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# Hospital-Based Assessment of the New Visual Acuity Level in Rapid Assessment of Avoidable Blindness

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## Abstract

**Background:** There are currently two versions of rapid assessment of avoidable blindness (RAAB) method in use: RAAB5 and RAAB6. While RAAB5 uses visual acuity (VA) of 6/18 as cutoff for visual impairment (VI), RAAB6 uses VA of 6/12. **Aim:** The aim of the study was to determine the average additional time it will take to test from 6/18 to 6/12 VA levels and to compare the causes of VI across these VA cutoffs. **Methods:** It was a cross-sectional study of patients aged 50 years and above attending a tertiary hospital in Jos between April and September 2016 (6 months). RAAB6 methodology was used to test presenting VA of all participants. The time taken to obtain a VA of 6/18 and to test from 6/18 to 6/12 was recorded separately for each eye. Those with VA worse than 6/12 in one or both eyes had their eyes examined to determine the cause of VI. The data collected were analyzed using the Statistical Package for Social Sciences for windows software, version 20. **Results:** The average additional time taken to test VA from 6/18 to 6/12 was 42.11 seconds (95% confidence interval: 32.86–51.35). Cataract was the major cause of VI with both VA cutoffs with no significant difference in its proportion ($P = 0.924$). Uncorrected refractive error and glaucoma were the next important causes of VI with 6/12 ($P = 0.041$) and 6/18 ($P = 0.041$) cutoffs, respectively. **Conclusion:** The spectrum of disease causing VI may not differ significantly between the two RAAB versions, but survey duration will likely be prolonged with RAAB6.

**Keywords:** Rapid assessment of avoidable blindness, visual acuity, visual impairment

**Key Message:** Increased VA assessment time without a significant change in magnitude and causes of VI may not sufficiently justify the change from RAAB5 to RAAB6.Text

## Introduction

The RAAB method during field surveys has become a vital tool for generating reliable data needed for planning and monitoring of eye care services in situations where scarcity of time and resources limit the use of conventional epidemiological surveys.[1-3] There are currently two versions; RAAB5 and RAAB6.[1,2] The later was introduced to reflect the latest International Classification of Disease version 11 (ICD-11) of World Health Organization (WHO) for blindness and visual impairment (VI), which has changed from ICD-10, with mild VI now classified as presenting visual acuity (VA) <6/12 to 6/18.[4]

This study determined the additional time needed to assess VA when RAAB6 is used instead of RAAB5 and compared the causes of VI across the two versions, highlighting the implication of these findings on efficient data generation, which is essential for planning of eye care programs.

## Subjects and Methods

A descriptive, cross-sectional, hospital-based study was carried out among patients aged 50 years and above attending the Ophthalmology clinic of a tertiary hospital in Jos, Plateau State between April and September 2016. Consecutive patients who consented to participate in the

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study were recruited while eligible participants who were not willing to participate were excluded. Written informed consent was obtained from all patients who participated in the study and ethical approval was granted by the Research and Ethics Committee of the hospital. The study adhered to tenets of the declaration of Helsinki. A 1 day training of the researchers and research assistants on VA assessment as is done in RAAB version 6 (RAAB6) and on timing from 6/18 to 6/12 was conducted by a certified RAAB trainer.

Data collection: Participants were interviewed to obtain their demographic data. VA was assessed and timed using the RAAB6 protocol. Patients with VI (VA worse than 6/12) in one or both eyes proceeded to undergo eye examination to determine the cause of VI.

VA assessment: Presenting VA (PVA) was measured using the tumbling "E" chart. Tumbling "E" single optotype with size 18 on the one side and size 60 on the other side was used. A second card with a size 12 optotype was also used where indicated. The procedure was performed in a well illuminated room at a distance of 6, 3, and 1 m, respectively, as indicated. For each participant, the right eye was tested first followed by the left. In each case, the eye not being tested was covered with an occluder held by the patient. Where pinhole (PH) testing was needed for the right eye, this was completed before testing the left eye. Each optotype was presented five times at the specified distance and a patient was required to point in the direction of the open ends of the "E". The optotype was rotated in varying directions before each reading to change the direction of the open ends. A patient was required to correctly identify the direction at least four out of five times to score that level of VA.

First, the "E" card and PH were shown from nearby and procedure was explained to each participant. For each eye, the examiner started with the size 60 card shown at a distance of 6 m. Where the size 60 optotype was correctly read at this distance, the card was then flipped to the size 18 optotype at 6 m. Where the size 18 optotype was correctly seen at 6 m, the size 12 card was then presented at the same distance. But where the size 60 card could not be read correctly at 6 m, VA was first measured with the same optotype at a distance of 3 m and then at 1m if the optotype could not be seen at 3 m. Whenever the size 60 optotype could not be seen at 1 m, a pen torch was used to test whether the person could perceive light or not. All eyes with PVA worse than 6/12 were examined for acuity with a multiple PH and with available correction as well. VA was recorded separately for each eye on the questionnaire.

Timing of VA: The time it took a patient to score a VA of 6/18 (with or without PH) was recorded as time one (T1) in seconds and designated as VA timing for RAAB5, while the additional time required to test the 6/12 VA level was recorded as time two (T2) in seconds. A combination of T1 and T2 was designated as VA timing for RAAB6. Eyes that could not achieve VA of 6/18 even with a PH had their timing aborted and no time was recorded for them.

A stopwatch was started at the beginning of VA testing and ran until 6/18 was achieved. The watch was stopped and T1 recorded. The stopwatch was reset to zero. VA testing and timing was resumed with the size 12 card and the additional time taken to test VA to the 6/12 level whether achieved or not was recorded as T2. VA assessment was timed independently by a trained member of the research team.

A stopwatch was used to record the time taken to determine the VA. The person determining the VA called out "start stopwatch" and "stop stopwatch" at the appropriate intervals, provided instruction on PH use, and read out VA achieved by each patient.

Ocular examination: Patients with PVA of 6/12 in both eyes were considered to have normal vision and so exited the study after VA assessment. While those with VA worse than 6/12 in one or both eyes subsequently underwent ocular examination. The anterior segment was examined using a pen torch and red reflex test looking out for the lens status and other anterior segment causes of VI. Any cause of vision loss based on this examination was noted. Mydriatic direct ophthalmoscopy was then performed with the room darkened after an initial nonmydriatic assessment. Mydriasis was achieved by application of one drop each of 1% tropicamide and 5% phenylephrine (unless contraindicated). The status of the lens, posterior segment cause of VI where present, were also

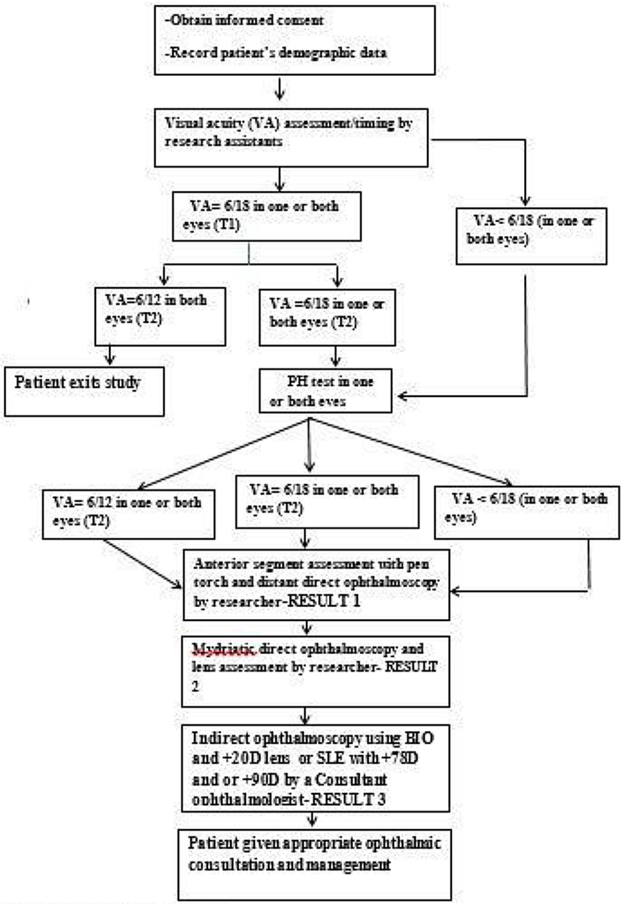


**Figure 1:** Flow chart of Study Activities.

documented. Flow chart of study protocol is illustrated in Figure 1.

Data analysis: Data collected were entered into Microsoft excel spreadsheet and validated by double entry. The data were then processed and analyzed using Statistical Package for Social Sciences for Windows software, version 20 (SPSS Inc., Chicago, IL, USA). Frequency tables were generated for all data collected. Mean and standard deviation of VA assessment time were computed. Results were presented in the form of tables and graphs. Pearson chi-squared test was used to test statistical significance between categorical variables. Analysis of variance, student *t* test, and linear regression analysis were used to test relationship between the average additional time taken to test vision from 6/18 to 6/12 with level of education, PH test, and age, respectively. A $P < 0.05$ was regarded as statistically significant in all instances.

Study definitions:

(1) Presenting VA: VA in the better eye using currently available refractive correction.[4]

(2) Definition of blindness/VI[4]:
Mild (Early) VI: PVA of < 6/12 to 6/18 in the better eye.
Moderate VI: PVA of < 6/18 to 6/60 in the better eye.
Severe VI: PVA of < 6/60 to 3/60 in the better eye.
Blindness: PVA of <3/60 in the better eye.

(3) Glaucoma: Presence of a pale, cupped disk with a vertical cup to disk ratio of ≥0.8.[4]

(4) Diabetic retinopathy: Presence of any one of the following in a patient suspected to be diabetic; clinically significant macular oedema or the presence of proliferative retinopathy at the disc or elsewhere.[4]

(5) Age-related macular degeneration: Presence of macular scar, macular hemorrhage, or geographic atrophy in the absence of other known causes.[4]

(6) Cataract: Presence of visually significant lens opacity.[4]

(7) Corneal opacity: Opacity obscuring pupillary axis that is visually significant.[4]

(8) Refractive error (RE): VA of <6/12 that improves with PH to 6/12.[4]

(9) Complications of cataract surgery: An eye that is blind or visually impaired and that has undergone cataract surgery or couching (traditional cataract surgery) in the absence of other causes of blindness/VI.[4]

(10) Major cause of VI: When there were two or more conditions coexisting in the same or different eyes contributing to VI, the condition that was most visually significant was chosen as the major cause of VI.[5] This criterion is a modification of the WHO coding instruction for assigning the major cause of VI. This was adopted to eliminate bias for posterior segment eye diseases (PSEDs).

## Results

A total of 250 patients were enrolled into the study. Their mean age was 63.7 ± 9.1 years. One hundred and twelve (44.8%) of them were males, with a male to female ratio of 1.2:1 ($P = 0.4$). Table 1 shows the age and sex distribution of the study participants. Seventy-three (29.2%) participants had tertiary education, while 35(14%) and 70 (28%) had secondary and primary levels of education, respectively. The remaining 72 (28.8%) participants had no formal education.

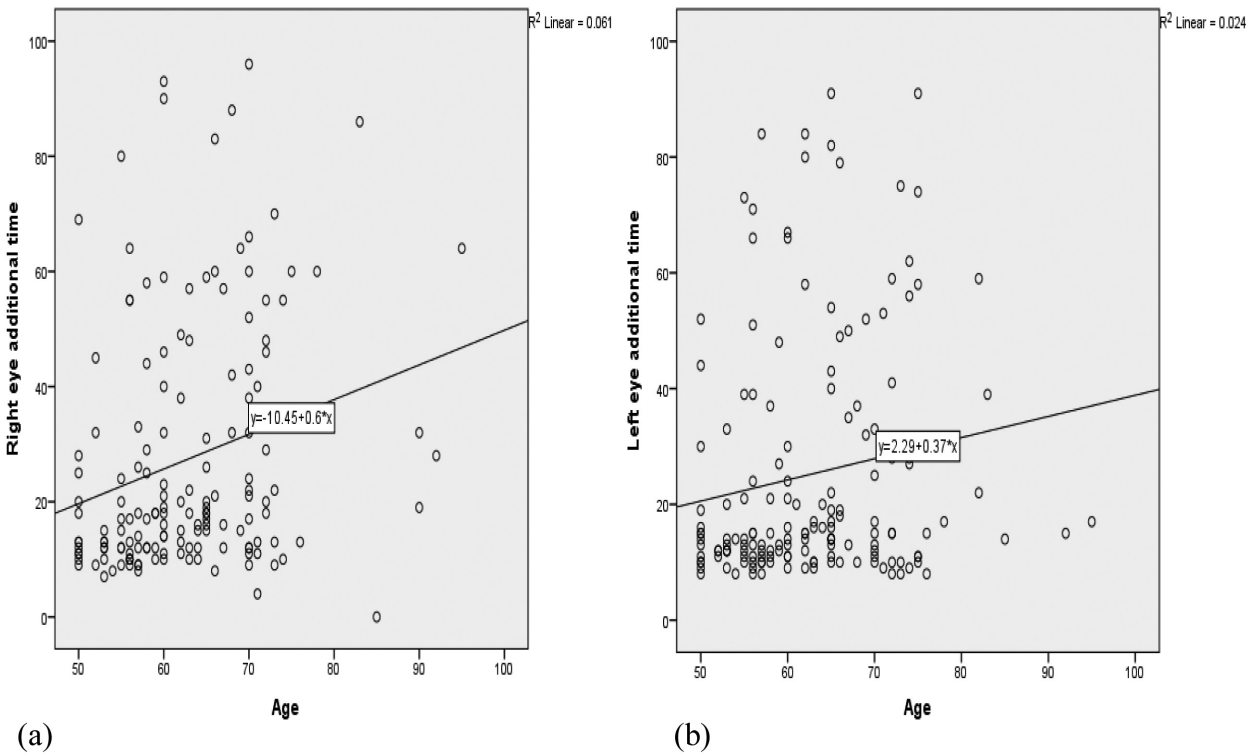


**Figure 2:** Scatterplot regressing additional test time on age. Right eye (a) and left eye (b).

The mean total VA assessment time per eye was 95.67 seconds (95% confidence interval: 88.23–103.91) for RAAB6 and 53.56 seconds (95% confidence interval: 48.84–58.54) for RAAB5. The difference in mean between the two tests was 42.11 seconds (95% confidence interval: 32.86–51.35), which was statistically significant at a *P* value of 0.001 as shown in Table 2. It took each eye an average of 53.56 seconds to attain a VA of 6/18 (RAAB5) and an additional 42.11 seconds to test from 6/18 to 6/12 VA level with the average additional time accounting for 44% of the average VA time in RAAB6. Correlation coefficient (*r*) presented in Figure 2 and Table 3 shows that additional time taken to complete the test increased with increasing age in both right and left eyes. This correlation was significant for only right eyes ($P = 0.002$). The regression coefficient of 0.694 ($P = 0.001$) for the right eyes indicates that every 1 year increase in age resulted in a 0.694 second increase in the average additional time as depicted in Table 3. There was no difference in additional time for VA testing when compared with participant's level of education. Those who used PH had significantly longer additional VA test time for all eyes as shown in Table 3.

When 6/12 was used as cutoff for VI, 294 (58.8 %) of eyes had VI compared to 231 (46.2 %) when 6/18 was used ($P < 0.001$). The proportion of those with mild to moderate VI was significantly higher with the 6/12 cutoff. The proportion of eyes with severe visual impairment and blindness did not differ between 6/12 and 6/18 VA cutoffs as shown in Table 4.

Untreated cataract was the main cause of VI across the two VA cutoffs with no significant difference in its magnitude ($P = 0.924$). Glaucoma was the second most important cause of VI using the 6/18 cutoff, while uncorrected refractive error (URE) emerged as the next important cause of VI after cataract using the 6/12 cutoff. The difference in proportions of VI caused by glaucoma and RE between the two cutoffs were both statistically significant ($P = 0.041$ in both instances). Other causes of VI and how they compare across the VI cutoffs are presented in Table 5.

**Table 1: Age-sex distribution of study participants**

| Age groups (years) | Male No % | Female No % | Total No % |
|---|---|---|---|
| 50-54 | 18(16.1) | 22(15.9) | 40 (16.0) |
| 55-59 | 16(14.3) | 30(21.7) | 46 (18.4) |
| 60-64 | 18(16.1) | 27(19.6) | 45 (18.0) |
| 65-69 | 21(18.8) | 26(18.8) | 47 (18.8) |
| 70-74 | 27(24.1) | 20(14.5) | 47 (18.8) |
| 75-79 | 7(6.3) | 7(5.1) | 14 (5.6) |
| 80+ | 5(4.5) | 6(4.3) | 11 (4.4) |
| Total | 112(100.0) | 138(100.0) | 250 (100) |

## Discussion

RAAB version 6 (RAAB6) uses a VA level of 6/12 as cutoff for VI to determine the prevalence of blindness and VI among people aged 50 years and above. While RAABs are designed to be conducted in the field, this study simulated the RAAB6 methodology in a hospital setting in order to evaluate the VA assessment time and determine the causes of VI among the study population.

In this study, the additional VA testing time accounted for nearly half of the total VA assessment time for RAAB6. This demonstrates the possible impact the introduction of RAAB6 will have on the entire study duration. Extrapolating the results of this study to a RAAB field setting, one can infer that it will take an average of 42.71 hours to test VA of 62.4% of an average sample size of 4600 eyes (2300 persons) if RAAB5 is used. An additional 33.58 hours will be needed to test VA to the 6/12 level. Hence, total VA assessment time for RAAB6 will be 76.29 hours compared to 42.71 hours for RAAB5. The above estimate implies a significant increase in VA assessment time if RAAB6 is used with likelihood of a substantial increase in overall survey duration. Moreover, additional time will be required in RAAB6 to examine the additional number of persons with VI at the 6/12 level. This, however, was not assessed in our study. During the course of this research, RAAB7, which is a digital version of RAAB6, was introduced and the software is still under development and undergoing field testing and may have additional resource implications.[6]

Right eyes recorded significantly longer additional time. This may suggest that the right eyes, which were tested first in all cases, had a longer learning curve or bore a greater weight of first-time effect in the VA assessment protocol. But once the procedure was understood, it became easier to undertake in the left eye. In both right and left eyes, there was no difference in the additional VA assessment time across the various levels of education. This is most likely due to the fact that the single optotype tumbling "E" chart is simple to understand by both

**Table 2: Comparison of the average total visual acuity test duration in RAAB6 and RAAB5**

| Eyes | RAAB6 | | RAAB5 | | Difference of Mean | | *t*-test | *P*-value |
|---|---|---|---|---|---|---|---|---|
| | Mean±SD | 95% C.I. | Mean±SD | 95% C.I. | | 95% C.I. | | |
| **Right N= 154** | 60.71±33.24 | 55.68-66.27 | 33.12±18.64 | 30.33-36.34 | 27.58 | 24.15-31.02 | 15.857 | **0.001*** |
| **Left N= 158** | 54.16±30.01 | 49.52-58.89 | 29.01±17.29 | 26.30-31.86 | 25.15 | 21.63-28.67 | 14.117 | **0.001*** |
| **Total eyes N= 312** | 95.67±50.24 | 88.23-103.91 | 53.56±29.96 | 48.84-58.54 | 42.11 | 32.86-51.35 | 8.962 | **0.001*** |

*Statistically significant.

**Table 3: Factors influencing average additional time taken to read from 6/18 to 6/12 Visual acuity Level**

| Factor | | Right eyes | Left eyes |
|---|---|---|---|
| Age (years) | Regression coefficient | 0.602 | 0.366 |
| | t-test (p- value) | **3.138 (0.002[x])** | 1.944 (0.054) |
| | r | **0.247[*]** | 0.154 |
| | $R^2$ | 0.061 | 0.024 |
| | | **T2x (SD)** | **T2x (SD)** |
| Level of education | Non formal | 25.98±18.63 | 28.64±23.04 |
| | Primary | 33.13±26.16 | 25.88±21.33 |
| | Secondary | 26.18±20.41 | 19.06±14.58 |
| | Tertiary | 24.80±20.49 | 24.02±21.36 |
| | ANOVA(p-value) | 1.226 (0.303) | 0.929 (0.428) |
| Pin hole test | With pin hole | 45.7±23.4 | 44.9±25.1 |
| | Without pin hole | 26.0±9.7 | 16.7±11.7 |
| | t-test (p-value) | **7.303 (<0.001[x])** | **9.671 (<0.001[x])** |

Dependent Variable in regression model: average additional time in seconds *Correlation is significant at the 0.05 level (2-tailed) T2x: average additional time in seconds. [†]Statistically significant.

**Table 4: Visual impairment categories (by eyes) among study participants**

| Visual impairment Cut off level | 6/18 | 6/12 |
|---|---|---|
| | Frequency (%) | Frequency (%) |
| Normal vision | 269 (53.8) | 206 (41.2) |
| Mild/Moderate visual impairment | 108 (21.6) | 171 (34.2) |
| Severe visual impairment | 24 (4.8) | 24 (4.8) |
| Blindness | 99 (19.8) | 99 (19.8) |
| Total | 500 (100.0) | 500 (100.0) |

$X$= 22.582, $df$=3, $P$ value <0.001.

**Table 5: Relationship between causes of visual impairment (person) and visual impairment cut off levels**

| Causes of visual Impairment | Visual impairment cutoff level | | $X^2$ (P value) |
|---|---|---|---|
| | VA ≤ 6/18 | VA≤ 6/12 | |
| Cataract untreated | 55 (35.3) | 66 (35.1) | 0.009 (0.924) |
| Glaucoma | 53 (33.9) | 58 (30.9) | 4.191 (0.041[*]) |
| Refractive error | 9 (5.8) | 22 (11.7) | 4.191 (0.041[*]) |
| Cataract surgery Complications | 19 (12.2) | 21 (11.2) | –0.538 |
| Other PSEDs | 5 (3.2) | 6(3.2) | (>0.999) |
| Others | 15 (9.6) | 15(8.0) | –0.078 |
| **Total** | **156 (100.0)** | **188 (100.0)** | |

*Statistically significant.

literate and nonliterate. While RAAB6 uses only three optotypes in the VA assessment protocol making the test easier and faster to undertake, the conventional epidemiologic studies, which are more time consuming, use the standard Snellen chart.[1-3] Furthermore, while the use of the standard Snellen letter or number charts require familiarity with English symbols or letters, this is not the case with the tumbling E single optotypes. The presentation of each optotype five times in different directions for every level of VA in the RAAB examination protocol allows for better understanding of the principles of VA testing rather than memorization of the optotype; this is the more likely explanation for a shorter additional VA time in the left eyes.

Increasing age was significantly associated with a longer additional VA test duration for only right eyes. This might suggest that the rate of initial comprehension of the VA procedure declined with increasing age. But once the basics were mastered, age was no longer a crucial factor. Morris and Hamilton[7] in their assessment of VA and reaction time among navy fighter pilots also reported that as age increases, simple visual reaction time was slower.

Patients whose vision was tested with PH had considerably longer additional testing time in both right and left eyes. Though the PH is an excellent way of screening for RE and disorders of the ocular media, a few studies have reported difficulty in its use in older participants.[8] Initial difficulty in localizing the pinhole and or poor steadiness of hands to keep the handheld pinhole along the visual axis may be responsible for the increased VA assessment time with PH use. In contrast, a population-based study to assess the sensitivity and specificity of the pinhole in the detection of significant RE showed that the use of the multiple PH occluder increased the chances of the elderly subjects finding one of the holes and measurement of vision was achieved faster.[9]

Untreated cataract was the main cause of VI among participants, followed closely by glaucoma and URE. Mpyet *et al*.[10] reported cataract as the lead cause of VI, followed by URE in Plateau state. Similar reports of cataract and URE as major causes of blindness and VI have been documented from RAAB surveys from Thailand and India.[11,12] Results from national surveys in Nigeria and Burundi are however at variance with the findings of this study.[13,14] Both surveys documented URE followed by

cataract as the major causes of VI. The WHO global data on VI 2010 also reports URE followed by cataract as the major causes of VI globally.[15] The emergence of URE as a more important cause of VI using the 6/12 cutoff in our study suggests that some cases of RE that would have been missed if RAAB5 was used can now be detected with the introduction of RAAB6. Fortunately, even if left untreated, these patients are unlikely to become blind from RE at this age, but their quality of life could be affected. The proportion of glaucoma and other PSEDs as causes of VI was found to be high compared with results from field surveys.[16,17] The hospital-based nature of this study and the operational definition of the major cause of VI, being the condition that is most consistent with the VA of the patient and not necessarily the most avoidable cause, may be largely responsible for this increase. Conversely, this may be a pointer to the fact that the cataract backlog is being reduced appreciably such that glaucoma and other PSEDs are now being brought to the fore as important causes of VI. The proportion of other PSEDs detected in the study did not differ across the two VA cutoffs. This suggests that RAAB6 is unlikely to change the magnitude of VI attributable to PSEDs.

### Limitations of the study

(1) The presence of significant lens opacity in some patients might have led to underdiagnoses of some PSEDs.
(2) Owing to the hospital-based nature of this research, its conclusions must be extrapolated to the field setting with caution.

## Conclusion

The significant additional VA assessment time in RAAB6 will likely prolong the entire survey duration without necessarily changing the spectrum of diseases that a blindness prevention program needs to plan for. The detection of more people with URE using RAAB6, though commendable, may not be sufficient to justify any substantial increase in study duration with respect to conservation of time and resources, which are some of the hallmarks of the RAAB methodology.


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Nil.

### Conflicts of Interest

There are no conflicts of interest.


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