A Review of Corneal Blindness Data from the Rapid Assessment of Avoidable Blindness (RAAB) Repository

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ABSTRACT

Introduction: Corneal blindness continues to be a leading cause of avoidable vision loss and blindness. The Rapid Assessment of Avoidable Blindness (RAAB) is a standardized survey instrument that measures causes of blindness and provides results in an accessible online format.

Objective: We examined the studies contained in the RAAB repository to measure the availability of data on corneal blindness as represented on the main page of for each study.

Methods: 331 studies from 2007 through the present were reviewed. After exclusion criteria were applied the final dataset consisted of 145 studies. Results for causes of blindness reported on the main pages for each study were then compared with the complete study results.

Results: Corneal blindness findings represent a significant cause of avoidable blindness, with regional variation, and were generally underrepresented on the RAAB main page findings.

Conclusion: As the RAAB format continues to evolve, minor revisions to this survey instrument could be included to represent more clearly where corneal blindness is significant cause of vision loss and blindness and thus assist in regional and global vision service planning.

Blindness and visual impairment affect over 2 billion people around the world.[1] Corneal blindness remains a significant cause of avoidable blindness, with the true extent of corneal blindness likely underreported.[2] Current estimates are that 75 to 80% of overall global blindness and vision impairment are avoidable.[3] The definition of "avoidable" can encompass some variation but is generally understood to mean blindness that is either preventable, or treatable. Corneal blindness falls generally into this category of avoidable blindness, although it is caused by a variety of conditions including disease, injuries, and Vitamin A deficiency. It is deemed to be avoidable since it is usually reversible with transplant of corneal tissue, a proven and cost effective method for alleviating the burden of blindness for individuals, communities, and countries.[4] Infectious corneal diseases can also be treated or prevented.

The Rapid Assessment of Avoidable Blindness (RAAB) is a population based survey instrument that measures blindness, visual impairment, and eye care services among people aged 50 years and over, and which provides regional estimates of the prevalence and causes of blindness.[5] RAAB study results are contained in an online repository that summarizes the main findings in a standard format, and also provides links to available publications and datasets associated with each study, as well as email addresses for study investigators. RAAB provides standardized baseline information on mostly avoidable causes, and other select indicators of eye health such as cataract surgical coverage (CSC) and cataract surgical rates (CSR).[6] This information is shown when the user selects the Information button associated with each study.[7] The RAAB does not purport to provide accurate estimates of all causes of blindness and vision loss; rather, it is known to provide a "reasonably accurate estimate" of blindness prevalence in a specific geographic region.

PURPOSE

The purpose of this study was to examine the data available in the RAAB repository from 2007 until the present and summarize the availability of corneal blindness data as one of the subsets of avoidable blindness. Since corneal conditions comprise a significant proportion of avoidable blindness, and the RAAB was designed to focus on these avoidable causes, we were interested in determining the extent to which corneal blindness data was captured on the front, or main, pages of the studies listed in the repository.

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 ISSN 2161-5546

METHODS

At the time of this writing, the RAAB Repository contained a total of 331 studies; of those, we examined the 254 studies from 2007 onwards in order to capture data that was no more than 10 years older than the calendar year of the most recently available studies. Of these 254 studies, 46 in 2016 or later and had not yet reported their data. 6 studies were then excluded for the following reasons: in 2 studies the participants were not aged 50+ years; 1 study presented data in an unusable format, 1 study only presented data as "ocular morbidity," 1 study was a duplicate of another study, and another study was excluded for not actually being a RAAB study. There were 7 instances where multiple studies had been conducted in the same location; for these, only the most recent studies that data could be obtained from were included. 29 studies were only available upon request, so we attempted to obtain this data using links provided by the RAAB to contact the 29 principal investigators (PI) associated with those studies, however at time of writing no data had been acquired. 21 studies did not provide data or PI contact information. After this exclusion criteria was applied, a total of 145 studies were left to be included in the final dataset, represented in Table 1.

We compared the main findings from the RAAB front pages of these 145 studies with the linked reports and complete datasets provided by the researchers, and when available, linked publications, to determine how the corneal causes of blindness were represented. For the purpose of our analysis, we included blindness due to both trachomatous corneal opacity (TCO) and non-TCO in the definition of corneal blindness. Blindness was defined to be a presenting visual acuity (PVA) < 3/60 and low vision was defined to be a PVA < 6/18 but ≥ 3/60 (moderate + severe visual impairment [MSVI]). Within the RAAB repository, MSVI is used interchangeably with the term "low vision". The data were captured from information presented on the front page for each study, and if they were provided, the associated report and publication associated. We also collected the country, state, district, and year conducted, and prevalence of blindness and MSVI/low vision due to TCO and non-TCO. We included data for corneal pathologies, pterygium, onchocerciasis, and cataract surgery complications as these may contribute additional corneal causes of blindness. However, of these additional categories of blindness and vision impairment, only corneal pathology was included in our definition of corneal blindness because not all instances of the other conditions can be stated to necessarily have corneal implications.

RESULTS

Full results are shown in Table 1. All 145 studies presented main page findings related to blindness prevalence and causes. However, 3 studies did not contain data for low vision; 2 studies only contained data for blind and severe visual impairment (6/60 < PVA ≥ 3/60); and 14 studies from Vietnam only presented data that was adjusted for age, sex, ethnicity, and domicile (unadjusted data was collected from all other studies). Considerable variation existed among different districts or regions within a given country; for example, in Papa New Guinea the proportion of corneal blindness ranged from 0.0 to 9.6%, with the highest prevalence in the Islands (Table 1). The data on TCO blindness was captured on the front page, with a few exceptions. The data for non-TCO blindness was generally found in the supporting documentation provided by the researchers, or a linked publication.

As represented within the RAAB studies, the proportions of corneal causes of blindness ranged from 0% to 27.5% of avoidable blindness in the populations and regions studied. Overall, the majority of corneal causes of blindness fell into the non-TCO category, comprising 5.8% of blindness on average, while TCO blindness averaged just 1.4% of blindness. The proportion of TCO blindness was higher than non-TCO in only 14 studies, (9.6%). 105 of the 145 studies, or 72.4%, contained data showing that corneal causes occupied a range from 4.0% to 13.99% of all blindness, with 23 studies finding this proportion to be 10% or more. The highest number of studies in a specific interval was 39 in the 4.0-5.99% range, shown in Table 2. The top ten districts for corneal blindness prevalence in the RAAB database are shown in Table 3. Corneal conditions accounted for a compelling amount of the blindness burden in these districts, ranging from 15.9% to 27.5% of all blindness.

In addition, 3 studies reported corneal blindness as "corneal pathologies" instead of using the typical RAAB terminology, in Table 4. Two studies conducted in India found corneal pathologies to constitute 3.0 and 4.5 % of blindness while a single study from Qatar found this proportion to be 21.0%. Prevalence data for onchocerciasis, pterygium and cataract surgery complications, which could potentially implicate corneal complications are summarized in Table 5. Only 20 studies sought to record data for pterygium; of these, 6 reported values. 109 studies sought information on onchocerciasis and only 15 reported values. These 21 studies found averages of 4.5 and 5.0% percent of blindness respectively. Surgery complications were recorded in 111 of the 142 studies that sought data and averaged 3.6% of reported blindness in these studies.

 ISSN 2161-5546

Table 1

GBD Region	Country	State	District	Year	TCO Blindness	non-TCO Blindness	Total CB	% Blindness attributed to corneal blindness not captured on RAAB front page
Andean Latin America	Ecuador	-	-	2009	0.0%	1.4%	1.4%	1.4%
Andean Latin America	Bolivia	-	-	2014	1.0%	3.4%	4.4%	3.4%
Andean Latin America	Peru	-	-	2011	1.5%	5.3%	6.8%	5.3%
Central Latin America	Costa Rica	-	-	2015	0.0%	2.1%	2.1%	2.1%
Central Latin America	Panama	-	-	2013	0.0%	2.2%	2.2%	2.2%
Central Latin America	Honduras	-	-	2013	0.0%	2.6%	2.6%	2.6%
Central Latin America	Mexico	Chiapas	Central, Highland, and Frialesca	2010	3.1%	1.5%	4.6%	1.5%
Central Latin America	Mexico	Nuevo Leon	-	2014	0.0%	4.7%	4.7%	4.7%
Central Latin America	Guatemala	-	-	2015	2.1%	4.5%	6.6%	4.5%
Central Latin America	Mexico	Queretaro	-	2015	0.0%	7.3%	7.3%	7.3%
Central Latin America	El Salvador	-	-	2011	1.0%	7.1%	8.1%	7.1%
Southern Latin America	Argentina	-	-	2013	0.0%	0.0%	0.0%	0.0%
Tropical Latin America	Paraguay	-	-	2011	0.0%	9.4%	9.4%	9.4%
Caribbean	Domincan Republic	-	-	2008	0.0%	0.0%	0.0%	0.0%
Caribbean	Suriname	-	-	2013	0.0%	1.6%	1.6%	1.6%
Central Europe	Hungary	-	-	2015	0.0%	0.0%	0.0%	0.0%
Eastern Europe	Moldova	-	-	2012	0	3.6%	3.6%	3.6%
Eastern Europe	Russia	Wolga	Samara City	2008	0.0%	3.8%	3.8%	3.8%
North Africa and Middle East	Qatar	-	-	2009	N/A	N/A	0.0%	N/A
North Africa and Middle East	Jordan	Irbid	-	2012	0.0%	0.0%	0.0%	0.0%
North Africa and Middle East	Yemen	Al Amran	-	2009	0.0%	1.8%	1.8%	1.8%
North Africa and Middle East	Yemen	Lahj	-	2009	0.0%	2.1%	2.1%	2.1%
North Africa and Middle East	Sudan	White Nile	-	2010	0.6%	6.0%	6.6%	6.0%
North Africa and Middle East	Sudan	Northern	-	2010	1.1%	6.3%	7.4%	6.3%
North Africa and Middle East	Saudi Arabia	Taif	-	2011	1.3%	6.3%	7.6%	6.3%
North Africa and Middle East	Sudan	North Kordofan	-	2010	0.0%	7.7%	7.7%	7.6%
North Africa and Middle East	Afghanistan	Laghman	-	2010	0.0%	8.2%	8.2%	8.2%
North Africa and Middle East	Sudan	Sennar	-	2010	0.7%	9.1%	9.8%	9.1%
North Africa and Middle East	Saudi Arabia	Jazan	-	2011	0.5%	9.6%	10.1%	9.5%
North Africa and Middle East	Sudan	River Nile	-	2010	0.8%	9.9%	10.7%	10.7%
North Africa and Middle East	Sudan	Geriza	-	2010	1.5%	9.6%	11.1%	11.1%
North Africa and Middle East	Afghanistan	Herat	-	2010	0.0%	12.5%	12.5%	12.5%
North Africa and Middle East	Libya	-	-	2010	0.8%	13.5%	14.3%	14.3%
North Africa and Middle East	Palestine	-	-	2008	1.7%	14.2%	15.9%	14.1%
North Africa and Middle East	Iran	Tehran	Varamin	2009	2.4%	14.6%	17.0%	14.7%
North Africa and Middle East	Iran	Kordestan	-	2014	9.7%	8.1%	17.8%	8.1%
North Africa and Middle East	Afghanistan	Badakhshan	-	2010	17.4%	6.5%	23.9%	6.5%

Legend: IABP region color

- Andean Latin America
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- East Asia
- Southeast Asia
- South Asia

 ISSN 2161-5546

***Table 1**: (cont.)*

GBD Region	Country	State	District	Year	TCO Blindness	non-TCO Blindness	Total CB	% Blindness attributed to corneal blindness not captured on RAAB front page
Southern Sub-Saharan Africa	South Africa	Western Cape	Cape Town	2010	0.0%	2.7%	2.7%	2.7%
Southern Sub-Saharan Africa	South Africa	KwaZulu-Natal	Durban	2009	N/A	3.4%	3.4%	3.4%
Southern Sub-Saharan Africa	Botswana	-	-	2015	2.9%	12.9%	15.8%	12.9%
Eastern Sub-Saharan Africa	Burundi	Ngozi and Kayanza	-	2012	0.0%	2.5%	2.5%	2.5%
Eastern Sub-Saharan Africa	Kenya	Coast	Kwale	2007	0.0%	2.6%	2.6%	2.6%
Eastern Sub-Saharan Africa	Kenya	Eastern	Embu	2007	1.6%	1.6%	3.2%	1.6%
Eastern Sub-Saharan Africa	Madagascar	Atsinanana	-	2011	0.0%	3.2%	3.2%	3.2%
Eastern Sub-Saharan Africa	Tanzania	Kilimanjaro	-	2007	2.4%	3.6%	6.0%	3.6%
Eastern Sub-Saharan Africa	Uganda	Western	Hoima	2013	4.8%	3.2%	8.0%	3.1%
Eastern Sub-Saharan Africa	Tanzania	Singida	-	2012	1.7%	7.5%	9.2%	7.5%
Eastern Sub-Saharan Africa	Kenya	Rift Valley	Kericho	2007	2.0%	8.2%	10.2%	8.2%
Eastern Sub-Saharan Africa	Eritrea	-	-	2008	1.1%	9.2%	10.3%	9.1%
Eastern Sub-Saharan Africa	Mozambique	Inhambane	-	2016	4.8%	5.8%	10.6%	5.8%
Eastern Sub-Saharan Africa	Uganda	Central	Mubende	2012	1.6%	11.1%	12.7%	11.1%
Eastern Sub-Saharan Africa	Zambia	Southern	-	2011	N/A	14.5%	14.5%	14.5%
Eastern Sub-Saharan Africa	Mozambique	Sofala	-	2012	3.7%	11.2%	14.9%	11.3%
Eastern Sub-Saharan Africa	Malawi	Southern Region	Blantrye, Chikwawa, Nsaje, Thyolo, Chiradzulu, Mwanza, and Neno	2009	4.4%	12.3%	16.7%	12.3%
Western Sub-Saharan Africa	Senegal	Kaolack	-	2010	2.6%	3.8%	6.4%	3.60%
Western Sub-Saharan Africa	Burkina Fasso	West Central	-	2011	3.4%	5.7%	9.1%	5.80%
Western Sub-Saharan Africa	Guinea Bissau	-	-	2010	6.0%	7.1%	13.1%	7.10%
Western Sub-Saharan Africa	Mali	Koulikoro	-	2011	5.0%	9.0%	14.0%	9%
Western Sub-Saharan Africa	Senegal	Fatick	-	2010	9.4%	6.8%	16.2%	6.70%
Western Sub-Saharan Africa	Nigeria	Sokoto	Sokoto	2016	8.0%	11.6%	19.6%	11.60%
Oceania	Papua New Guinea	Coastal	-	2017	0.0%	0.0%	0.0%	0.0%
Oceania	Papua New Guinea	NCD	-	2017	0.0%	0.0%	0.0%	0.0%
Oceania	Papua New Guinea	Highlands	-	2017	0.0%	2.9%	2.9%	2.9%
Oceania	Papua New Guinea	Islands	-	2017	4.8%	4.8%	9.6%	4.7%
East Asia	China	Xinjiang	Altay and Tacheng	2015	0.0%	1.4%	1.4%	1.4%
East Asia	China	Jiangxi	Wanzai	2007	0.0%	2.2%	2.2%	2.2%
East Asia	China	Inner Mongolia	Tuoketuo	2010	0.0%	4.2%	4.2%	4.2%
East Asia	China	Jiangxi	Xingan	2007	0.0%	4.3%	4.3%	4.3%
East Asia	China	Jiangxi	Gao'an	2007	0.0%	7.1%	7.1%	7.1%
East Asia	China	Yunnan	Lancang	2012	0.0%	7.1%	7.1%	7.1%
East Asia	China	Hainan	-	2012	N/A	11.2%	11.2%	11.2%
East Asia	China	Sichuan	Dechang	2011	N/A	11.4%	11.4%	11.4%
East Asia	China	Kunming	-	2008	0.0%	14.9%	14.9%	14.9%
East Asia	China	Sichuan	Mianning	2011	0.0%	15.3%	15.3%	15.3%
East Asia	China	Inner Mongolia	Shangdu	2010	0.0%	20.0%	20.0%	20.0%
East Asia	China	Yunnan	Jianchuan	2012	0.0%	27.5%	27.5%	27.5%
Southeast Asia	Malaysia	Kelantan, Terengganu, and Pahang	-	2014	0.0%	0.0%	0.0%	0.0%
Southeast Asia	Malaysia	Kuala Lumpur, Putrajaya, Selangor, and Negeri Sembilan	-	2014	0.0%	0.0%	0.0%	0.0%
Southeast Asia	Vietnam	Can Tho	-	2007	0.0%	0.0%	0.0%	0.0%
Southeast Asia	Vietnam	Dien Bien*	-	2015	0.0%	0.0%	0.0%	0.0%
Southeast Asia	Vietnam	Tien Giang*	-	2015	0.0%	0.0%	0.0%	0.0%

Legend: IABP region color

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 ISSN 2161-5546

***Table 1**: (cont.)*

GBD Region	Country	State	District	Year	TCO Blindness	non-TCO Blindness	Total CB	% Blindness attributed to corneal blindness not captured on RAAB front page
Southeast Asia	Thailand	-	-	2013	N/A	2.0%	2.0%	2.0%
Southeast Asia	Vietnam	Binh Duong*	-	2015	0.0%	2.0%	2.0%	2.0%
Southeast Asia	Vietnam	Ca Mau*	-	2015	0.0%	2.0%	2.0%	2.0%
Southeast Asia	Timor L'este	-	-	2016	0.0%	2.1%	2.1%	2.1%
Southeast Asia	Malaysia	Sarawak	-	2014	0.0%	2.4%	2.4%	2.4%
Southeast Asia	Vietnam	Phu Tho*	-	2015	0.0%	3.0%	3.0%	3.0%
Southeast Asia	Vietnam	Quang Tri*	-	2015	0.0%	3.0%	3.0%	3.0%
Southeast Asia	Vietnam	Binh Phuoc	-	2007	1.7%	1.7%	3.4%	1.6%
Southeast Asia	Vietnam	Hue	-	2007	0.0%	3.4%	3.4%	3.4%
Southeast Asia	Cambodia	Takeo	-	2012	0.6%	3.5%	4.1%	3.5%
Southeast Asia	Vietnam	Son La	-	2010	0.0%	4.4%	4.4%	4.4%
Southeast Asia	Malaysia	Johor and Melaka	-	2014	0.0%	4.5%	4.5%	4.5%
Southeast Asia	Vietnam	Hai Phong	-	2007	0.0%	4.6%	4.6%	4.6%
Southeast Asia	Vietnam	Thai Nguyen	-	2007	3.6%	1.8%	5.4%	1.9%
Southeast Asia	Vietnam	Binh Dinh	-	2007	0.8%	4.6%	5.4%	4.6%
Southeast Asia	Maldives	-	-	2016	0.0%	5.6%	5.6%	5.6%
Southeast Asia	Vietnam	Nam Dinh*	-	2015	1.8%	4.0%	5.8%	4.2%
Southeast Asia	Vietnam	Quang Nam	-	2011	0.0%	6.1%	6.1%	6.1%
Southeast Asia	Vietnam	Ha Tinh*	-	2015	3.3%	3.0%	6.3%	2.7%
Southeast Asia	Vietnam	Quang Ngai*	-	2015	3.4%	3.0%	6.4%	2.6%
Southeast Asia	Vietnam	Thanh Hoa	-	2011	1.0%	6.0%	7.0%	6.0%
Southeast Asia	Vietnam	Vung Tau*	-	2015	0.0%	7.0%	7.0%	7.0%
Southeast Asia	Vietnam	Gia Lai*	-	2015	0.0%	8.0%	8.0%	8.0%
Southeast Asia	Malaysia	Perlis, Kedah, Penang, and Perak	-	2014	0.0%	8.1%	8.1%	8.1%
Southeast Asia	Cambodia	-	-	2007	0.4%	8.0%	8.4%	7.6%
Southeast Asia	Vietnam	Nghe An	-	2012	0.5%	8.0%	8.5%	8.0%
Southeast Asia	Vietnam	Ho Chi Minh	-	2007	0.0%	9.8%	9.8%	9.8%
Southeast Asia	Vietnam	Bac Ninh*	-	2015	0.0%	10.0%	10.0%	10.0%
Southeast Asia	Vietnam	Tuyen Quang*	-	2015	6.1%	5.0%	11.1%	4.9%
Southeast Asia	Vietnam	Ha Tay	-	2007	7.5%	3.8%	11.3%	3.8%
Southeast Asia	Vietnam	Lao Cai	-	2007	7.1%	4.8%	11.9%	4.8%
Southeast Asia	Malaysia	Sabah and Labuan	-	2014	7.3%	5.5%	12.8%	5.4%
Southeast Asia	Vietnam	Ninh Thuan	-	2007	1.9%	13.0%	14.9%	12.9%
Southeast Asia	Vietnam	Lam Dong*	-	2015	6.5%	10.0%	16.5%	9.5%
South Asia	Bangladesh	Khulna	Narail	2010	0.0%	0.0%	0.0%	0.0%
South Asia	Bangladesh	Rajshahi	Natore	2009	0.0%	0.0%	0.0%	0.0%
South Asia	Nepal	Bagmati	-	2008	0.0%	0.0%	0.0%	0.0%
South Asia	Bangladesh	Khulna	Satkhira	2012	0.0%	1.0%	1.0%	1.0%
South Asia	Bhutan	-	-	2009	0.0%	1.5%	1.5%	1.5%
South Asia	Bangladesh	Dhaka	Gazipur	2010	0.0%	2.3%	2.3%	2.3%
South Asia	Bangladesh	Dhaka	Tangail	2011	0.0%	2.6%	2.6%	2.6%
South Asia	India	Karnataka	Kolar	2011	0.0%	2.6%	2.6%	2.6%
South Asia	India	Delhi	-	2014	N/A	3.1%	3.1%	3.1%
South Asia	Bangladesh	Barisal	Barisal	2013	0.0%	3.7%	3.7%	3.7%
South Asia	Nepal	Mechi	-	2009	0.0%	3.8%	3.8%	3.8%
South Asia	Nepal	Narayani	Rautahat	2008	N/A	4.0%	4.0%	4.0%
South Asia	Nepal	Dhaulagiri	-	2010	0.0%	4.8%	4.8%	4.8%
South Asia	Nepal	Karnali	-	2008	2.5%	2.5%	5.0%	2.5%
South Asia	Nepal	Sagarmatha	-	2009	0.0%	5.1%	5.1%	5.1%
South Asia	Bangladesh	Dhaka	Jamalpur	2010	0.0%	5.3%	5.3%	5.3%
South Asia	India	Maharashtra	Nandurbar	2009	3.0%	3.0%	6.0%	6.0%
South Asia	Nepal	Seti and Mahakali	-	2008	4.2%	2.8%	7.0%	2.7%
South Asia	Bangladesh	Chittagong	Brahmanbaria	2012	0.0%	7.1%	7.1%	7.1%
South Asia	Nepal	Koshi	-	2009	0.0%	7.4%	7.4%	7.4%
South Asia	Bangladesh	Chittagong	Cox's Bazar	2010	0.0%	7.8%	7.8%	7.8%
South Asia	Bangladesh	Dhaka	Kishoreganj	2010	0.0%	8.8%	8.8%	8.8%
South Asia	Nepal	Narayani	-	2015	0.0%	8.8%	8.8%	8.8%
South Asia	Bangladesh	Khulna	Kushtia	2009	2.3%	7.0%	9.3%	7.0%
South Asia	Nepal	Bheri	-	2009	0.0%	9.9%	9.9%	9.9%
South Asia	Nepal	Rapti	-	2010	0.0%	10.2%	10.2%	10.2%
South Asia	Nepal	Janakpur	-	2008	2.6%	7.7%	10.3%	7.7%
South Asia	India	Uttar Pradesh	Chitrakoot	2008	2.0%	12.2%	14.2%	12.3%
South Asia	Pakistan	FATA	Peshawar	2015	0.0%	14.6%	14.6%	14.6%
South Asia	India	Maharashtra	Sindhurg	2012	N/A	15.2%	15.2%	15.2%

Legend: IABP region color

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 ISSN 2161-5546

***Table 2**: CB not captured on RAAB front page*

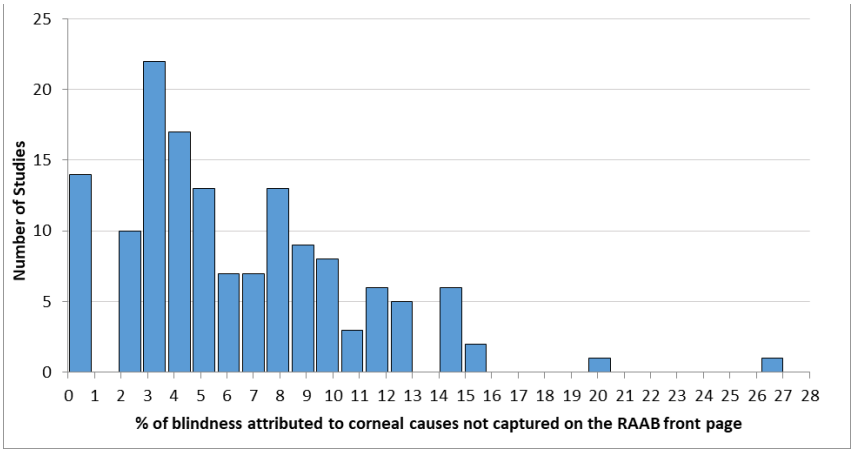

***Table 3**: Highest Prevalence*

GBD Region	Country	State	District	Year	TCO Blindness	non-TCO Blindness	Total CB
North Africa and Middle East	Palestine	-	-	2008	1.7%	14.2%	15.9%
Western Sub-Saharan Africa	Senegal	Fatick	-	2010	9.4%	6.8%	16.2%
Southeast Asia	Vietnam	Lam Dong*	-	2015	6.5%	10.0%	16.5%
Eastern Sub-Saharan Africa	Malawi	Southern Region	Blantrye, Chikwawa, Nsaje, Thyolo, Chiradzulu, Mwanza, and Neno	2009	4.4%	12.3%	16.7%
North Africa and Middle East	Iran	Tehran	Varamin	2009	2.4%	14.6%	17.0%
North Africa and Middle East	Iran	Kordestan	-	2014	9.7%	8.1%	17.8%
Western Sub-Saharan Africa	Nigeria	Sokoto	Sokoto	2016	8.0%	11.6%	19.6%
East Asia	China	Inner Mongolia	Shangdu	2010	0.0%	20.0%	20.0%
North Africa and Middle East	Afghanistan	Badakhshan	-	2010	17.4%	6.5%	23.9%
East Asia	China	Yunnan	Jianchuan	2012	0.0%	27.5%	27.5%

***Table 4**: Reporting of Corneal Blindness as Corneal Pathology*

Country/Year	State	District	% of Blind	% MSVI	Total Blindness Prevalence
India/2012	Maharashtra	Sindhudurg	3.0%	1.8%	4.8%
India/2014	Delhi		4.5	3.1	7.0
Qatar/2009			21.0	18.0	1.6

***Table 5**: Other Corneal Causes*

	# studies recording*	**Average % of recorded blindness**	**# studies reporting** ***	**Average % of reported blindness**
Onchocerciasis	109	0.5%	15	5.0%
Pterygium	20	0.6%	6	4.5%
Cataract Surgery Complications	142	2.9%	111	3.6%

*Recording: Studies that looked for blindness due to this cause
**Reporting: Studies that found at least one case of blindness due to this cause

 ISSN 2161-5546

DISCUSSION

These findings demonstrate that corneal blindness remains a significant portion of avoidable blindness worldwide, although not explicitly recognized as such within the RAAB reporting format. Generally, only TCO data was cited on the front page as a "main finding." Determining the prevalence of non-TCO blindness and vision impairment requires further examination within either the data or a published article. While trachoma, which does implicate the cornea, and is both preventable and treatable, has received global attention for being a major cause of avoidable blindness, our results affirm that trachoma is not the dominant cause of corneal blindness in most areas.

The RAAB's primary strengths are its ability to capture avoidable blindness, and the standardization of results which enables comparisons across study populations. Our findings illustrate the utility of RAAB studies for capturing within a given country, where corneal blindness prevalence may be concentrated according to a specific region or district. Such regional variations function as both a strength and a limitation of the RAAB instrument. While identifying regional differences is important for eye health system planning in these regions, the RAAB's conclusions cannot be extrapolated to the country's total population unless the study is a smaller part of a national survey.

The lack of information on corneal causes reflected as a main finding on the front page of the RAAB Repository is somewhat at odds with the RAAB objective of capturing causes of avoidable blindness. Regions with pressing need of corneal interventions are thus not as easily identified as they could be. The true prevalence of corneal blindness is likely also not entirely represented within the RAAB database, since we are not able to determine the proportion of corneal blindness implicated within the RAAB categories of pterygium, onchocerciasis, and cataract surgical complications. A lack of more specific corneal blindness data on the front page also implies that this category of avoidable blindness is not in itself a worthwhile global cause worthy of intervention. A further limitation of the RAAB is the exclusion of child populations. Depending on region and country, children may be equally or even more susceptible to vision loss from corneal conditions.[8]

Whether due to disease, injury, or surgical complications, all incidences of blindness where the cornea is implicated outside of trachoma could conceivably be represented in the non-TCO category. Since the RAAB already collects data on blindness and low vision due to non-TCO causes, it would be expeditious to add a category for non-TCO to the front page. Expanding the age groups captured in the current RAAB, would provide better data for child populations, however this would be a significant change to RAAB methodology. Such a major change might not be needed given there is a Trachoma Rapid Assessment that can be utilized with children; as well as the Key Informant (KI) system.[9] As designed, the ease and low cost of the RAAB lends itself to the potential for repeat trials at certain intervals, to capture trends.

As the RAAB design continue to evolve with successive revisions, a possible future enhancement could be an added element for capturing all corneal causes, perhaps a "RACC" or a RAAB-CC, for "corneal conditions" which is an analogous format to the existing RAAB-DR (diabetic retinopathy). Alternatively, we recommend that the RAAB reports corneal blindness as a separate category of blindness, by combining the TCO and non-TCO categories on the Front Page of each study. These could be abbreviated as "CB". The distinction between the two categories is useful to facilitate the distinction between trachoma prevention and the other treatment/prevention options for non-TCO, however since both categories of blindness are treatable with transplanted corneal tissue, the combined category would accurately present the data on people in need of treatment.

SUMMARY

The RAAB in its current form does not present study findings on corneal causes of blindness as a main finding on its front page. This erroneously gives rise to an implication that corneal blindness is not a global problem in need of attention. The inclusion of all corneal causes in one category on the main page of the current RAAB instrument, or even enhanced inclusion via modification would be useful for researchers, surgeons and eye banking systems to readily to identify and target specific areas where donor corneal tissue is required for the restoration of sight. In this manner the RAAB can continue to build on its utility and further help facilitate a significant facet of eye health services planning.

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 ISSN 2161-5546