Prevalence of visual impairment, cataract surgery and awareness of cataract and glaucoma in Bhaktapur district of Nepal: The Bhaktapur Glaucoma Study

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Abstract

Background: Cataract and glaucoma are the major causes of blindness in Nepal. Bhaktapur is one of the three districts of Kathmandu valley which represents a metropolitan city with a predominantly agrarian rural periphery. This study was undertaken to determine the prevalence of visual impairment, cataract surgery and awareness of cataract and glaucoma among subjects residing in this district of Nepal.

Methods: Subjects aged 40 years and above was selected using a cluster sampling methodology and a door to door enumeration was conducted for a population based cross sectional study. During the community field work, 11499 subjects underwent a structured interview regarding awareness (heard of) and knowledge (understanding of the disease) of cataract and glaucoma. At the base hospital 4003 out of 4800 (83.39%) subjects underwent a detailed ocular examination including log MAR visual acuity, refraction, applanation tonometry, cataract grading (LOCSIII), retinal examination and SITA standard perimetry when indicated.

Results: The age-sex adjusted prevalence of blindness (best corrected <3/60) and low vision (best corrected <6/18 ≥3/60) was 0.43% (95%C.I. 0.25 - 0.68) and 3.97% (95% C.I. 3.40 - 4.60) respectively. Cataract (53.3%) was the principal cause of blindness. The leading causes of low vision were cataract (60.8%) followed by refractive error (12%). The cataract surgical coverage was 90.36% and was higher in the younger age group, females and illiterate subjects. Pseudophakia was seen in 94%. Awareness of cataract (6.7%) and glaucoma (2.4%) was very low. Among subjects who were aware, 70.4% had knowledge of cataract and 45.5% of glaucoma. Cataract was commonly known to be a ‘pearl like dot’ white opacity in the eye while glaucoma was known to cause blindness. Awareness remained unchanged in different age groups for cataract while for glaucoma there was an increase in awareness with age. Women were significantly less aware (odds ratio (OR): 0.63; 95%, confidence interval (CI): 0.54 - 0.74) for cataract and (OR: 0.64; 95% CI: 0.50 - 0.81) for glaucoma. Literacy was also correlated with awareness.

Conclusion: The low prevalence of visual impairment and the high cataract surgical coverage suggests that cataract intervention programs have been successful in Bhaktapur. Awareness and knowledge of cataract and glaucoma was very poor among this population. Eye care programs needs to be directed towards preventing visual impairment from refractive errors, screening for incurable chronic eye diseases and promoting health education in order to raise awareness on cataract and glaucoma among this population.

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Background
Cataract is the major cause of blindness worldwide. It is estimated that 41.8% of all global blindness is caused by cataract [1]. Glaucoma is the second leading cause of visual loss in the world. Quigley estimates that there will be 60.5 million people with glaucoma in 2010 and Asians are expected to represent 47% of those with glaucoma [2]. World Health Organization has estimated the prevalence of blindness amongst people over fifty years in South East Asia as 3.4% [3]. Nepal Blindness Survey conducted in 1981 reported the overall prevalence of blindness in Nepal as 0.84% and in subjects more than 45 years of age as 3.8% [4]. After this survey few population based studies have been undertaken in Nepal [5-7].

Implementing health care programs in a given community and promoting awareness of common eye diseases can bring forth people to have an eye examination. This could result in the early diagnosis, treatment and reduction of visual impairment and blindness from eye diseases. Studies undertaken in the region have revealed a poor awareness of eye diseases among the general population [8-10]. It has also been reported that approximately 50% of patients with glaucoma were unaware of their condition at the time of diagnosis [11] and present in the advanced stage of the disease [12,13].

The aim of this paper is to describe the prevalence and causes of visual impairment, to calculate the cataract surgical coverage and to determine the awareness and knowledge of cataract and glaucoma among the population aged 40 years and above. This is the first study to determine the reduction of visual impairment in one of the districts within Kathmandu valley. It is also the first study to determine the awareness of cataract and glaucoma in a Nepali population.

Methods
The study was designed as a population based cross-sectional study. A sample size of 4758 was calculated after assuming a 3% prevalence of blindness, a relative precision of 25%, compliance of 85% and a design effect of 2. An assumption of 3% was based on previous studies conducted in Nepal. According to the 2001 Census, the population of Bhaktapur was 225,461 with a population density of 1,895 per square kilometer [14]. The sampling frame comprised of 161 wards, with an estimated total population of 48,223 people above the age of 40 years residing in this area. The survey involved selection of 4800 subjects, 40 years and above, using WHO 30 cluster sampling procedure [15].

At the first stage, a list of all wards or clusters from 16 Village Development Committees (VDC) and 2 municipalities were obtained from National Census data [14]. Thirty clusters were randomly selected and subjects sampled with probability proportionate to size. While undertaking the census, community field workers interviewed 11,499 subjects enlisted during the field work. Six community field workers were trained in the interview procedures by the principal investigator and conducted a structured-interview regarding awareness for cataract and glaucoma. The questionnaire was first designed in English and translated into Nepali, the national language of Nepal. Subjects were asked if they had heard of cataract and glaucoma. Those who responded with a ‘yes’ were termed as being ‘aware’ and were further encouraged to explain what they knew about those conditions. Subjects with responses which matched the list of answers in the questionnaire were regarded to have ‘knowledge’ of the eye disease. Demographic details as well as all responses were documented. A pilot study was conducted on volunteers and minor modifications were made later in order to finalize the interview questionnaire.

At the second stage, a database was prepared where names of eligible subjects were recorded. 4800 subjects were selected using EPI-INFO software, version 3.5.1 (Centers for Disease Control and Prevention, Atlanta, GA). The selected subjects were then revisited by the community field staff and referred to Tilganga Institute of Ophthalmology (TIO) for a comprehensive eye examination.

The distance and near visual acuity (VA) both presenting and best corrected after refraction were measured using logarithm of minimum angle of resolution (log MAR) tumbling E charts (Precision Vision, USA) placed at 4 meters. Objective refraction was done using a streak retinoscope (Beta 200 Heine, Germany) followed by a subjective refraction. The log MAR chart was moved to 1 meter if the subject was unable to read the top line, and acuity was tested again. If VA could not be measured then counting fingers at 1 meter, hand movements and light perception were sequentially checked. A detailed ocular examination with slit-lamp biomicroscope (Haag Streit BQ 900) was carried out. This included measurement of intraocular pressure with Goldmann applanation tonometer and gonioscopy with 4 mirror Zeiss gonioscope. The angle was graded according to the Shafer system [16]. Lens was examined after pupilary dilatation (unless contra-indicated) and cataract graded using Lens Opacities Classification System (LOCS) II. Stereoscopic fundus examination was done using 90-diopter lens and indirect ophthalmoscopy using 20-diopter lens. Automated visual field test using the SITA Standard 24-2 program (Model 750, Humphrey Instruments, San Leandro, CA, USA) was performed for all the subjects who were glaucoma subjects and with diseases such as glaucoma, optic atrophy, and retinitis pigmentosa.

Visual impairment (VI), blindness and low vision were defined as per International Classification of Diseases
10th edition (ICD-10) [17]. The International Classification of Diseases 10th edition (ICD-10) defines visual impairment as VA of less than 6/18 (20/60, 0.3) in the better eye with the best correction [17]. Visual impairment has been categorized to blindness and low vision. A VA of less than 3/60 (20/400, 0.05) with best correction or a visual field less than 10° from fixation in the better eye has been considered blindness. Low vision has been defined as a best corrected VA of less than 6/18 (20/60, 0.3), but not less than 3/60 (20/400, 0.05) in the better eye. Presenting VA has also been used to describe visual impairment within the study sample.

Diagnosis was recorded using International Classification of Diseases-ninth revision (ICD-9). If more than one disease was present, the disease most likely to have a significant effect on vision was considered as the cause for blindness.

Cataract blindness burden was defined as a sum of those people already operated for cataract in both eyes and the unoperated cataract blind. It was not possible to obtain the preoperative vision of an already operated eye and assumption was made that both eyes were blind preoperatively if both eyes were operated for cataract, or if one eye was operated and the other eye was blind at the time of our examination. Cataract surgical coverage was calculated as number of bilaterally blind cataract cases operated divided by the number who could have been operated. The denominator includes the already operated bilateral blind (the numerator) plus the unoperated bilaterally blind with cataract being the principal cause of blindness in at least one eye.

Literacy was determined by asking subjects whether they could read and write. Those who could were considered to be literate. This study was approved by the Institutional Review Board and Ethics Committee of TIO and conducted in accordance with declaration of Helsinki. Informed consent was obtained from all subjects after being explained in detail about all the procedures to be undertaken. The informed consent was written in the vernacular. The consent form was read out for those unable to read. Upon agreement by the subject, they were asked to sign the consent form. For those unable to sign, thumb impressions were taken.

Descriptive statistical measures were presented to summarize data. Univariate and multivariable logistic regression analysis were applied. Odds ratio (OR) were computed. Statistical analysis was carried out using STATA software version 9.0.

Results

Participants

Out of 4800 enumerated subjects, 4003 were examined (response rate of 83.39%). Data was incomplete for 24 subjects, leaving 3979 subjects for analysis (82.90%). Mean age of study population was 55.10 years (SD 11.50), more females were examined (54.49%) and 2119 subjects (53.25%) were illiterate. More illiterate subjects refused to participate in the study. The demographics of examined subjects are presented in Table 1.

Prevalence and causes of visual impairment

Overall prevalence of VI at presentation was 18.57% (95% CI: 17.37 - 19.82) and after best correction 4.4% (95% CI: 3.78 - 5.82). VA measurements are presented in Table 2. There were 710 (17.83%) subjects with low vision at presentation. Vision improved to better than 6/18 in 552 (77.75%) in subjects after refraction, remaining 158 (3.97%) had low vision after correction. Prevalence of blindness at presentation was 0.73% and after correction 0.43%. 17 were blind even after best correction and there were 10 males (58.82%), 7 females (41.18%) with a mean age of 71.29 (SD 11.21) years. Out of 17, 9 (52.94%) were literate.

Causes of VI are presented in Table 3. Cataract was the leading cause of blindness in all four groups. Leading causes of low vision were cataract (60.8%) and refractive error (12%). In subjects with bilateral blindness cataract was responsible in 16 (47.1%) eyes while corneal scars and retinal disorders accounted for 5 (14.7%) eyes each. 15 subjects were blind from the same cause in both eyes, cataract was responsible in 8 (53.3%) subjects while corneal scar and retinal disorders were accountable in 2 (13.3%) subjects each.

Since the number of blind people was very few (17 out of 3979) we combined two groups (low vision and blindness) together for analysis. The results for VI are presented in Table 4. VI had a positive association with increasing age (p < 0.001) in each age group. Odds ratio (OR) increased from 2.06 (1.57 - 2.69) for 50 - 59 years...
age group to 25.94 (16.30 - 41.30) for subjects aged ≥80 years. The odds of VI at presentation was significantly higher in females (OR: 1.30, 95% C.I.: 1.09 - 1.55) but after best correction there was no difference. Literacy had no direct association with VI.

Cataract blindness and surgery
Among 17 blind, 8 (47.06%) were blind as a result of cataract in both eyes. The prevalence of bilateral cataract blindness was 0.2% (95% C.I. 0.09 - 0.39). Among 143 unilaterally blind, cataract was responsible in 53 (37.5%) subjects representing a prevalence of 1.3% (95% C.I. 1.00 - 1.74). Together 61/160 (38.1%) subjects, 1.5% (95% C.I. 1.17 - 1.96) of the unilateral and bilateral blind with cataract as the principle cause of blindness in at least one eye could potentially have been helped by cataract surgery.

A total of 151 subjects underwent cataract surgery (Table 5). Pseudophakia was present in 142 (94.0%), males 58 (40.9%) and females 84 (59.1%), while aphakia in 9 (6%). 70 (49.3%) subjects had pseudophakia in one eye, 70 (49.3%) had in both eyes and 2 (1.4%) subjects had aphakia in one eye and pseudophakia in the other. The distribution of 47 individuals who were never operated with cataract blindness (we excluded 14 out of the 53 unilateral blind who had been operated in the fellow eye, none for the bilateral blind group) is presented in table 5. Cataract blindness and surgery was only associated with advancing age. The cataract surgical coverage of the study population was 90.36%. Surgical coverage was higher in the younger age group, females and among those who were illiterate.

Awareness of cataract and glaucoma
Out of a total of 11,499 subjects that were interviewed complete data was available for 10,303 subjects. In this group 52.32% were males, 61.48% were illiterate and 56.65% belonged to the Newar caste. 55.8% of the total subjects had never undergone an eye examination.

A total of 682 (6.7%) of the subjects were aware of cataract while 244 (2.3%) of glaucoma. Multivariate logistic regression analyses (Table 6) indicated that awareness of cataract did not increase considerably with the increase in age group while for glaucoma the awareness increased significantly except for subjects in the highest age group.

Table 2 Presenting visual acuity and best corrected visual acuity (better eye)

| Presenting visual acuity (better eye) | Best corrected visual acuity (better eye) |
|--------------------------------------|------------------------------------------|
| >6/18                               | >6/18                                    |
| 6/18 - 3/60                         | 6/18 - 3/60                              |
| ≤3/60                               | ≤3/60                                    |
| **Sex**                             | **p**                                    |
| Male                                | 1502 (82.94%)                            |
|                                    | 295 (16.29%)                             |
|                                    | 14 (0.77%)                               |
|                                    | 1737 (95.91%)                            |
|                                    | 64 (3.53%)                               |
|                                    | 10 (0.55%)                               |
| Female                              | 1738 (80.17%)                            |
|                                    | 415 (19.14%)                             |
|                                    | 15 (0.69%)                               |
|                                    | 0.063                                    |
|                                    | 2067 (95.34%)                            |
|                                    | 94 (4.34%)                               |
|                                    | 7 (0.32%)                                |

| **Age (Years)**                     | **p**                                    |
| 40-49                               | 1381 (93.25%)                            |
|                                    | 97 (6.55%)                               |
|                                    | 3 (0.20%)                                |
|                                    | 1471 (99.32%)                            |
|                                    | 9 (0.61%)                                |
|                                    | 1 (0.07%)                                |
| 50-59                               | 949 (87.14%)                             |
|                                    | 139 (12.76%)                             |
|                                    | 1 (0.09%)                                |
|                                    | 1075 (98.71%)                            |
|                                    | 13 (1.19%)                               |
|                                    | 1 (0.09%)                                |
| 60-69                               | 619 (74.13%)                             |
|                                    | 207 (24.79%)                             |
|                                    | 9 (1.08%)                                |
|                                    | 792 (94.85%)                             |
|                                    | 39 (4.67%)                               |
|                                    | 4 (0.48%)                                |
| 70-79                               | 257 (53.88%)                             |
|                                    | 207 (43.40%)                             |
|                                    | 13 (2.73%)                               |
|                                    | 400 (83.86%)                             |
|                                    | 68 (14.26%)                              |
|                                    | 9 (1.89%)                                |
| ≥ 80                                | 34 (35.05%)                              |
|                                    | 60 (61.86%)                              |
|                                    | 3 (0.99%)                                |
|                                    | <0.001                                   |
|                                    | 66 (68.04%)                              |
|                                    | 29 (29.90%)                              |
|                                    | 2 (2.06%)                                |
|                                    | <0.001                                   |

| **Education**                       | **p**                                    |
| Literate                            | 1516 (81.51%)                            |
|                                    | 328 (17.63%)                             |
|                                    | 16 (0.86%)                               |
|                                    | 1781 (95.75%)                            |
|                                    | 70 (3.76%)                               |
|                                    | 9 (0.48%)                                |
| Illiterate                          | 1724 (81.36%)                            |
|                                    | 382 (18.03%)                             |
|                                    | 13 (0.61%)                               |
|                                    | 0.063                                    |
|                                    | 2023 (95.47%)                            |
|                                    | 88 (4.15%)                               |
|                                    | 8 (0.38%)                                |
|                                    | 0.723                                    |

Prevalence of blindness (presenting visual acuity, better eye): 0.73% (95% C.I. 0.49 - 1.04).
Prevalence of low vision: presenting visual acuity, better eye: 17.83% (95% C.I. 16.65 - 19.05).
Prevalence of blindness (best corrected visual acuity, better eye): 0.43% (95% C.I. 0.25 - 0.68).
Prevalence of low vision (best corrected visual acuity, better eye): 3.97% (95% C.I. 3.38 - 4.62).

Table 3 Causes of visual impairment (best corrected, better eye)

| Cause                  | Low vision | Unilateral blindness | Bilateral blindness |
|------------------------|------------|----------------------|---------------------|
| Cataract               | 96 (60.88%)| 53 (37.1%)           | 16 (47.1%)          |
| Retinal disorder       | 18 (11.4%) | 21 (14.7%)           | 5 (14.7%)           |
| Corneal scar           | 4 (2.5%)   | 18 (12.6%)           | 5 (14.7%)           |
| Refractive error       | 19 (12.0%) | 10 (7.0%)            | 3 (8.8%)            |
| Phthisis bulbi         | 0 (0.0%)   | 14 (9.8%)            | 2 (5.9%)            |
| Trauma                 | 0 (0.0%)   | 11 (7.7%)            | 1 (2.9%)            |
| Glaucoma               | 4 (2.5%)   | 5 (3.5%)             | 2 (5.9%)            |
| Surgical complication  | 5 (3.1%)   | 4 (2.8%)             | 0 (0%)              |
| Amblyopia              | 1 (0.6%)   | 3 (2.1%)             | 0 (0%)              |
| Optic atrophy          | 1 (0.6%)   | 3 (2.1%)             | 0 (0%)              |
| Undetermined           | 2 (1.3%)   | 1 (0.7)              | 0 (0%)              |
| PCO                    | 6 (3.8%)   | 0 (0%)               | 0 (0%)              |
| Aphakia                | 2 (1.3%)   | 0 (0%)               | 0 (0%)              |
| Total                  | 158 (100%) | 143 (100%)           | 34 (100%)           |

PCO: Posterior Capsule Opacification.
For both cataract and glaucoma, awareness was higher among males, literates and in the Brahmin and Chhetri caste groups.

Responses to questions on cataract and glaucoma are presented in Table 7 and the questionnaire in Table 8. Of the 682 subjects who were aware of cataract 480 (70.38%) also had knowledge of the condition. 423 (62.0%) subjects had knowledge that cataract was as an appearance of a ‘pearl like dot’ white opacity in the eye. Of the 268 subjects who were aware of glaucoma, 122 (45.5%) subjects had knowledge of the condition. 71 (26.49%) subjects had known that glaucoma could cause blindness. Media was the most frequent source of information for both cataract (39.7%) and glaucoma (40.3%).

### Table 4 Effect of age, sex and literacy on visual impairment after best correction

| Variable     | Normal (%) | Visual impairment (%) | Univariate OR(95% CI) P value | Multivariable OR(95% CI) P value |
|--------------|------------|-----------------------|------------------------------|---------------------------------|
| Age (years)  |            |                       |                              |                                 |
| 40 - 49      | 1471(38.67)| 10(5.71)              | 1.00                         | 1.00                            |
| 50 - 59      | 1075(28.26)| 14(8.00)              | 1.91(0.85 - 4.33)            | 0.118                           |
| 60 - 69      | 792(20.82)| 43(24.57)             | 7.99(3.99 - 15.98)           | <0.001                          |
| 70 - 79      | 400(10.52)| 77(44.00)             | 28.32(14.52 - 55.23)         | <0.001                          |
| ≥80          | 66(1.74)   | 31(17.71)             | 69.09(32.50 - 146.89)        | <0.001                          |
| Sex          |            |                       |                              |                                 |
| Male         | 1737(45.66)| 74(42.29)             | 1.00                         | 1.00                            |
| Female       | 2067(54.34)| 101(57.71)            | 1.15(0.84 - 1.56)            | 0.381                           |
| Education    |            |                       |                              |                                 |
| Literate     | 1781(46.82)| 79(45.14)             | 1.00                         | 1.00                            |
| Illiterate   | 2023(53.18)| 96(54.86)             | 1.07(0.79 - 1.45)            | 0.260                           |

For both cataract and glaucoma, awareness was higher among males, literates and in the Brahmin and Chhetri caste groups.

Responses to questions on cataract and glaucoma are presented in Table 7 and the questionnaire in Table 8. Of the 682 subjects who were aware of cataract 480 (70.38%) also had knowledge of the condition. 423 (62.0%) subjects had knowledge that cataract was as an appearance of a ‘pearl like dot’ white opacity in the eye. Of the 268 subjects who were aware of glaucoma, 122 (45.5%) subjects had knowledge of the condition. 71 (26.49%) subjects had known that glaucoma could cause blindness. Media was the most frequent source of information for both cataract (39.7%) and glaucoma (40.3%).

### Table 5 Cataract blindness (VA < 3/60) and cataract surgery prevalence by age, sex and literacy

| Age    | No examined | Never operated cataract blind | All operated | Presumed blind | Cataract blindness burden % Surgical coverage |
|--------|-------------|-------------------------------|--------------|---------------|----------------------------------------------|
|        | No Prevalence | No Prevalence | Prevalence | No Prevalence | Prevalence | No Prevalence |
| 40-49  | 1481        | 0.00                          | 0.20        | 2.03          | 2.13     | 100          |
| 50-59  | 1089        | 0.07                          | 0.19        | 1.74          | 1.28     | 1.65         |
| 60-69  | 835         | 11.32                         | 37.44       | 4.43          | 2.27     | 3.59         |
| 70-79  | 477         | 21.40                         | 66.13       | 13.84         | 8.59     | 13.00        |
| >80    | 97          | 11.34                         | 26.26       | 26.80         | 19.19    | 30.92        |

- Adjusted odds ratio with 95% C.I. versus age 40 - 49: 8.79 (2.59 - 29.78).
- Adjusted odds ratio with 95% C.I. versus age 40 - 59: 23.22 (7.14 - 75.58).
- Adjusted odds ratio with 95% C.I. versus age 40 - 69: 79.47 (24.85 - 254.09).
- Adjusted odds ratio with 95% C.I. versus age 40 - 79: 182.67 (53.97 - 618.17).
- Adjusted odds ratio with 95% C.I. versus age 40 - >80: 333.54 (78.04 - 1425.51).
Discussion
Our data has been presented using WHO criteria for VI in order to compare results with other studies. Data has also been presented based on presenting VA to address the ‘real’ magnitude of VI in this population.

The overall prevalence of VI was low in Bhaktapur. It was associated with advancing age, female sex prior to best correction and was not associated with literacy. After best correction there was no difference between the sexes. The prevalence of blindness and low vision in Bhaktapur district is lower than reports from studies undertaken in Nepal.

The prevalence of blindness at presentation was 0.73% which is lower than NBS (3.4%), 1995 Lumbini survey (3%) and 2002 Gandaki zone study (1.4%). This is also lower than studies conducted in neighboring countries and the estimate of 3.4% for the South East Asian region [18-22]. However there are several studies in Asia that have also reported a low prevalence of blindness [23-27]. After best correction the prevalence of blindness was 0.43%.

Cataract remains the principle cause of blindness. The prevalence of cataract blindness was 1.5% which is almost similar to the Gandaki zone study (1.9%) where the outcome of the study were from the area best served by the local eye hospital. The major cause of bilateral blindness (53.3%) was cataract which was comparable to other studies in Nepal. Together, cataract (60.8%) and refractive error (12.0%) contributed 72.8% of the total burden of low vision which was curable. There were more women with low vision due to uncorrected refractive error. The 1981 NBS and the 1995 Lumbini survey have also reported that females were more likely to have VI. This finding in our population could suggest that women were not seeking eye care for reasons such as...

Table 6 Association of awareness of cataract and glaucoma with age, sex, literacy and caste (N = 10303)

| Variable                | Total number | Num aware of Cataract (%) | OR for being aware of Cataract (95% C.I.) | Num aware of Glaucoma (%) | OR for being aware of Glaucoma (95% C.I.) |
|-------------------------|--------------|---------------------------|------------------------------------------|---------------------------|------------------------------------------|
| Age (yrs.)              |              |                           |                                          |                           |                                          |
| 40 - 49                 | 4032         | 328 (8.1)                 | 1.00                                     | 118 (2.9)                 | 1.00                                     |
| 50 - 59                 | 2707         | 181 (6.7)                 | 1.02 (0.84 - 1.25)                       | 81 (3.0)                  | 1.38 (1.02 - 1.85)                       |
| 60 - 69                 | 1931         | 106 (5.5)                 | 1.02 (0.80 - 1.30)                       | 53 (2.7)                  | 1.65 (1.16 - 2.35)                       |
| ≥70                     | 1633         | 67 (4.1)                  | 0.97 (0.73 - 1.30)                       | 16 (1.0)                  | 0.78 (0.45 - 1.35)                       |
| Total                   | 10303        | 682 (6.6)                 |                                          | 268 (2.6)                 |                                          |
| Sex                     |              |                           |                                          |                           |                                          |
| Male                    | 4912         | 398 (8.1)                 | 1.00                                     | 157 (3.2)                 | 1.00                                     |
| Female                  | 5391         | 284 (5.3)                 | 0.63 (0.54 - 0.74)                       | 111 (2.1)                 | 0.64 (0.50 - 0.81)                       |
| Literacy                |              |                           |                                          |                           |                                          |
| Literate                | 3968         | 499 (12.6)                | 1.00                                     | 215 (5.4)                 | 1.00                                     |
| Illiterate              | 6335         | 183 (2.9)                 | 0.23 (0.18 - 0.28)                       | 53 (0.8)                  | 0.15 (0.10 - 0.21)                       |
| Caste                   |              |                           |                                          |                           |                                          |
| Brahmin/Chhetri         | 2396         | 383 (16.0)                | 1.00                                     | 161 (6.7)                 | 1.00                                     |
| Newar                   | 7177         | 230 (3.2)                 | 0.22 (0.18 - 0.26)                       | 87 (1.2)                  | 0.23 (0.18 - 0.30)                       |
| Others                  | 730          | 69 (9.4)                  | 0.71 (0.54 - 0.94)                       | 20 (2.7)                  | 0.55 (0.34 - 0.89)                       |

*All p < 0.001 for cataract and glaucoma each, \( \chi^2 \) test in univariate analysis.

Table 7 Responses among those aware of cataract and glaucoma

| What is Cataract/ Glaucoma? | Number (%) | Source of information | Number (%) |
|-----------------------------|------------|-----------------------|------------|
|                             | Cataract   | Glaucoma              | Cataract   |
| Blurred vision              | 48 (7.0)   | 18 (6.7)              | 86 (12.6)  |
| Blindness                   | 6 (0.9)    | 71 (26.5)             | 91 (13.3)  |
| Pearl like opacity          | 423 (62.0) | 3 (1.1)               | 69 (10.1)  |
| Rainbow haloes              | 3 (0.4)    | 22 (8.2)              | 107 (15.7) |
| Raised eye pressure         | 0 (0.0)    | 8 (2.9)               | 271 (39.7) |
| Unmatched answers           | 202 (29.6) | 146 (54.5)            | 58 (8.5)   |
| Total                       | 682 (100)  | 268 (100)             | 682 (100)  |

\[a, b, c, d, e, f\] considered as knowledge.
### Table 8 Questionnaire on Awareness of Cataract and Glaucoma

**Tilganga Institute of Ophthalmology**  
**Bhaktapur Glaucoma Study**  
**Questionnaire: Awareness of Cataract and Glaucoma**

| Date of Interview | Please write the English Date (dd/mm/yr): |
|-------------------|-----------------------------------------|
| **Name of Interviewer:** | **Code** | **Education** | **Have you had your eyes examined by a doctor?** | **If yes, where?** | **Do you know about these eye diseases?** | **If yes, what do you know about them?** | **What is your source of information?** |
| **House No.** | **S** | **N** | **How many years have you been living here?** | **Sex** | **Caste** | **Age** | **Illiterate** | **< 6 grade** | **6-10** | **> 10** | **Others** | **Glaucoma** | **Cataract** | **Glaucoma** | **Cataract** |
| M = 1 | F = 2 | Brahmin/Chhetri = 1 | Newar = 2 | Tamang = 3 | Muslim = 4 | Dalit = 5 | Others (specify)= 6 | Tilganga Hospital = 1 | Community Eye Centre Bhaktapur = 2 | Other Hospital = 3 | Private Clinic/Nursing home = 4 | Healt camps = 5 | Others (specify) = 6 | Yes = 1 | No = 0 | Blurred Vision = 1 | Blindness = 2 | Pearl like opacity = 3 | Rainbow haloes = 4 | Raised eye pressure = 5 | Unmatched answers = 6 | Don’t know = 9 |
| < 1 year = 0 | Yes = 1 | Write the name serially. | Yes = 1 | Glaucoma Cataract | Glaucoma Cataract | | |
| > 1 year = 1 | No = 0 | | No = 0 | |

*If the time of stay is less than 1 year/there is no one in the family of 40 or above age - do not interview.*
unequal access, social stigma related to wearing spectacles and others. In the future, rehabilitation programs will need to targeted for women among this population.

A cataract surgical coverage (CSC) of 90.36% was highest in comparison to all the other studies of Nepal. Since 1994, TIO has held numerous cataract screening programs in Kathmandu valley particularly focusing on Bhaktapur. These services could have lead to the high CSC. In comparison to populations from other districts of Nepal, people of Bhaktapur have a better access to eye care as there are two community eye centers that are affiliated to tertiary eye hospitals in Kathmandu. A higher CSC among the younger age groups is consistent with reports from other studies in Nepal. This is not unusual considering that younger population is more active and likely to seek earlier treatment. CSC being higher in females was different from previous studies undertaken in Nepal and elsewhere [28,29]. We are unable to explain why there were more females that had undergone surgery.

Among subjects that had undergone cataract surgery, 94% had pseudophakia. This was very high compared to 16.4% seen in Lumbini district [30]. The Fred Hollows Intraocular Lens Laboratory at TIO has been manufacturing intraocular lenses since 1994. The availability and affordability of intraocular lenses could also have lead to a high prevalence in Bhaktapur. Awareness and knowledge of cataract and glaucoma was very poor. We are alarmed and unable to explain the reason for such a low awareness on cataract despite there being several cataract screening programs held in the past several years in Bhaktapur. Subjects mostly understood cataract as a ‘pearl like dot’ white appearance in the eye while glaucoma was known to cause blindness. Very few had knowledge of glaucoma as a disease of eye pressure. Previous studies on cataract surgery undertaken in Nepal [31] and south India [32] have reported that males, literates and those affluent were more likely to be aware of cataract surgery. Similarly in our study males, literates and the affluent Brahmin and Chettri [33] classes were more aware of both conditions.

It need not be stressed that patient education programs will have to be incorporated in cataract intervention programs to raise awareness and encourage the people to come forth for an eye examination. Majority of the subjects (55.8%) had never undergone an eye examination.

It is well known that patient education programs have been successful in decreasing the morbidity of diseases [34,35] and have also helped improve compliance in glaucoma patients [36]. A novel approach to screening and patient education has been adopted by TIO to promote awareness, screening and follow up of patients [37].

Bhaktapur is one of the three districts of Kathmandu valley which represents a metropolitan city with a predominantly agrarian rural periphery. It is situated approximately 15 kilometers from Kathmandu the capital city of Nepal. We selected this district because it does not have an eye hospital to serve its population. From findings of this study, it is possible that the other two districts within Kathmandu valley which share similar socioeconomic conditions and geographic terrain could also have a low prevalence of VI. With the availability of eye services in these districts the prevalence of VI could in fact be much lower. However, further population based studies are required to confirm this statement.

The required sample size of 4758 subjects couldn’t be fulfilled because we were not able to convince all subjects to undergo an eye examination at the hospital, besides seventy five subjects had also died during the time of the survey. The major strength of our study was the large number of subjects interviewed during the field work and the comprehensive eye examination at the base hospital that resulted in accurate diagnosis.

Conclusions
The low prevalence of visual impairment and the high cataract surgical coverage suggests that cataract intervention programs have been successful in Bhaktapur. Awareness and knowledge of cataract and glaucoma was very poor in this population. Eye care programs needs to be directed towards preventing visual impairment from refractive errors, screening for incurable chronic eye diseases and promoting health education to raise awareness of cataract and glaucoma in this population.

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Authors’ contributions
SST has drafted the manuscript, contributed to the design of the study, analysis and interpretation of data. PP has contributed to the design of the study. RVDB, SK, NM has helped analyze and interpret of data. SNT has helped in the field work. SK, IP, RG, SR and GHMBR have revised the manuscript critically. All authors have read and approved the final manuscript.

Competing interests
None of the authors has a financial or proprietary interest in any material or method mentioned.

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References

1. Thylefors B, Négrel AD, Pararajasegaram R, Dadzie KY: Global data on blindness. Bull World Health Organ 1995, 73:115-21.
2. Quigley HA, Broman AT: The number of people with glaucoma worldwide in 2010 and 2020. Br J Ophthalmol 2006, 90:262-267.
3. Pascolini D, Mariotti SP, Pokuarev GP, Pararajasegaram R, Etya'ale D, Négrel AD, Resnikoff S: 2002 Global Update of Available Data on visual impairment: a compilation of population-based prevalence studies. Ophthalmic Epidemiol 2004, 11:67-115.
4. Brilliant LB, Pokuarev RP, Grasset NC, Lepkowski JM, Kolstad A, Hawks W, Pararajasegaram R, Brilliant GE, Gilbert S, Shrestha SR: Epidemiology of blindness in Nepal. Bull World Health Organ 1985, 63:375-86.
5. Pokuarev GP, Regmi G, Shrestha SK, Négrel AD, Ellwein LB: Prevalence of blindness and cataract surgery in Nepal. Br J Ophthalmol 1998, 82:600-5.
6. Sapkota YD, Pokuarev GP, Nirmalan PK, Dulal S, Maharjan IM, Prakash K: Prevalence of blindness and cataract surgery in Gandaki Zone, Nepal. Br J Ophthalmol 2006, 90:411-16.
7. Sherkhan A, Kandel RP, Sharma MK, Sapkota YD, Aghajanjan J, Bassett KL: Blindness prevalence and cataract surgical coverage in Lumbini Zone and Chetwan District of Nepal. Br J Ophthalmol 2010, 94:161-6, Epub 2009 Aug 18.
8. Dandona R, Dandona L, John RK, McCarty CA, Rao GN: Awareness of eye diseases in an urban population in southern India. Bull World Health Organ 2001, 79(2):96-102, Epub 2003 Sep 18.
9. Krishnaiah S, Kova V, Srinivas M, Shambhun BR, Rao GN, Thomas R: Awareness of glaucoma in the rural population of Southern India. Indian J Ophthalmol 2005, 53:205-8.
10. Sathyamangalam RV, Paul PG, George R, Baskaran M, Hemamalini A, Madan RV, Augustian J, Prema R, Lingam V: Determinants of glaucoma awareness and knowledge in urban Chennai. Indian J Ophthalmol 2009, 57:355-360.
11. Tielch JM, Sommer A, Katz J, Royall RM, Quigley HA, Javitt J: Racial variations in the prevalence of primary open angle glaucoma - The Baltimore Eye Survey. J Am Med Assoc 1991, 265:369-74.
12. Dandona L, Dandona R, Srinivas M, Mandal P, John RK, McCarty CA, Rao GN: Open-angle glaucoma in an urban population in southern India: the Andhra Pradesh eye disease study. Ophthalmology 2000, 107(9):1702-9.
13. Dandona L, Dandona R, Srinivas M, Mandal P, John RK, McCarty CA, Rao GN: Blindness in the Indian state of Andhra Pradesh. Invest Ophthalmol Vis Sci 2001, 42:908-16.
14. Thulasiraj RD, Nirmalan PK, Ramakrishnan R, Krishnasad R, Manimekali TK, Baburajan NP, Katz J, Tielch JM, Robin AL: Blindness and vision impairment in a rural south Indian population: the Aravind Comprehensive Eye Survey. Ophthalmology 2003, 110:1491-8.
15. Dandona L, Dandona R, Srinivas M, Girdhar P, Vilas K, Prasad MN, John RK, McCarty CA, Rao GN: Blindness in the Indian state of Andhra Pradesh. Invest Ophthalmol Vis Sci 2001, 42:908-16.
16. Thulasiraj RD, Nirmalan PK, Ramakrishnan R, Krishnasad R, Manimekali TK, Baburajan NP, Katz J, Tielch JM, Robin AL: Blindness and vision impairment in a rural south Indian population: the Aravind Comprehensive Eye Survey. Ophthalmology 2003, 110:1491-8.
17. Dandona L, Dandona R, Srinivas M, Girdhar P, Vilas K, Prasad MN, John RK, McCarty CA, Rao GN: Blindness in the Indian state of Andhra Pradesh. Invest Ophthalmol Vis Sci 2001, 42:908-16.
18. Thulasiraj RD, Nirmalan PK, Ramakrishnan R, Krishnasad R, Manimekali TK, Baburajan NP, Katz J, Tielch JM, Robin AL: Blindness and vision impairment in a rural south Indian population: the Aravind Comprehensive Eye Survey. Ophthalmology 2003, 110:1491-8.
19. Dandona R, Dandona L, John RK, McCarty CA, Rao GN: Blindness and vision impairment: a compilation of population-based prevalence studies. Ophthalmic Epidemiol 2004, 11:67-115.
20. Brilliant LB, Pokuarev RP, Grasset NC, Lepkowski JM, Kolstad A, Hawks W, Pararajasegaram R, Brilliant GE, Gilbert S, Shrestha SR: Epidemiology of blindness in Nepal. Bull World Health Organ 1985, 63:375-86.
21. Dandona R, Dandona L, Srinivas M, Mandal P, John RK, McCarty CA, Rao GN: Blindness and vision impairment: a compilation of population-based prevalence studies. Ophthalmic Epidemiol 2004, 11:67-115.
22. Liang YB, Friedman DS, Wong TY, Zhan SY, Sun LP, Wang JJ, Duan XR, Yang XY, Wang FH, Zhou Q, Wang NL: Handan Eye Study Group: Prevalence and causes of low vision and blindness in a rural Chinese adult population: the Handan Eye Study. Ophthalmolology 2008, 115:1965-72.
23. Wong TY, Chong FW, Wong WL, Rosman M, Aung T, Loo JL, Shen S, Loon SC, Tan DT, Tai ES, Saw SM: Singapore Malay Eye Study Team: Prevalence and causes of low vision and blindness in an urban Malay population: the Singapore Malay Eye Study. Arch Ophthalmol 2008, 126:1091-9.
24. Zanali M, Ismail SM, Ropiah AR, Elias H, Anumugam G, Alias D, Fathilah J, Lim TO, Ding LM, Goh PP: Prevalence of blindness and low vision in Malaysian population: results from the National Eye Survey 1996. Br J Ophthalmol 2002, 86:951-6.
25. Michon JJ, Lau J, Chan WS, Ellwein LB: Prevalence of visual impairment, blindness, and cataract surgery in the Hong Kong elderly. Br J Ophthalmol 2002, 86:333-9.
26. Isawa A, Arata M, Tordjokoro A, Yamamoto T, Shimizu H, Kitazawa Y, Tajimi Study Group: Prevalence and causes of low vision and blindness in a Japanese adult population: the Tajimi Study. Ophthalmology 2006, 113:1354-62.
27. Lewallen S, Courtright P: Gender and use of cataract surgical services in developing countries. Bull World Health Organ 2002, 80:300-3.
28. Lewallen S, Mousa A, Bassett K, Courtright P: Cataract surgical coverage remains lower in women. Br J Ophthalmol 2009, 93:295-8.
29. Pokuarev GP, Selvaraj S, Ellwein LB: Visual functioning and quality of life outcomes among cataract operated and unoperated blind populations in Nepal. Br J Ophthalmol 1998, 82:606-10.
30. Brilliant GE, Brilliant LB: Using social epidemiology to understand who stays blind and who gets operated for cataract in a rural setting. Social Science and Medicine 1985, 21:553-558.
31. Brilliant GE, Lepkowski JM, Zuntra B, Thulasiraj RD: Social determinants of cataract surgery utilization in south India. Archives of Ophthalmology 1991, 109:584-589.
32. Population Monograph of Nepal Vol I, His Majesty's Government National Planning Commission Secretariat, Central Bureau of Statistics, Ramshah Path, Kathmandu. Nepal, 2003.
33. The sixth report of the joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. Arch Intern Med 1997, 157:2413-46.
34. Cleeman JI, Lentient C: The national Cholesterol Education Program: progress and prospects. JAMA 1998, 280:2099-104.
35. Zimmerman TJ, Zalta AH: Facilitating patient compliance in glaucoma therapy. Surv Ophthalmol 1983, 28(5):252-8.
36. Thapa SS, Kelly Kurt H, Van Rens, Indira Poudyal, Lan Chang: A novel approach to glaucoma screening and education in Nepal. BMC Ophthalmology 2006, 6(1):21.

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