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Trachoma: global magnitude of a preventable cause of blindness.

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Abstract

Objectives: Trachoma is the leading cause of infectious blindness worldwide. It is known to be highly correlated with poverty, limited access to health care services and water. In 2003 the WHO estimated that 84 million people were suffering from active trachoma and 7.6 million were severely visually impaired or blind as a result of trachoma: this study provides an updated estimate of the global prevalence of trachoma based on the most recent information available.

Methods: A literature search of recent published and unpublished surveys in the 57 endemic countries was carried out: the result of surveys that used the WHO trachoma grading system and additional information from regional and country experts served as basis to determine the prevalence of trachoma in each country.

Results: Population based surveys provided recent information for 42 out of 57 endemic countries. 40.6 million people are estimated to be suffering from active trachoma and 8.2 million are estimated to have trichiasis.

Conclusions: The current estimate of prevalence of trachoma is lower than the previous WHO estimates: this can be explained by the success in implementing control strategy, by more accurate data, as well as by socio-economic development in endemic countries.

Introduction

Trachoma is the leading cause of infectious blindness worldwide¹: it is caused by ocular infections with *Chlamydia Trachomatis* that might result in chronic inflammation of the eyelids. These infections occur mainly in children, peaking around age 1-5 and declining thereafter. This chronic inflammation of the eyelids produces scarring of the conjunctiva that can subsequently cause entropion trichiasis, resulting in inturned eyelashes. The inturned eyelashes as well as other alterations of the eye, such as lacrimal function and corneal limbus, harm the cornea causing severe pain, corneal opacity and consequent vision loss.²

The disease is known to be highly correlated with poverty, lack of personal and community hygiene, limited access to health care and water. It is prevalent in Africa, Asia and some parts of Latin America, the Middle East and the Western Pacific.³ Active trachoma affects mainly women and children, cicatricial trachoma affects on average women three times more than men likely secondary to their prolonged contact with infected children.^{4,5} In 2003 the WHO estimated that 84 million people were suffering from active trachoma and 7.6 million were severely visually impaired or blind as a result of trachoma.⁶

When visual impairment occurs during the productive years of life, it results in economic hardship for families and communities: it has been estimated that in countries ranked with a low Human Development Index (<http://hdr.undp.org/en/statistics/>) the disease could result in a total of 2.9 billion dollars in lost productivity each year.⁷

In 1997 the WHO established the Alliance for Global Elimination of Trachoma (GET) by the year 2020.⁸ The elimination strategy has been summarized with the acronym SAFE, which stands for Surgery for trichiasis, Antibiotics, Facial cleanliness and Environmental change, such as clean water and latrines.^{9,10}

This paper provides an updated estimate of the global magnitude of trachoma based on the most recent information available. The knowledge of the prevalence of trachoma at country and global level is essential for the planning and for the implementation of the interventions needed to eliminate this preventable cause of blindness and ultimately for the achievement of the WHO World Health Assembly Resolution for the Global Elimination of Trachoma by 2020 WHA 51:11 (available at <http://www.who.int/blindness/causes/WHA51.11/en/index.html>).

Methods

Epidemiological data

An extensive literature search was carried out for published and unpublished literature from the year 2000 onwards regarding the prevalence of trachoma in the 57 countries known to be endemic. Published data was searched using Medline with the keywords “trachoma prevalence” up to July 6th 2007. The studies selected were population based surveys that gave a description of sample design and plan, sample size, response rate and examination methods. Unpublished data was gathered in part during the Eleventh Meeting of the WHO Alliance for the Global Elimination of Trachoma by 2020¹¹ from the reports and presentations of country experts. Additional data was obtained by contacting experts from countries and regions or researchers in academic institutions.

The majority of the surveys used an established WHO protocol for sampling populations to determine prevalence of trachoma (available at http://www.who.int/blindness/prevalence_protocol_english.pdf). All surveys selected assessed trachoma using the simplified WHO trachoma grading system (www.WHO.int/Blindness/Causes/Priority/en/index2.html): Trachomatous Inflammation – Follicular (TF) was defined as the presence of five or more follicles in the upper tarsal conjunctiva; Trachomatous Inflammation – Intense (TI) was defined as pronounced inflammatory thickening of the tarsal conjunctiva that obscures more than half of the normal deep tarsal vessels; Trachomatous Trichiasis (TT) was defined as at least one eyelash rubbing on the eyeball. Active trachoma was defined as Trachomatous Inflammation – Follicular and/or Trachomatous Inflammation – Intense (TF/TI).

A database was created to record and analyse country specific data on prevalence of active trachoma and trichiasis.

Populations

Estimates of country population were based on the 2004 UN demographic assessment by the United Nations Population Division¹², urban and rural distribution from the UN World Urbanization Prospect.¹³ Population size and structure for districts, provinces or states within countries were based on country census when available or from other public domain sources (<http://www.geohive.com>, <http://world-gazetteer.com>).

Estimates of prevalence

Prevalence of active trachoma was estimated from the available data for children less than 10 years old. The prevalence of active trachoma for all ages was estimated using the model proposed at the WHO 2nd Global Scientific Meeting on Trachoma in 2003⁶ that was based on the results from the available data from countries and that has been validated in subsequent studies from Gambia¹¹, Ethiopia¹⁴ and Tanzania¹⁵. The model applies four correction factors to the prevalence of TF/TI <10 years to make projections for all ages (1.0, 1.1, 1.2, 1.3 to prevalence of <10%, 10-19%, 20-29%, \leq 30% respectively). The same model provides three correction factors to estimate the prevalence of trichiasis for all the population 14 years and older: 1.3 to be applied to the prevalence determined for women ages 14 and older; 1.05 to age-specific prevalence determined for both sexes over 30 and 1.1 to age-specific prevalence determined for both sexes over 40.

Prevalence was first determined at district level; the results from a single survey within a district were extrapolated to the entire district if it was considered representative and if it was known that the whole district was endemic. Prevalence estimated for one

district in a province/state was extrapolated to the whole province/state using analogous criteria.

The total number of cases of trachoma in the country was then estimated from the prevalence in districts, provinces or states; information from country experts was essential to identify the endemic areas and thus avoid over or underestimates. In few cases, national surveys were available (see Table 1).

In the case of countries missing data prevalence was estimated from the information in unpublished reports from Ministries of Health or from proxy countries chosen according to similarity of epidemiology and demographic structure..

Based on the prevalence of active trachoma and trichiasis the Ultimate Intervention Goals (UIG) for Antibiotics and for Surgery were estimated for each country. The UIG-A is the number of people to be treated with antibiotics. In low endemic districts, where prevalence of active trachoma is less than or equal to 10% it is the number of cases multiplied by a factor of 3 to include the average number of family members; in high endemic districts, prevalence higher than 10% UIG-A amount to all the population in the district. The ultimate intervention goal for trichiasis surgery UIG-S is to provide surgical interventions to all current estimated patients.

Results

For 42 countries out of the 57 known to be endemic for trachoma there were population based surveys or assessments consistent with the inclusion criteria for this study. Notably, 32 countries have carried out in the last 5 years national surveys or

surveys of entire endemic areas: among them the most populous of the endemic countries, China, India and Nigeria.

For 11 of the known endemic countries (Benin, Botswana, Cote d'Ivoire, Guatemala, Iraq, Libyan Arab Jamahiriya, Namibia, Papua New Guinea, Somalia, Togo, and Zimbabwe) there were no surveys conducted in the last 15 or 20 years; for 4 countries (Algeria, Central African Republic, Djibouti, and Lao's People Democratic Republic) the information was prior to the year 2000. In these 15 countries the estimated population living in endemic areas for trachoma is 58 million, only 22% of the total population. The available studies for 42 countries are shown in Table 1 (for the bibliography see

http://www.who.int/blindness/publications/references/en/trachoma_08.pdf).

Table 2 shows for the 57 endemic countries the estimated population living in endemic areas, the number of people with active trachoma and trichiasis (*italics indicate countries for which prevalence was estimated on proxy countries or on other assumptions because of the lack of recent, population-based data*).

Globally 1.2 billion people live in endemic areas, 40.6 million people are suffering from active trachoma and 8.2 million have trichiasis. 48.5 percent of the global burden of active trachoma is concentrated in five countries: Ethiopia, India, Nigeria, Sudan and Guinea. On the other hand, fifty percent of the global burden of trichiasis is concentrated in only three countries: China, Ethiopia and Sudan.

Overall, Africa is the most affected continent. 27.8 million cases of active trachoma (68.5% of all) and 3.8 million cases of trichiasis (46.6% of all) are located in 28 of the 46 countries in the WHO African Region, with an estimated population of 279

million living in endemic areas. The disease is still prevalent in some countries or areas of countries of four other WHO regions: the Eastern-Mediterranean (12 countries, population in endemic areas 144 million), the Western Pacific (11 countries, population in endemic areas 400 million), the South-East Asia (3 countries, population in endemic areas 362 million) and the Americas (3 countries, population in endemic areas 58 million). The European region is the only WHO region to be free of trachoma. According to these estimates, the ultimate intervention goals require antibiotic treatment for some 340 million people and trichiasis surgeries for 8.2 million people. Trichiasis however continues to occur in adults exposed to trachoma in the past: the UIG for trichiasis surgery determined in this paper does not make projections on the incident cases and is therefore an underestimate.

Discussion

Limitations

The estimates presented in this paper are based partly on population-based surveys and assessments and partly on assumptions and projections. Each of these sources can introduce errors on the final estimates due to the following factors:

Heterogeneity of sampling and examination methods despite the use of the same WHO protocol; use of a model to estimate prevalence of active trachoma and trichiasis for all ages and for both sexes; assumptions on the prevalence and geographical distribution of trachoma to extrapolate data from communities to districts, from districts to provinces/states and from states/provinces to countries; assumptions to extrapolate prevalence from proxy countries to countries missing data.

To minimize the bias introduced by the limitations above, studies were chosen only if they were consistent with the selection criteria. The projections for all ages and

sex were compared to the results from studies that reported age and sex specific data and were found to be consistent. All extrapolations made for countries or areas within a country were based on information from country experts or academic researchers.

Given the heterogeneity of the data and in some cases the non-reporting of the confidence intervals of the studies, it was not possible to determine the extent of uncertainty of the estimates at global level.

Estimated prevalence of active trachoma and trichiasis

The estimate of 40 million cases of active trachoma presented in this paper is significantly lower than the previous WHO estimate of 84 million made in 2003.⁶ This difference can be attributed to previous overestimations for China and India, but it is also due to declines in prevalence attributable to stable socio-economic development in some countries and in the success of current interventions in other countries where development is still lagging.

In China and in India reassessment of prevalence was conducted recently. The estimate made in 2004 for China of 26 million cases of active trachoma was based on partial and probably dated figures from the endemic provinces: current estimates are based on population based assessments conducted in ten provinces in 2005, Beijing, Sichuan, Yunnan, Qinghai, Chongqing, Shanxi, Zhanjiang, Neimeng, Hainan and Hebei. The standardized prevalence of active trachoma for these provinces was 2.34% in children aged 10 years and younger. In the absence of data suggesting active trachoma or trichiasis in other provinces, the prevalence was applied only to the population in these

provinces. The number of 1.3 million cases of active trachoma therefore could be a conservative estimate.

In India, the previous estimate for 2004 was based on extensive surveys conducted in 1989 in 15 states and one pilot study conducted in 1995. According to the pilot study there was a 25% reduction in prevalence of trachoma in India since 1989. Applied to the prevalence values of 1989, this reduction resulted in an estimated 20 million cases of active trachoma. The current estimate is based on the population based assessments conducted in 2006 in 5 States, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, Haryana, and Gujarat that were identified as possibly the only endemic areas in the country. The assessments showed an average prevalence of active trachoma of 6% in children under 10 years of age resulting in 4.5 million cases when applied to the 5 endemic States.

Trichiasis is perhaps the most important measure of the severity of the disease because of increased risk of visual impairment. The present estimate of 8.2 million cases of trichiasis exceeds the estimated 7.6 million in 2004: this increase is due to a revision of the estimates according to new available data.

Conclusion

Despite the limitations, this study represents an updated global estimate of trachoma. It is clear that trachoma remains an important public health concern with millions still suffering from an eliminable disease. This study also shows that trachoma remains endemic in many parts of Africa, and Asia and still affects many in Latin American and the Middle East, highlighting the needs and gaps in the provision of

services. Obtaining the ultimate intervention goals for antibiotic treatment and trichiasis surgeries clearly will require calling for action to governments, NGOs, private sectors and all other health professionals. The SAFE integrated approach recommended by WHO to reach elimination of trachoma by the year 2020 must continue to be implemented and expanded, targeting social development along with health care interventions.

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Table 1. Available studies on the prevalence of trachoma: 1996 to 2007

country	date of survey	location	type of survey	age group	sources
Afghanistan	2006	4 provinces	door to door assessment	all ages	Comprehensive Eye Care Program, Ministry of Public Health Afghanistan
Australia	1997-2003	Aboriginal and Torres Strait Islander communities	screening in schools and in remote communities, clinical assessments	all ages	Mak DB et al., The Office for Aboriginal and Torres Strait Islander Health, Australian Government Department of Health
Brazil	2003-2006	13 States	school screening	1-9	Trachoma Control Program, Health Surveillance Secretariat, Brazil Ministry of Health
Burkina Faso	2005	Bugondè, Diapaga districts	population based survey	1-9 15 and older	Programme National de Prévention de la Cécité, Ministry of Health, Burkina Faso
Cambodia	2000	6 endemic regions	trachoma rapid assessment	0-14 40 and older	National Prevention of Blindness Program, National Program for Eye Health, Ministry of Health, Cambodia
Cameroon	2006	Kolofata district, Far North Province	population based survey	1-10 women over 14	Einterz EM et al. 2008
Chad	2001-2005	8 Provinces	population based survey	1-10 women over 14	Dézoumbé D. et al. 2007, Programme National de lutte contre la cécité, Ministry of Health, Republic of Chad
China	2003-2006	10 Provinces	trachoma rapid assessment	1-9 40 and older	National Programme for Prevention of Blindness, Ministry of Health, China
Egypt	2001	Menofiya Governorate	population based survey	2-6 50 and older	Gamal Ezz al Arab et al. 2001
Eritrea	2006	3 endemic regions: North Red Sea, Debub, Gash Barka	population based survey	1-9 15 and older	Blindness Prevention Program, Ministry of Health of the State of Eritrea
Ethiopia	2005-2006	all regions of the country	population based survey	all ages	Berhane Y et al. 2006, Federal Ministry of Health of Ethiopia
Gambia	2006	North Bank, Lower River	population based survey	0-9	Prevention of Blindness Program, Ministry of Health, Gambia
Ghana	2000-2003	Northern Region, Upper West Region	population based survey	1-10 40 and older	National Eye Care Programme, Ministry of Health, Ghana
Guinea	2001-2002	Upper and Middle Guinea	population based survey and assessment	0-10 women over 14	Programme de lutte contre la cécité, Ministry of Health, Guinea

Guinea-Bissau	2005	whole country	population based survey	all ages	Prevention of Blindness and Deafness, Ministry of Public Health, Republic of Guinea-Bissau
India	2006	Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, Haryana, Gujarat	trachoma rapid assessment	<10 15 and older	Directorate General of Health Services, Ministry of Health and Family Welfare, India
Iran (Islamic Republic of)	2002	4 Provinces in the south	trachoma rapid assessment	all ages	Ministry of Health and Education,
Kenya	2004	5 endemic districts in Rift Valley Province and 1 in Eastern Province	population based survey	1-9 15 and older	Karimurio J et al. 2006
Malawi	2002-2003	Salima and Chikwana districts (Central and South Provinces)	trachoma rapid assessment	5-9 and 0-9	National Programme for Prevention of Blindness, Ministry of Health, Malawi
Mali	1996 and 2005-2006	all endemic regions	population based survey	0-9 15 and older	Programme national de lutte contre la cécité, Ministry of Health, Mali
Mauritania	2004	national survey	population based survey	1-9 14 and older	Programme national de lutte contre la cécité, Ministry of Health, Mauritania
Mexico	2006	Chiapas	surveillance house to house	all ages	State Institute of Health, Chiapas, Mexico
Morocco	2004	5 endemic regions	community based surveillance	all ages	Programme national de lutte contre la cécité, Ministry of Health, Kingdom of Morocco
Mozambique	2002	Northern Manica Province	population based survey	1-9 40 and older	National Programme for Prevention of Blindness, Ministry of Health, Mozambique
Myanmar	2006	Meiktila District	population based survey	40 and older	Durkin SR et al. 2007
Nepal	1996-2002 2003, 2006	several endemic districts	population based survey and trachoma rapid assessment	all ages	National Trachoma Program, Ministry of Health and Population, Nepal
Niger	2001-2006	several districts in the Zinder, Maradi and Diffa regions	population based survey	1-9 15 and older	Programme national de lutte contre la cécité, Ministry of Public Health, Republic of Niger and Abdou A et al. 2007
Nigeria	2005-2006	8 endemic regions	population based survey	1-9 15 and older	National Programme for Prevention of Blindness, Ministry of Health, Nigeria
Oman	2005	3 regions: Dhakhiliya, North Sharqiya, South Batinah	population based survey	1-5	Khandekar R. et al. 2006
Pacific Islands Subregion		Kiribati, Nauru, Solomon Islands, Vanuatu, Fiji	trachoma rapid assessment	1-10 40 and older	Mathew A et al. 2007

Pakistan	2004	All four provinces and in the Northern Area	door to door assessment	all ages	Prevention and Control of Blindness Programme, Ministry of Health, Government of Pakistan
Senegal	2000-2004	whole country and Thiès Region	population based survey	1-9 women over 14	Saal MB et al. 2003 and Programme National de Lutte contre la Cécité, Ministry of Health, Senegal
Sudan	2003, 2005-2006	Eastern Equatoria, Upper Nile, Unity, Northern, Kassala and Khartoum States	population based survey	1-9 15 and older	Ngondi J et al 2005, 2006 and Prevention of Blindness Administration Federal Ministry of Health, Sudan
Tanzania (United Republic of)	2004-2006	50 districts in endemic regions	population based survey	1-9 15 and older	National Eye Care Program, Ministry of Health and Social Welfare, United Republic of Tanzania
Uganda	2006	3 districts in the Northern and Eastern regions	population based survey	1-9 15 and older	National Programme for Prevention of Blindness, Ministry of Health, Uganda
Viet Nam	2001, 2006	districts in the northern provinces	school based assessment and population based survey	1 - 5 35 and older	National Programme for Prevention of Blindness, Ministry of Health Viet Nam and Khandekar R et al. 2006
Yemen	2004	9 Governorates and Socotra Island	trachoma rapid assessment	1-9	Al Khatib TK et al. 2006
Zambia	2001-2003	Gwembe District, Southern Region	exhaustive screening of population in chosen villages	all ages	Astle WF et al. 2006

Table 2. Estimated Active Trachoma and Trachomatous Trichiasis in endemic countries in 2007 from available data.

Country	Country population in 2004 (millions)	Population living in endemic areas (millions)	Cases of TF/TT in endemic areas (thousands)	Cases of TT in endemic areas (thousands)
Afghanistan	28.57	9.80	190.8	83.1
Algeria	32.36	2.83	146.7	86.7
Australia	19.94	0.12	7.3	1.1
Benin	8.18	1.27	111.2	7.6
Botswana	1.77	0.20	17.6	32.9
Brazil	183.91	58.00	574.5	58.0
Burkina Faso	12.82	12.82	553.1	32.8
Central African Republic	3.99	0.20	26.5	1.0
Cambodia	13.80	4.43	503.3	29.2
Cameroon	16.04	4.55	366.2	47.2
Chad	9.45	4.78	607.7	34.3
China	1315.41	364.38	1,267.0	2,330.6
Cote d'Ivoire	17.87	6.10	510.8	59.9
Djibouti	0.78	0.78	4.7	3.9
Egypt	72.64	3.61	393.1	35.4
Eritrea	4.23	4.23	130.1	42.0
Ethiopia	75.60	75.60	9,935.2	1,272.6
Fiji	0.84	0.84	18.9	0.8
Gambia	1.48	1.20	27.1	10.5
Ghana	21.67	2.72	133.1	3.0
Guatemala	12.29	0.25	0.2	0.03
Guinea	9.20	3.00	323.3	25.1
Guinea-Bissau	1.54	1.54	118.7	16.4
India	1087.12	328.18	4,450.2	443.0
Iran (Islamic Republic of)	68.80	8.81	0.0	49.3
Iraq	28.06	22.03	719.4	43.9
Kenya	33.47	15.95	1,535.0	306.8
Kiribati	0.10	0.10	8.6	0.1
Lao People's Democratic Republic	5.79	0.50	24.1	0.9
Libyan Arab Jamahiriya	5.74	0.42	20.9	13.2
Malawi	12.61	9.53	608.7	33.4
Mali	12.12	9.12	676.7	67.6
Mauritania	2.98	1.64	43.8	2.5
Mexico	105.70	0.13	0.1	0.02
Morocco	31.02	1.18	3.9	6.4
Mozambique	19.42	7.85	879.2	60.5
Myanmar	50.00	17.40	68.9	65.8
Namibia	2.01	0.80	30.5	6.1
Nauru	0.013	0.013	0.7	0.0
Nepal	26.59	16.53	513.5	138.8
Niger	13.50	13.50	1,799.0	59.6
Nigeria	128.71	50.82	3,252.5	627.3
Oman	2.53	0.07	0.2	0.6
Pakistan	154.79	51.00	800.6	71.7
Papua New Guinea	5.77	5.77	16.8	5.8
Senegal	11.39	11.4	260.5	129.8
Solomon Islands	0.47	0.47	32.5	0.5
Somalia	7.96	5.16	18.1	10.3

Sudan	35.52	21.00	1,773.4	528.1
Tanzania (United Republic of)	37.63	12.56	1,220.8	214.8
<i>Togo</i>	5.99	1.83	22.5	2.9
Uganda	27.82	11.65	2,436.1	610.6
Vanuatu	0.21	0.21	14.1	0.2
Vietnam	83.12	23.29	919.3	210.0
Yemen	20.33	20.33	468.0	270.8
Zambia	11.48	1.98	388.3	8.5
<i>Zimbabwe</i>	12.94	9.70	1,669.5	44.1
all endemic countries		1,244.17	40,643.5	8,248.2

