical clustering of senile cataract. Additional multivariate analyses are needed before making any firm conclusions about individual risk factors.

Trachoma

Trachoma is the most widespread potentially blinding disease in Nepal. Of the 39 887 people examined, 2770 had trachoma with or without blindness (an estimated 909 834 persons or 6.5% of the total population). There are an estimated 58 328 persons with trichiasis or entropion (the lid deformities resulting from severe trachoma which can lead to blindness from corneal opacification). Although the condition is so prevalent, trachoma causes only 2.4% of the blindness in Nepal. As may be expected from the natural history of trachoma, most cases found in the survey were relatively mild and less than one out of every fifty cases of trachoma is blind from the disease. There are an estimated 2822 persons blind in both eyes and an additional 9453 persons blind in one eye from trachoma.

Trachoma and its major blinding sequelae (trichiasis, entropion, and corneal opacities) are clustered in certain geographical areas and among certain population groups. Most notably, despite the higher density of population in the Eastern and Central regions of the country, most trachoma is located in the Far Western terai and affects females much more than it does males. During the survey, all those blind from trachoma in both eyes, two-thirds of those blind in one eye, and three-quarters of those with trichiasis and entropion from trachoma were found to be women. Active infectious trachoma is particularly prevalent among children under the age of 10 years and, somewhat surprisingly, among older women. The prevalence of trichiasis and entropion is very high among women over the age of 30 years. The patterns of trachoma infection, trichiasis and entropion, and trachoma blindness support the hypothesis that women are more commonly affected by repeated episodes of trachoma than men, and that re-infection among women is related to their constant contact with infected children.

Three of the 75 ethnic groups in Nepal (the Chhetri, Magar, and Tharu) account for nearly 60% of Nepal's trachoma, more than 60% of the trichiasis and entropion, and more than 85% of trachoma blindness. The highest prevalence rates occur among the Tharus. Most of the Far Western terai, which has the highest prevalence of trachoma, is populated by Tharus.

The area within a radius of 100 km of Nepalganj, a city in Bheri zone in the Far Western terai, contains about one-half of the trachoma, trichiasis and entropion, and trachoma blindness in Nepal (Fig. 3). The area within a radius of 200 km of Nepalganj (Bheri zone and Seti zone) contains three-quarters of the trachoma and trichiasis and entropion and eight of the nine cases of trachoma blindness found in the survey. The highly localized distribution of trachoma suggests that this particular area is "hyperendemic". In these two administrative zones more than one-quarter of the residents (26.6%) have trachoma, whereas nationwide 6.5% of the population is affected. The two zones combined contain 48% of Nepal's trachoma, an estimated 433 751 cases.

Altogether 87% of the trachoma in Nepal is of "trivial" or "mild" intensity. The remaining 13% is of moderate or severe intensity and is of more concern since it has been linked to infectivity and perhaps to trichiasis and entropion and trachoma blindness. The prevalence of more than 5% of moderate and severe intensity trachoma in children under the age of 10 years has been suggested as one possible indicator of the need for mass chemotherapeutic intervention. In Nepal, only the Bheri (15.8%) and Seti (8.8%) zones have prevalence rates which exceed this threshold.

Nutritional blindness (xerophthalmia and keratomalacia)

Of the 39 887 persons examined in the survey, 90

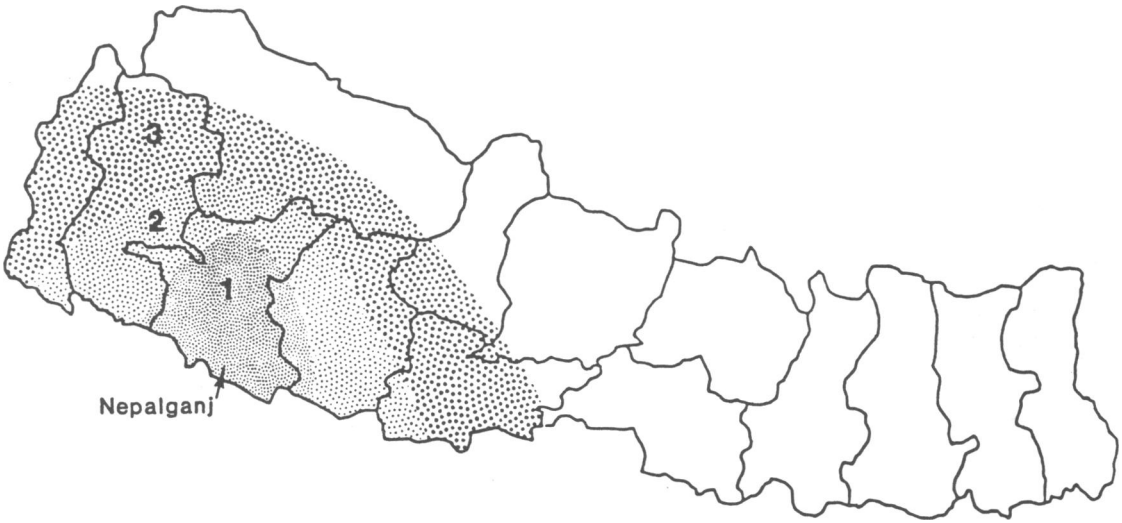

Fig. 3. Trachoma hyperendemic areas of Nepal. Priority area 1 contains one-third of the trachoma, trichiasis/entropion (T/E), and trachoma blind cases. Areas 1 and 2 together contain about half of all these cases. Areas 1, 2 and 3 combined account for 75% of the trachoma and T/E cases and 90% of all trachoma blindness in Nepal. In summary, approximately 50% of trachoma cases are within 50 miles (80 km) and 75% are within 75 miles (120 km) of Nepalganj.

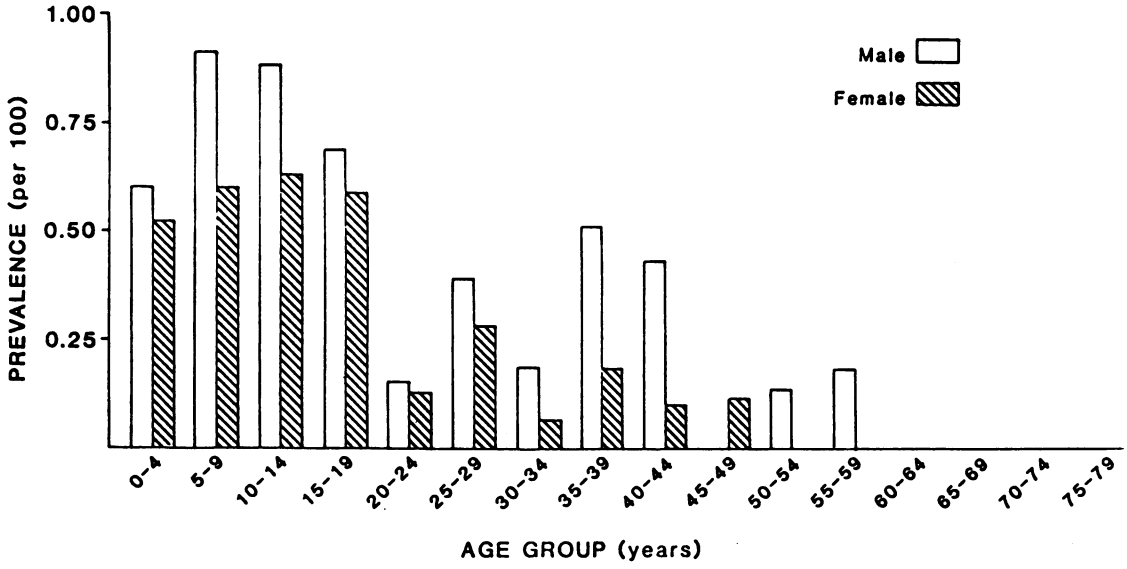

Fig. 4. Prevalence of Bitot's spots (XIB) in Nepal, by age and sex, from December 1980 to April 1981.

persons were identified with signs of conjunctival xerosis (XIA) and 169 had signs of Bitot's spots (XIB). The total cases with these two signs of xerophthalmia was 259 (0.63 per 100 population) or an estimated 89 119 cases in Nepal. No cases of active keratomalacia were detected in the survey. Males had 1.5 times the prevalence of xerophthalmia than females for all age groups. Less than one-quarter (23.5%) of persons with signs of conjunctival xerophthalmia were under the age of 6 years. As shown in Fig. 4, the highest prevalence of Bitot's spots was in boys aged 5–14 years. Boys account for about three-fifths of the cases of Bitot's spots (59.3%) and active xerophthalmia (62.9%).[c] Boys are 1.5 times as likely to have Bitot's spots as girls.

Of the 7580 children under the age of 6 years examined, 16 had signs of xerosis (XIA) and 45 had signs of Bitot's spots (XIB). The estimated number of cases in children under 6 years is 5324 cases of XIA (a prevalence rate of 0.22 per 100 children) and for XIB an estimated 15 534 cases (0.64 per 100 children). Bitot's spots were three times as common as conjunctival xerosis in children. Thus, the overall prevalence of Bitot's spots in this age group exceeds the WHO criterion of 0.5%, which some experts suggest as a criterion for a significant public health problem. The estimated prevalence of xerophthalmia-related corneal scars is 0.2%, which also exceeds the 0.05% WHO criterion relating to corneal scars in children, thus providing additional evidence of a serious public health problem, at least in certain areas of Nepal. From the survey data, the Eastern and Central terai has been identified as the major geographical focus of xerophthalmia in Nepal. This area accounted for more than two-thirds of the Bitot's spots found in the survey. Along with this geographical concentration of xerophthalmia cases, there is substantial evidence that xerophthalmia is concentrated in particular groups living in the high-risk area. Nearly 90% of cases come from the Vaish and Shudra castes (the least affluent castes), none from families possessing more than a small amount of land, none from families able to afford modern amenities like a radio, and very few from households in which one or more family members have a watch. Individual risk factors in xerophthalmia include living in crowded and unsanitary conditions, reduced consumption of certain vegetables, intermittent periods of food shortages and, most of all, a history of diarrhoea.

Whether diarrhoea causes xerophthalmia or whether both are related to other factors cannot be determined from a cross-sectional study. However, in the reported time sequence at least, diarrhoea precedes xerophthalmia in a high proportion of cases. In a case-control study in which cases and controls were matched by age, sex, season, and village, the cases were nearly 30 times more likely to have had diarrhoea in the past 4 weeks than matched controls. This was the strongest association between any disease and any risk factor found in the survey, although the number of matched pairs (50) was very small. Xerophthalmia in Nepal appears to be yet one more additional burden placed on precisely those persons and communities who can least afford it, the children of poor families with a low social and economic status.

Keratomalacia is only one of several causes of childhood blindness in Nepal. Out of eleven blind children under the age of 15 years detected in the survey, nutritional blindness accounted for only two cases. With only eleven cases, however, there are too few for detailed discussion, and there are problems in interpreting the utility of cross-sectional prevalence data for a disease like keratomalacia because it is believed to be part of a syndrome which often causes a swift onset of blindness, rapidly followed by death in a high percentage of cases. More than four-fifths of cases of childhood blindness detected in the survey were not due to keratomalacia, however, but were due to other diseases like congenital cataract, infections, and trauma. Nutritional blindness was a small component of total blindness in Nepal, accounting for an estimated 1095 cases out of the 117 623 estimated blind persons in Nepal. The quality of data on xerophthalmia has some important limitations, in part owing to a low or unknown inter-observer agreement, and to a survey period that may have missed the high incidence season for xerophthalmia.

Trauma

Trauma is not a major cause of blindness since eye accidents seldom involve both eyes simultaneously. Nonetheless, the survey findings indicate that trauma is a major cause of unilateral blindness. It is the second leading cause of blind eyes in Nepal after cataract, accounting for an estimated 37 216 blind eyes (7.9% of all blind eyes).

An estimated 120 717 persons (8.6 persons per 1000) in Nepal have signs and/or a history of trauma. The population with signs and a history of eye trauma is distributed uniformly across the geographical and political units of Nepal; however, there appears to be a somewhat higher prevalence of eye trauma among persons residing in the West and Far Western hills and mountains, accounting for approximately two-fifths (40.2%) of the eye trauma in the country.

Risk of trauma to the eye increases with age; persons aged 50 years and older have had 3.6 times as many cumulative signs of trauma and 17.4 times as much trauma blindness as do persons under the age of

[c] "Active xerophthalmia" includes both conjunctival xerosis (XIA) and Bitot's spots (XIB).

15 years. Increasing prevalence rates with age undoubtedly reflect a cumulative lifetime exposure to eye injuries with permanent residual signs, rather than a specific link to the biological process of aging. There is little variation in the prevalence of trauma blindness by geography, caste, sex, or mother tongue. Education had a protective effect; educated persons had less than one-third the risk of those who had not been educated.

There was a lower prevalence of residual signs of trauma (corneal scars) when hospitals, nurses, and doctors were available nearby. Trauma blind persons tended to seek treatment more often from modern health practitioners than did the trauma cases without the risk of blindness, which is perhaps a reflection of the severity of the initial injury.

An analysis of the results of the ancillary trauma study indicated that eye trauma in Nepal occurs mostly in an agricultural context. Paddy husks, seeds, or twigs, and pieces of wood accounted for nearly one-half of the trauma and trauma blindness investigated. Nearly all the injuries occurred around the home, or in nearby fields or forest. Penetrating and burn injuries were the type of accident most likely to lead to trauma blindness (occurring in 63% and 100% of cases, respectively), followed by blunt (34%) and foreign body (18%) injuries. Only about half (53%) of the trauma cases sought treatment, and only one-third (35%) of those seeking treatment did so within 24 hours of the injury. One-half of the trauma blind seeking treatment waited one week or more after the injury.

DISCUSSION

It may be useful to compare the burden of blindness in Nepal and other countries. For example, Nepal, with a population less than one-sixteenth the United States, has nearly the same number (100 857) of blind people as the USA (101 000) if comparable groups[d] are considered. For a young population such as in Nepal, the burden of this blindness is potentially tragic. As health, social, and economic conditions improve in Nepal, the population can be expected to grow older and more closely resemble the age distribution of developed countries.

The population's age distribution complicates our understanding of the burden of blindness in Nepal as well as in other countries. In the rich, developed countries where people live longer, the crude blindness prevalence rate may actually increase in proportion to the number of elderly in the population. On the other hand, where birth rates are high and the median age is low, as in Nepal, the blindness prevalence rate may be "diluted" by the large number of children who are not at risk of blindness from senile cataract and other blinding diseases of the aged.

With the aging of the population the number of cataract blind will increase. Unless a way is found to prevent cataract, the annual incidence of cataract blindness is likely to double during the next twenty years, perhaps reaching over 46 000 in Nepal by the year 2000. An age-sex standardized blindness prevalence rate was computed for Nepal using the United States 1971–72 population, for a comparison. The computed rate was 14.9 blind per 1000 population, suggesting that Nepal currently has an adjusted blindness rate which is 27 times higher than the blindness prevalence rate in the United States. Assuming Nepal's population reaches 20 million, this would be equivalent to 300 000 blind in the country. This very high rate of blindness may be considered an estimate of the future burden of blindness in Nepal unless effective interventions are implemented successfully.

An important consideration is how much of this blindness is avoidable. Avoidable blindness is a term widely used to mean blindness that is either preventable or curable. The objective of the Nepal Blindness Programme is to reduce by 90% both the prevalence of curable blindness and the incidence of preventable blindness. Each blind person in the survey was therefore evaluated with respect to whether the cause of blindness was avoidable (preventable or curable) or not. Briefly, out of an estimated 117 623 cases of blindness, approximately 80% were determined to be due to diseases that were avoidable in the context of a blindness control programme in Nepal. Of these, approximately 14 800 cases were considered preventable (12.6% of all blindness), approximately 73 700 were considered curable (62.7% of all

Table 5. Avoidable blindness in Nepal, by cause

Cause of blindness	Percentage of avoidable blindness
Cataract and sequelae	83.6
Trachoma	3.0
Smallpox	2.8
Other infections	1.7
Trauma	1.5
Malnutrition	1.2
Miscellaneous	6.2

[d] Non-institutionalized population aged 4–74 years old. There are more institutionalized blind in the USA than in Nepal; however, these are the only national data available with which to make comparisons. The WHO definition of blindness (visual acuity less then 3/60 in the better eye) was used.

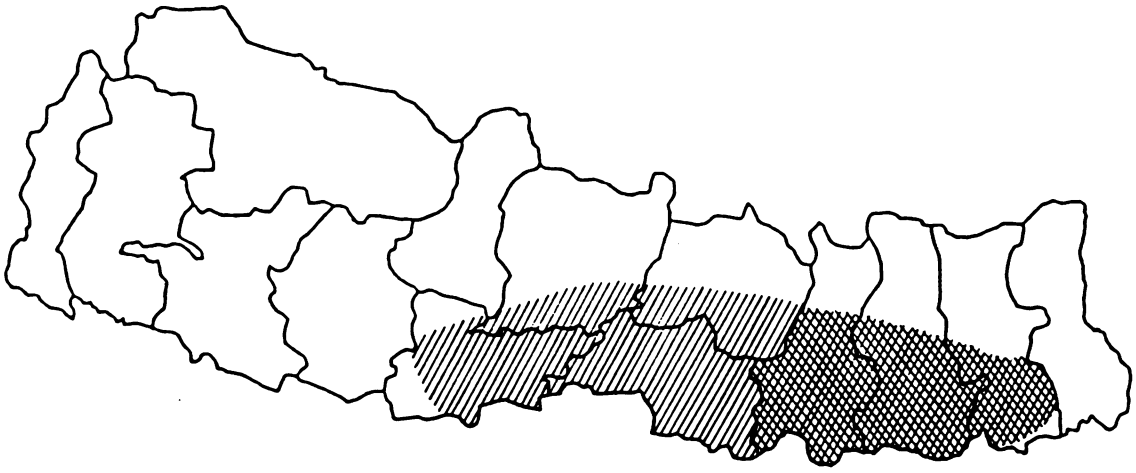

Fig. 5. Priority areas for health education about cataract surgery. The shaded areas contain more than half the cataract blind cases in Nepal. The eastern half of this area (cross-hatched) presents the greatest challenge because over 80% of the unoperated cataract patients here had never heard of cataract surgery.

blindness), and 5761 were cases due to cataract sequelae which are considered avoidable by a combination of both cure and prevention.

As shown in Table 5, by far the major cause of avoidable blindness is cataract. Cataract and its sequelae account for 83.6% of the avoidable blindness in Nepal. If smallpox is excluded from the list because it has been eradicated, then cataract and sequelae account for 86% of the remaining avoidable blindness in Nepal. This predominance of cataract, which can be cured by surgical intervention, should be considered in the context of primary health care so that cataract surgery will be included within the definition of basic health services; otherwise thirteen out of fourteen cases of avoidable blindness would be beyond the reach of basic health care in Nepal.

To reach the programme target of 90% reduction in the prevalence of curable cataract by the year 1987, an estimated 300 000 to 350 000 operations will have to be performed (*2*). To meet the programme's goal of self-sufficiency in ophthalmic manpower, the 15 Nepalese eye surgeons now available will be insufficient. If each surgeon performs 2000 cataract operations per year along with routine eye care duties, 20–25 new Nepalese ophthalmic surgeons will be needed to meet the expected increase in cataract incidence by the year 2000. A sufficient number of trained ophthalmic assistants will also be essential. The "surgical coverage ratio" (the share of those in need of surgery who receive it) in Nepal today is 35%. In other words, two out of three cataract blind persons have not been operated on. Surgical coverage is not uniform throughout the country. The cataract populations living near the eye hospitals in Kathmandu and Sitapur (in India) have been well served while those living in the eastern areas of Nepal are underserved (Fig. 5). Priority must be given to those categories of the population who form the largest portion of the unoperated cataract blind—namely, illiterate females in the rural areas who represent the least wealthy and least educated group. These people do not receive surgery because of several interrelated factors such as poor access to hospitals or eye camps, lack of community and family resources, and lack of awareness of cataract surgery. These factors must be taken into consideration when implementing an effective surgical programme.

Nearly half (46%) of the unoperated cataract blind did not know that cataract surgery was available to restore sight. Even among those who know about the availability of sight-restoring surgery, many cannot afford it. Education, easier access to medical facilities, and family support are also important in determining who demands cataract surgery. Health education is needed to increase the public's awareness of such operations and to remove misconceptions about the procedure. Education of the population should be aimed at specific underserved language groups, especially those who are illiterate, and should include the entire family, not the patient alone. Most people

who have overcome their reluctance to be operated have known at least one successfully operated patient. Satisfied patients, after successful surgery, who can once again walk through their villages without assistance, are the best "motivators" for others to seek sight-restoring surgery.

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RÉSUMÉ

EPIDÉMIOLOGIE DE LA CÉCITÉ AU NÉPAL

Une enquête nationale sur la cécité a été menée au Népal en 1979–1980 afin d'évaluer la prévalence, les causes et les corrélats de la cécité dans le pays. Des enquêteurs ophtalmologistes ont examiné au total 39 887 personnes, tirées d'un échantillon aléatoire stratifié à 2 degrés.

Le nombre des aveugles au Népal est évalué à 117 623 (0,84% de la population). La prévalence de la cécité est plus élevée chez les femmes que chez les hommes. Si l'on considère des groupes comparables, le Népal, avec une population 16 fois moindre, compte le même nombre d'aveugles que les Etats-Unis d'Amérique. La cataracte et ses séquelles interviennent pour plus des deux tiers dans le total des cas de cécité, et sont responsables de plus de 80% de toutes les cécités évitables. Les principaux facteurs de risque de cataracte relevés par l'enquête étaient le grand âge, le sexe féminin et l'excès d'exposition à la lumière solaire. Du fait de l'allongement de l'espérance de vie, le nombre des personnes atteintes de cataracte et devant être opérées aura doublé d'ici l'an 2000. D'après l'enquête, le trachome est la cause potentielle de cécité la plus répandue au Népal, affectant 6,5% de la population; il est concentré dans certaines zones géographiques. Le nombre d'individus présentant des symptômes de xérophtalmie a été évalué à 89 119 (0,63% de la population), mais on n'a relevé aucun cas actif de kératomalacie. Il existait une association marquée entre les symptômes de xérophtalmie et un épisode récent de diarrhée. Les traumatismes de l'œil, surtout observés dans le milieu agricole, étaient la seconde cause principale de perte de vision d'un œil, la perte de vision bilatérale par traumatisme étant rare.

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