Viewpoints



African Programme for Onchocerciasis Control 1995– 2015: Updated Health Impact Estimates Based on New Disability Weights

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Viewpoint

Since 1995, the African Programme for Onchocerciasis Control (APOC) has coordinated mass treatment with ivermectin in 16 sub-Saharan countries (Angola, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, Liberia, Malawi, Nigeria, North Sudan, South Sudan, Uganda, and the United Republic of Tanzania) with the aim to control morbidity due to infection with Onchocerca volvulus, a filarial nematode. Recently, we predicted trends in prevalence of infection, visual impairment, blindness, and troublesome itch due to onchocerciasis in APOC countries for the period 1995-2015, based on extensive data on pre-control infection levels, population coverage of ivermectin mass treatment, and the association between infection and morbidity [1]. We also estimated the associated health impact, expressed in disability-adjusted life years (DALYs). However, the estimated health impact was based on disability weights from the 2004 update of the Global Burden of Disease (GBD) study [2], which have been criticized for being based solely on the opinions of health professionals [3,4]. The recently published GBD 2010 study addressed this criticism by providing updated disability weights based on household surveys in Bangladesh, Indonesia, Peru, and Tanzania, an open internet survey, and a telephone survey in the United States [5]. As a result of this populationbased approach, the disability weights for visual impairment, blindness, and troublesome itch have changed considerably and should better reflect our ideas and beliefs as a society of what constitutes health. For future reference, we provide an updated estimate of the health impact of APOC activities, based on previously predicted trends in averted number of cases with infection and morbidity, but using updated disability weights for visual impairment, blindness, and troublesome itch.

Identical to previously used methods [1], we calculated the health impact of APOC for each year between 1995 and 2015, expressed in DALYs averted. The DALY metric is the sum of years of life lost (YLL) due to premature mortality (from blindness) and years lived in disability (YLD), weighted by a disability weight representing the loss of quality of life [5]. DALYs averted were calculated as the difference between two scenarios: a factual scenario in which APOC activities have taken place as documented, and a counterfactual scenario in which APOC activities have not taken place at all, effectively translating to $DALY_{averted} = \Delta YLL_{blindness}$ $+ \Delta YLD_{blindness} + \Delta YLD_{visual impairment} +$ ΔYLD_{itch} . Here, $\Delta YLL_{blindness}$ is the averted number of YLL related to premature mortality from blindness (as previously estimated [1]), and ΔYLD_x is the averted number of YLD due to symptom *x*. Averted YLD were calculated as $\Delta YLD_x = \Delta N_x \cdot dw_x$, where ΔN_x is the averted number of person-years of symptom *x* (i.e., difference in annually prevalent cases between the factual and counterfactual scenarios, as previously estimated [1]), and dw_x is the associated updated disability weight, derived from the GBD 2010 study [5].

Compared to previous disability weights [2], updated weights were considerably lower for visual impairment (0.033, previously 0.282) and blindness (0.195, previously 0.594), reflecting that the loss in quality of life because of these manifestations is considerably lower than previously assumed. On the contrary, the disability weight for troublesome itch has increased (0.108, previously 0.068). The disability weight for visual impairment represents "moderate visual impairment" in the GBD 2010 study. The updated disability weights do not include a category for itch alone. Hence the disability weight for troublesome itch was derived from a

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Competing Interests: The International Bank for Reconstruction and Development/World Bank serves as Fiscal Agent to WHO APOC through its fiduciary oversight of the APOC Trust Fund and contributed to this paper through its work with the APOC secretariat in the maintenance of accurate financial records. The findings, interpretations and conclusions expressed in this paper do not necessarily reflect the views of the World Bank. Furthermore, HGMZ, KBA, MN, GF, and UVA are or have been employees of the African Programme for Onchocerciasis Control (APOC), World Health Organization. The authors state that their employment has not caused any conflict of interest in any of the following: study design, data collection, data analysis, interpretation, decision to publish. This does not alter our adherence to all PLOS policies on sharing data and materials.

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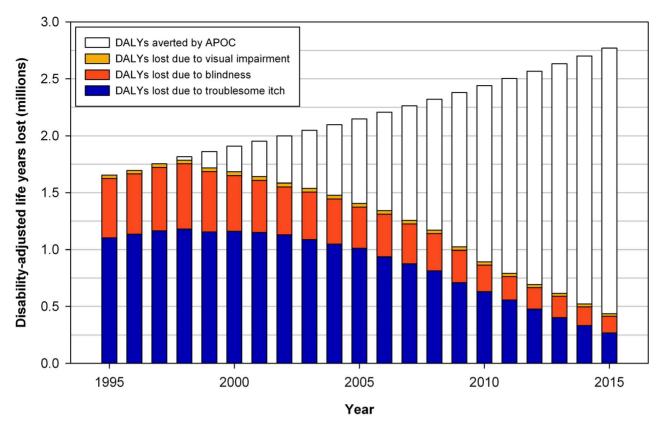


Figure 1. Disability-adjusted life years (DALYs) lost due to onchocerciasis from 1995 to 2015. The total height of the bars (colored plus blank) represents the estimated number of DALYs lost in a counterfactual scenario without ivermectin mass treatment (increasing trend due to population growth). The colored part of each bar represents the estimated actual number of DALYs lost (declining trend due to ivermectin mass treatment). The blank part of each bar therefore represents the annual number of DALYs averted by ivermectin mass treatment in the total APOC population.

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generic class of disability weights for "disfigurement with itch or pain." This class consists of three severity levels, characterized as "causing some worry and discomfort" (disability weight 0.029), "a person having trouble concentrating and sleeping" (disability weight 0.187), and "causing a person to avoid social contact, feel worried, sleep poorly, and think about suicide" (disability weight 0.562). Based on original precontrol data from a previously published, multicountry study [6] (excluding data from Ghana and Cameroon, which were collected based on convenience sampling rather than household surveys), we assumed that onchocercal itch regularly causes insomnia in about half of the cases and, therefore, calculated YLD due to itch using the mean of the disability weights for the first two severity levels (0.108). We assumed that this disability weight also applies during ivermectin mass treatment, even though the fraction of insomniacs among cases of itch might decrease with repeated mass treatments (due to lower infection loads and consequent lower severity of itch). Unfortunately, previous studies on trends of onchocercal itch during ivermectin mass treatment do not report on insomnia [7,8]. Therefore, if anything, we may be underestimating the impact of ivermectin mass treatment on the burden of itch (and the associated DALYs averted).

Figure 1 illustrates trends in DALYs lost due to troublesome itch, visual impairment, and blindness, and DALYs averted by APOC. Table 1 gives more detailed information on the number of prevalent cases (according to the factual scenario) and DALYs lost and averted per year. For onchocercal visual impairment and blindness, the updated estimates of the averted burden turned out lower than the previous estimates. In contrast, for troublesome itch, the updated estimate of the burden averted turned out higher than the previous estimate. For visual impairment and troublesome itch, the difference between previous and updated estimates was proportional to the change in values of the associated disability weights. For blindness, however, this difference was not proportional, as the burden of blindness also included years of life lost due to premature mortality (which is exactly the same for previous and updated estimates).

Overall, we estimated that APOC has cumulatively averted 8.9 million DALYs due to onchocerciasis through 2010, and will avert another 10.1 million DALYs between 2011 and 2015, adding up to a total of 19.0 million DALYs averted through 2015. These updated estimates do not differ much from previous estimates (8.2 million DALYs averted through 2010, and another 9.2 million between 2011 and 2025). In relative terms, the burden of onchocerciasis in APOC areas has decreased from 23.1 DALYs per 1,000 persons in 1995 to 8.6 DALYs per 1,000 persons in 2010, and is expected to further decrease to 3.7 DALYs per 1,000 persons in 2015.

The updated disability weights provided by the GBD 2010 study are based on population surveys rather than expert opinion. Therefore, they are presumably less subjective and should better reflect our ideas and beliefs as a society of what constitutes health than previous disability weights [5]. However, it has been argued that the disability weights for visual impairTable 1. Population at risk, number of cases, and disability-adjusted life years lost and averted due to onchocerciasis in areas covered by APOC.

| Pointedim fact right fact right fact rightTechTec | Year | Population and disease | size and nuı in APOC ar | Population size and number of cases of infection and disease in APOC areas (thousands) | nfection | | Disability-adjus | Disability-adjusted life years lost (thousands) | st (thousands) | | Disability-adjus | Disability-adjusted life years averted (thousands) | erted (thousa | nds) |
|---|---------|---|----------------------------|---|----------------------|-----------|----------------------------|---|----------------|--------|----------------------|--|---------------|--------|
| 3230 0.001 890 444 1,02 29 1,64 0 0 0 33209 0.999 910 410 1,134 30 530 1,644 0 0 0 0 34,051 0.992 944 142 1,134 30 1,735 0 </th <th></th> <th>Population (At risk of infection)</th> <th>Infected^a</th> <th>Troublesome itch</th> <th>Visual impairment</th> <th>Blindness</th> <th>Troublesome itch</th> <th>Visual impairment</th> <th>Blindness</th> <th>Total</th> <th>T roublesome itch</th> <th>Visual impairment</th> <th>Blindness</th> <th>Total</th> | | Population (At risk of infection) | Infected ^a | Troublesome itch | Visual impairment | Blindness | Troublesome itch | Visual impairment | Blindness | Total | T roublesome itch | Visual impairment | Blindness | Total |
| 33.00 0.049 0.1 1.34 10 134 10 134 0 | 1995 | 71,474 | 32,330 | 10,202 | 889 | 404 | 1,102 | 29 | 523 | 1,654 | 0 | 0 | 0 | 0 |
| 3(07) (070) (91) (16) (16) (16) (16) (17) < | 1996 | 73,310 | 33,209 | 10,499 | 910 | 410 | 1,134 | 30 | 530 | 1,694 | 0 | 0 | 0 | 0 |
| (4)(3) (1)(3)(2) (2)(3) (2)(3) (1)(3) (2)(| 1997 | 75,195 | 34,073 | 10,780 | 931 | 418 | 1,164 | 31 | 558 | 1,753 | 0 | 0 | 0 | 0 |
| 3 10 0 1 | 1998 | 77,132 | 34,951 | 10,925 | 957 | 427 | 1,180 | 32 | 573 | 1,785 | 6 | 0 | 21 | 30 |
| 6522 0749 91 161 32 457 166 13 1 15 8598 0653 987 420 151 33 457 1660 13 1 18 18 18 7338 0645 995 410 1129 33 417 1538 183 2 23 73748 9705 970 970 147 139 147 139 2 23 73748 9705 970 970 147 139 147 2 23 23 7470 950 970 147 329 140 147 29 23 8577 964 97 147 329 140 147 29 23 8679 864 97 147 329 140 147 29 24 8679 864 97 147 147 147 147 149 < | 1999 | 79,122 | 35,816 | 10,692 | 974 | 430 | 1,155 | 32 | 530 | 1,717 | 65 | 0 | 79 | 144 |
| 3698 0633 987 420 1/51 33 457 1/640 131 1 180 180 180 180 180 180 180 22 231 37,303 1045 995 410 1/129 33 417 1/538 256 23 231 37,503 10073 995 101 32 367 1/47 329 4 23 231 37,450 936 939 101 32 1/437 329 4 24 23 36,793 8111 931 1045 1437 1435 440 4 24 23 36,013 8111 931 1432 1435 1435 1405 140 < | 2000 | 81,165 | 36,522 | 10,749 | 981 | 427 | 1,161 | 32 | 489 | 1,683 | 90 | - | 135 | 226 |
| 37,338 10,456 99 410 1,129 33 41 1533 153 25 23 37,502 10073 990 402 1,088 33 147 1538 25 25 37,458 970 97 97 1,048 32 1,47 329 4 28 37,196 9357 956 379 1,01 32 1,47 329 4 28 36,719 964 951 1,01 32 1,47 1,47 329 4 28 36,719 964 951 1,91 379 1,47 509 5 34 36,019 8,11 919 369 31 1,47 509 5 34 36,019 654 856 34 37 1,47 509 5 34 36,019 654 854 1,47 529 6 6 6 4 4 | 2001 | 83,144 | 36,998 | 10,653 | 987 | 420 | 1,151 | 33 | 457 | 1,640 | 131 | 1 | 180 | 312 |
| 37,50 10/73 90 402 108 33 417 1,538 256 3 251 37,458 975 977 391 1040 32 407 329 47 38 37,196 955 579 1011 32 349 400 6 38 36/79 864 951 369 367 1,342 509 7 349 36/79 864 91 369 319 1,342 509 7 349 36/79 864 91 369 31 1,342 509 7 349 36/79 814 91 369 31 1,475 509 7 349 3381 654 885 310 21 1/11 7 60 7 40 3381 654 814 310 21 1/11 7 8 40 61 61 3381 519 | 2002 | 85,172 | 37,338 | 10,456 | 995 | 410 | 1,129 | 33 | 421 | 1,583 | 183 | 2 | 231 | 416 |
| 37,458 9/05 9/1 391 1,048 32 397 1,477 329 4 288 37,196 9357 965 379 1,011 32 363 1,405 600 6 338 36,79 864 951 369 338 1 342 509 7 349 36,03 8111 931 369 388 373 1,342 509 7 349 36,03 8111 931 369 388 373 1,342 509 7 349 35,043 814 30 219 319 1,256 608 7 349 33,811 6,564 886 310 219 327 1,171 708 17 349 33,811 6,564 886 310 327 1,171 708 1 349 33,811 6,564 886 310 510 510 510 510 | 2003 | 87,249 | 37,502 | 10,073 | 066 | 402 | 1,088 | 33 | 417 | 1,538 | 256 | ю | 251 | 510 |
| 37,196 9.357 965 379 1,011 32 8,57 400 6 33 36,779 8,684 951 369 938 31 373 1,342 509 7 349 36,073 8,11 931 358 8,739 910 345 814 30 1,71 708 7 349 35,085 7,339 910 345 814 30 327 1,71 708 10 340 3,508 5,139 910 345 340 327 1,71 708 10 340 3,3,11 6,564 885 330 709 232 1,71 708 10 40 54 3,2,2,46 6,83 864 20 249 264 10 6 63 3,2,2,48 6,14 70 246 862 10 10 10 10 10 10 10 10 10 1 | 2004 | 89,377 | 37,458 | 9,705 | 977 | 391 | 1,048 | 32 | 397 | 1,477 | 329 | 4 | 288 | 621 |
| 36,779 864 951 369 38 31 342 599 7 349 36,03 8,111 911 358 876 31 349 1,256 608 9 30 36,03 8,111 910 345 814 30 349 1,71 708 9 30 35,05 5,157 814 30 709 20 274 852 10 43 33,81 6,564 885 330 79 20 20 20 171 708 10 43 33,81 6,564 885 310 79 20 <td>2005</td> <td>91,558</td> <td>37,196</td> <td>9,357</td> <td>965</td> <td>379</td> <td>1,011</td> <td>32</td> <td>363</td> <td>1,405</td> <td>400</td> <td>6</td> <td>338</td> <td>744</td> | 2005 | 91,558 | 37,196 | 9,357 | 965 | 379 | 1,011 | 32 | 363 | 1,405 | 400 | 6 | 338 | 744 |
| 36,03 8,11 91 358 876 31 349 1,256 68 9 30 35,055 7,39 910 345 814 30 327 1,171 708 91 431 35,055 5,549 885 330 709 29 285 1,024 852 12 42 33,811 6,564 885 330 709 29 82 10,24 852 12 43 33,2146 5,157 825 230 234 82 10,24 82 12 42 30,355 5,157 825 230 234 82 10 14 56 30,355 5,157 825 234 82 10 1086 16 61 30,354 749 72 21 402 25 128 128 10 14 30,41 749 73 12 128 128 128 | 2006 | 93,928 | 36,779 | 8,684 | 951 | 369 | 938 | 31 | 373 | 1,342 | 509 | 7 | 349 | 864 |
| 35,085 7,539 910 345 814 30 327 1,171 708 10 431 3,811 6,564 885 330 709 29 285 1,024 852 12 492 3,2,16 5,836 854 310 630 29 285 1,024 852 12 492 3,2,24 5,157 825 210 579 26 790 1,086 16 61 30,355 5,157 825 270 27 206 790 1,086 16 61 30,345 741 797 27 26 189 692 1,208 16 61 25,979 3724 762 251 189 692 1,327 21 61 67 25,979 374 742 23 16,28 1,42 23 71 21,115 2,478 649 1,42 23 1,42 23 | 2007 | 96,360 | 36,093 | 8,111 | 931 | 358 | 876 | 31 | 349 | 1,256 | 608 | 6 | 390 | 1,007 |
| 33811 6,564 885 330 709 29 285 1,024 852 12 492 32,246 5,836 854 310 630 28 234 892 971 14 563 30,355 5,157 825 290 557 27 206 790 1,086 16 61 28,344 4,117 797 271 477 26 189 692 1,327 16 61 25,979 3,724 762 254 402 25 189 615 1,327 21 670 25,979 3,724 762 254 402 25 188 615 1,327 21 670 23,591 3074 724 237 322 24 165 1,420 23 715 21,115 2,478 690 790 1,420 73 719 755 751 751 751 751 < | 2008 | 98,857 | 35,085 | 7,539 | 910 | 345 | 814 | 30 | 327 | 1,171 | 708 | 10 | 431 | 1,149 |
| 32.246 5836 854 310 630 28 234 892 971 14 563 30.355 5,157 825 290 557 27 206 790 1,086 16 611 28,244 4,17 797 271 477 26 189 692 1,327 16 614 28,249 3,724 762 254 402 25 188 615 1,327 21 670 25,979 3,724 762 254 402 25 188 615 1,327 21 670 23,591 3074 719 322 24 165 521 1,442 23 715 21,115 2,478 630 232 249 682 521 1,442 23 715 21,11 1,11 1,12 1,11 1,12 1,12 1,12 1,12 1,12 1,13 | 2009 | 101,419 | 33,811 | 6,564 | 885 | 330 | 709 | 29 | 285 | 1,024 | 852 | 12 | 492 | 1,356 |
| 30.355 5157 825 290 557 27 206 790 1,086 16 611 28,244 417 797 271 477 26 189 692 1,208 18 648 25,979 3,724 762 254 402 25 188 615 1,208 18 648 23,591 3,074 724 237 332 24 165 521 1,442 23 715 21,115 2,478 690 220 268 23 145 435 1,552 25 757 21,115 2,478 690 220 268 23 145 8,57 25 75 75 21,115 2,478 690 220 268 23 7,19 752 25 757 21,115 2,478 6,90 26,667 26,667 1,742 25 757 21,115 2,478 6,90 < | 2010 | 104,050 | 32,246 | 5,836 | 854 | 310 | 630 | 28 | 234 | 892 | 971 | 14 | 563 | 1,549 |
| 28,244 4,17 797 271 4,77 26 189 692 1,208 18 648 25,979 3,74 762 254 402 25 188 615 1,327 21 670 25,979 3,74 762 254 402 25 188 615 1,327 21 670 23,591 3,074 724 233 332 24 165 521 1,442 23 715 21,115 2,478 690 220 268 23 145 435 1,552 23 751 21,115 2,478 690 220 268 23 145 435 1,552 251 757 757 21,115 2,478 690 220 268 23 145 435 1,552 757 757 210 1,1,24 1,1,74 1,1,74 1,1,74 1,1 7,19 | 2011 | 106,750 | 30,355 | 5,157 | 825 | 290 | 557 | 27 | 206 | 790 | 1,086 | 16 | 611 | 1,713 |
| 25,979 3724 762 254 402 25 188 615 1,327 21 670 23,591 3,074 724 237 332 24 165 521 1,42 23 715 21,115 2,478 690 220 268 23 145 435 1,552 25 757 21,115 2,478 690 220 268 23 145 435 1,552 25 757 21,115 2,478 690 220 268 23 145 8,357 2,3614 5,110 70 3,748 210 1,724 1,724 17,74 17,744 7,149 7,149 | 2012 | 109,521 | 28,244 | 4,417 | 797 | 271 | 477 | 26 | 189 | 692 | 1,208 | 18 | 648 | 1,875 |
| 23,591 3074 724 237 332 24 165 521 1,442 23 715 21,115 2,478 690 220 268 23 145 435 1,552 25 757 310 16,289 498 6,827 23,614 5,110 70 3,748 310 18,325 623 7,719 26,667 11,724 17,74 7,149 7,149 | 2013 | 112,366 | 25,979 | 3,724 | 762 | 254 | 402 | 25 | 188 | 615 | 1,327 | 21 | 670 | 2,018 |
| 21,115 2,478 690 220 268 23 145 435 1,552 25 757 310 16,289 498 6,827 23,614 5,110 70 3,748 110 16,289 698 6,827 23,614 5,110 70 3,748 111 11,724 11,724 174 7,149 7,149 | 2014 | 115,287 | 23,591 | 3,074 | 724 | 237 | 332 | 24 | 165 | 521 | 1,442 | 23 | 715 | 2,179 |
| 10 16,289 498 6,827 23,614 5,110 70 3,748 18,325 623 7,719 26,667 11,724 7,149 | 2015 | 118,285 | 21,115 | 2,478 | 690 | 220 | 268 | 23 | 145 | 435 | 1,552 | 25 | 757 | 2,334 |
| 18,325 623 7,719 26,667 11,724 174 7,149 | Subtot | al 1995–2010 | | | | | 16,289 | 498 | 6,827 | 23,614 | 5,110 | 70 | 3,748 | 8,929 |
| | Total 1 | 995-2015 | | | | | 18,325 | 623 | 7,719 | 26,667 | 11,724 | 174 | 7,149 | 19,048 |

^aInfection defined as presence of at least one adult female worm. I doi:10.1371/journal.pntd.0002759.t001

ment and blindness underestimate the burden of vision loss in rural Africa [9,10]. One of the main arguments is that the surveys used to establish new disability weights did not adequately cover rural Africa (Tanzania only). Furthermore, being strictly a metric of health loss rather than wellbeing [5], DALYs do not capture the effects of vision loss and skin disease on socioeconomic status [11] and productivity [12,13]. Therefore, the impact of APOC most likely encompasses more than what we report here in terms of health impact.

According to our updated estimates, skin disease is now the most important

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contributor to the burden of onchocerciasis, rather than eye disease. Moreover, the true disease burden of onchocercal skin disease (and the burden averted by APOC) is still larger than we estimate here, as our updated estimates do not include disfiguring skin disease, or other sequelae potentially associated with onchocerciasis, such as epilepsy [14] and head-nodding syndrome [15]. The additional burden of disfiguring skin disease is probably considerable, given the relatively high values of the updated disability weights for disfiguring skin disease and the high

the clinical and epidemiological burden of skin disease in Africa. Ann Trop Med Parasitol 96: 283–296.

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precontrol prevalence of disfiguring skin disease in areas endemic for onchocerciasis [6]. This underlines the importance of onchocercal skin disease, especially in forest areas where vision loss is relatively rare [16].

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