

# Mapping the Burden of Visual Impairment Due to Onchocerciasis Infection in Central Africa from 1990 to 2019

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## Background

Human onchocerciasis, also known as river blindness, mainly occurs (more than 99% of infected people globally) in 31 countries of the tropical areas of sub-Saharan Africa. The disease is transmitted by the bite of a black fly of the species *Simulium* and caused by infection from the filarial nematode (roundworm), *Onchocerca volvulus*. It is responsible for permanent blindness and one of the tropical, traveling diseases prioritized by the World Health Organization (WHO) for prevention and control. To eliminate *onchocerciasis*-associated blindness, it is important to identify areas where there is still high ongoing disease burden. Although the recent study has emerged highlighting the prevention and overall burden of *onchocerciasis* in Africa,<sup>1,2</sup> there is no evidence on the prevalence and burden of *onchocerciasis*-associated blindness and vision loss (BVI) as well as its severity throughout this region in detail.

## Methods

In order to fill these gaps, global burden of disease 2019 (GBD 2019) dataset, which provided cause-specific BVI data in the Global Health Data Exchange (<http://ghdx.healthdata.org/gbd-results-tool>), was used to map the regional and national burden of BVI from 1990 to 2019. The regional prevalence and years lived with disability (YLDs) of BVI attributable to *onchocerciasis* were reported for the African region, using the methodological framework and analytical strategies adopted by GBD 2019.<sup>3–5</sup> The present study used the data on number (thousand), and age-standardized rate (ASR, per 100,000) of BVI prevalence and YLDs estimates to assess the burden. The estimates were all reported as counts, and age-standardised rates, along with their corresponding 95% uncertainty intervals (UIs). Also, the average annual percentage changes (AAPC) with its 95% confidence interval (95% CI) were used to represent the trends of ASR. If the AAPC value as well as its 95% CI are all higher or lower than 0, it will be identified as statistically significant.

## Results

In 2019, the highest number of BVI attributable to *onchocerciasis* were observed in the Western Sub-Saharan Africa region, with an estimated 446.7 thousand BVI (95% UI: 392.3 to 508.7) and 35.3 thousand YLDs (95%UI: 24.6 to 49.5), which were decreased by 36% and 43% compared with 1990, respectively. The highest ASR of prevalence and YLDs of BVI were 588.2 (95%UI: 518 to 670.1) and 41.1 (95%UI: 28.2 to 57) in Central Sub-Saharan Africa in 2019, respectively. During past three decades, the ASR of prevalence and YLDs of BVI attributable to *onchocerciasis* decreased largely with AAPC of  $-3.95$  (95% CI:  $-4.16$  to  $-3.74$ ) and  $-4.39$  (95% CI:  $-4.77$  to  $-4$ ) in the Western Sub-Saharan Africa region, respectively (Table 1). The ASR of prevalence and YLDs in males was higher than that in females, and both the highest prevalence and YLD rates were found in the 65–69 age groups in 2019. At national level, South Sudan (2606.1, 95%UI: 2343.7 to 2893.8) and Niger (0.2, 95%UI: 0.2 to 0.3) had the highest and lowest ASR of BVI related prevalence attributable to *onchocerciasis* in 2019, respectively (Figure 1A). In terms of burden, South Sudan (220, 95%UI: 153.7 to 308.2) also had the highest ASR of YLD on *onchocerciasis* related BVI (Figure 1B). During study period, only South Sudan (AAPC: 0.67, 95% CI: 0.55 to 0.79) and Chad (AAPC: 0.58, 95% CI: 0.37 to 0.78) had increasing trends of ASR of prevalence. Cote d'Ivoire, Guinea-Bissau, Burkina Faso, Niger, Mali were top five countries with decreasing trends of prevalence (Figure 1C). In terms of YLDs, only South Sudan showed upward trends (AAPC: 0.41, 95% CI: 0.27 to 0.55). Furthermore, Cote d'Ivoire, Guinea-Bissau, Burkina Faso, Niger, and Ghana were top five countries with downward trends of YLDs (Figure 1D). In 2019, South Sudan had the highest ASR of prevalence and YLD of moderate, severe vision loss, and blindness, respectively.

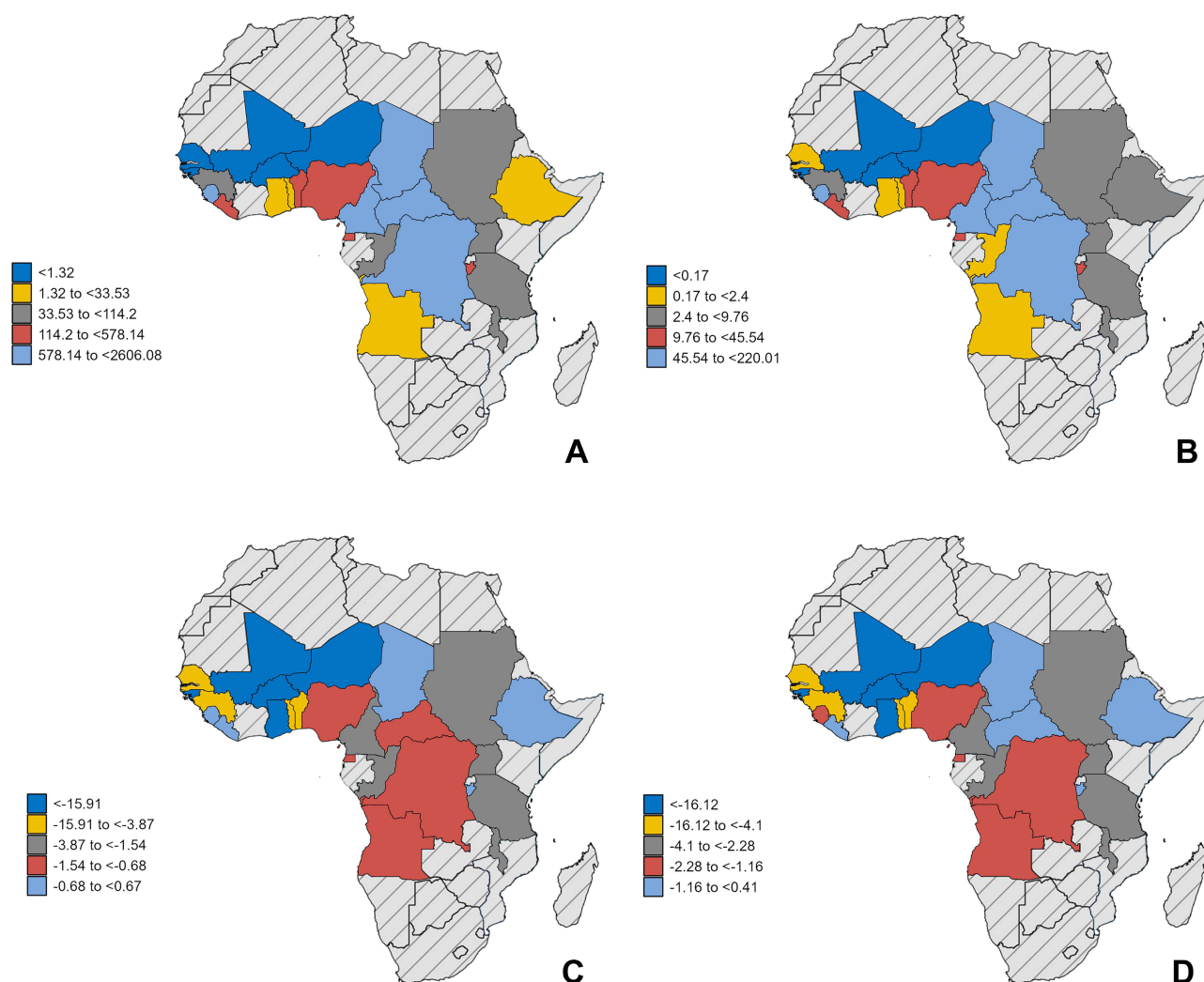
## Discussion

In recent decades, through vector control (larviciding) and using mass drug administration (MDA) with ivermectin, such as the Community-Directed Treatment with Ivermectin (CDTI) strategy,<sup>6</sup> and alternative treatment strategies (ATS) including ground larviciding,<sup>7</sup> there was a significant reduction in the age-standardised prevalence and YLD rate of BVI attributable to *onchocerciasis* over the period 1990 to 2019 in Africa, particularly in Western Sub-Saharan Africa region. This is in accordance with a regional reduction in the *onchocerciasis* infection over the last two decades throughout western and central Africa.<sup>1</sup> Due to the major public health concern on *onchocerciasis*, large-scale control programmes were performed previously with strategies for its control and prevention while in recent years strategies have been directed at its elimination. The Onchocerciasis Control Programme (OCP) aerial larviciding, the African Programme for Onchocerciasis Control (APOC) by Ivermectin mass drug administration (MDA), and alternative treatment strategies including enhanced community-directed treatment with ivermectin (CDTI), community-directed treatment (CDT) with drug combinations or new drugs and test-and-treat (TNT) strategies led to the control of *onchocerciasis* as a public health problem. Notably, Western Sub-Saharan Africa had the largest number of cases, while Central Sub-Saharan Africa had the highest ASR of disease burden. Moreover, there were also age, and gender differences in *onchocerciasis*-related BVI burden. Males with higher disease burden may be related to more involved in outdoor activities, exposing themselves to infective blackfly bites. Therefore, improved protection and ivermectin treatments should be performed for males. It is interesting that both the ASR of prevalence and YLDs increased with age, indicating that improved, longitudinal intervention strategies might overcome the disease burden. In 2019, the proportion of all BVI attributable to *onchocerciasis* varied markedly by country (from 0.2 to 2601.1). South Sudan had the highest burden in 2019 and faster annual increases in BVI due to *onchocerciasis*. This may be related to the lower ivermectin treatment coverage, the existence of abundant breeding sites of biting black flies in central Africa, and long-standing civil strife for several years. However, previous estimates showed particularly high burden in the Congo according to Rapid Epidemiological Mapping of Onchocerciasis (REMO) data. The African Programme for Onchocerciasis Control (APOC) or preventive chemotherapy with MDA are important for the control of *onchocerciasis* and elimination of transmission.<sup>2</sup> Potential limitations related to *onchocerciasis* estimated in GBD studies were described previously, including coverage rate, data quality and availability. Further well-designed and population-based study are still needed to estimate the disease burden.

**Table 1** Burden of Blindness and Vision Loss Attributable to Onchocerciasis in Africa Region from 1990 to 2019

	1990 Counts (Thousand)	Age-Standardised Rate (per 100000 Population), 1990	Crude Rate (per 100000 Population), 1990	2019 Counts (Thousand)	Age-Standardised Rate (per 100000 Population), 2019	Crude Rate (per 100000 Population), 2019	Average Annual Percent Change	% Change in Number Between 1990 and 2019
<b>Prevalence</b>								
Central Sub-Saharan Africa	185.7 (164.7 to 209.8)	819.5 (729.6 to 919.1)	334.6 (296.7 to 377.8)	317.8 (278.9 to 362.1)	588.2 (518 to 670.1)	241.6 (212 to 275.2)	-1.13 (-1.17 to -1.09)	0.71 (0.64 to 0.78)
Eastern Sub-Saharan Africa	101.6 (91.5 to 111.5)	114.3 (103 to 125.9)	53.4 (48.1 to 58.7)	169 (151.5 to 186.7)	90 (80.6 to 99.9)	41 (36.8 to 45.3)	-0.79 (-0.94 to -0.64)	0.66 (0.61 to 0.72)
North Africa and Middle East	13.9 (12.4 to 15.5)	6.6 (5.8 to 7.4)	4 (3.6 to 4.5)	11.8 (10.5 to 13.2)	2.3 (2.1 to 2.6)	1.9 (1.7 to 2.2)	-3.42 (-3.92 to -2.92)	-0.15 (-0.19 to -0.11)
Western Sub-Saharan Africa	694.3 (624.5 to 766.4)	693.2 (625.8 to 767.8)	360.5 (324.3 to 397.9)	446.7 (392.3 to 508.7)	214.7 (187.6 to 245.8)	97.9 (86 to 111.5)	-3.95 (-4.16 to -3.74)	-0.36 (-0.39 to -0.32)
<b>YLDs</b>								
Central Sub-Saharan Africa	14.4 (10 to 20.2)	61.9 (43.4 to 85.5)	26 (18.1 to 36.4)	22.9 (15.8 to 32)	41.1 (28.2 to 57)	17.4 (12 to 24.3)	-1.39 (-1.46 to -1.32)	0.59 (0.51 to 0.67)
Eastern Sub-Saharan Africa	9.8 (6.8 to 13.9)	11 (7.6 to 15.5)	5.2 (3.6 to 7.3)	14.5 (10.1 to 20.3)	7.7 (5.3 to 10.7)	3.5 (2.4 to 4.9)	-1.2 (-1.38 to -1.02)	0.47 (0.4 to 0.55)
North Africa and Middle East	1.4 (0.9 to 2)	0.6 (0.4 to 0.9)	0.4 (0.3 to 0.6)	1 (0.7 to 1.5)	0.2 (0.1 to 0.3)	0.2 (0.1 to 0.2)	-3.87 (-4.4 to -3.35)	-0.25 (-0.35 to -0.15)
Western Sub-Saharan Africa	62.1 (43.2 to 87.5)	61.9 (43 to 86.7)	32.2 (22.4 to 45.5)	35.3 (24.6 to 49.5)	16.7 (11.6 to 23.4)	7.7 (5.4 to 10.8)	-4.39 (-4.77 to -4)	-0.43 (-0.46 to -0.4)

**Abbreviation:** YLDs, years lived with disability.



**Figure 1** Regional map of onchocerciasis-related vision impairment burden. Geographic distribution of age-standardized prevalence (per 100,000 population) in nations with onchocerciasis-related vision impairment in 2019 (**A**); geographic distribution of age-standardized years lived with disability (YLDs, per 100,000 population) in nations with onchocerciasis-related vision impairment in 2019 (**B**); average annual percentage changes (AAPC) of age-standardized prevalence in nations with onchocerciasis-related vision impairment from 1990 to 2019 (**C**); AAPC of age-standardized YLDs in nations with onchocerciasis-related vision impairment from 1990 to 2019 (**D**).

## Conclusions

In sum, the ASR of prevalence and YLDs of *onchocerciasis*-related BVI in the African region have decreased over the past three decades. Closer prenatal monitoring is recommended for countries and territories, particularly those countries with higher disease burden. Further reduction can be facilitated by policy interventions targeted on the improvement of ivermectin treatment coverage, the landscape as well as living environment, and increasing public awareness.

## Abbreviation

BVI, blindness and vision loss; GBD, global burden of disease; YLDs, years lived with disability; MDA, mass drug administration; CDTI, Community-Directed Treatment with Ivermectin; REMO, Rapid Epidemiological Mapping of Onchocerciasis; APOC, African Programme for Onchocerciasis Control; ASR, age-standardized rate; UIs, uncertainty intervals; AAPC, average annual percentage changes; CI, confidence interval.

## Data Sharing Statement

The data that support the findings of this study are available from the Global Health Data Exchange (<http://ghdx.healthdata.org/gbd-results-tool>), which were used under license for this study, and so are publicly available. All data associated with this paper will be made available upon reasonable request from corresponding author (LL).

## Ethics Approval and Consent to Participate

The protocol for this study was approved by the Research Ethics Committee of the Guangdong Provincial People's Hospital (KY-Q-2022-495-01).

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## Disclosure

The authors declare that they have no competing interests.

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