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Comparison of Reported and Survey-Based Coverage in Onchocerciasis Programs over a Period of 8 Years in Cameroon and Uganda

Moses N. Katabarwa,[1]* Emily Griswold,[1] Peace Habomugisha,[2] Albert Eyamba,[3] Edson Byamukama,[2] Philippe Nwane,[4] Annet Khainza,[2] Lauri Bernard,[1] Paul Weiss,[5] and Frank O. Richards[1]

[1]*The Carter Center, Atlanta, Georgia;* [2]*The Carter Center, Kampala, Uganda;* [3]*Odza Center, Yaounde, Cameroon;* [4]*Centre de Recherche sur les Filarioses et Autres Maladies Tropicales (CRFilMT), Yaounde, Cameroon;* [5]*Emory University, Rollins School of Public Health, Atlanta, Georgia*

Abstract. Mass drug administration (MDA) with ivermectin must reach a high treatment coverage (90% of the eligible population) if onchocerciasis is to be eliminated. Questions have been raised as to whether reported treatment figures reaching such high coverage are reliable. Sample surveys are proposed as the method of choice for "validating" reported coverage figures. The purpose of this study was to compare the district-level MDA coverage reported by programs with contemporaneous surveys of randomly selected respondents living in those same districts. Over an 8-year period, 19,219 households were selected using multistage random sampling; 38,433 adult male and female heads of those households were asked about their recent ivermectin MDA treatment experience. District coverage reports were considered "accurate" if they fell within the 95% CIs determined by the corresponding district's survey. Ninety-eight treatment rounds were evaluated over an 8-year period. Overall, the reported coverage of 96.5% (range: 68–100%) was significantly higher than the 92.5% surveyed coverage (range: 62.1–99.6%, 95% CI: 91.9–93.2%). However, only 20% of districts reported significantly higher coverage than surveys, 68% of district program reports were judged as accurate, and 12% of districts reported significantly lower coverage figures than their corresponding surveys. Eighty-eight percent of districts reported coverage ≥ 90% threshold for success, compared with 97% of surveys that included 90% in their 95% CIs. We conclude that when analyzed statistically at the district level, most surveys verified the reported coverage.

INTRODUCTION

Understanding the reliability of the reported treatment coverage in mass drug administration (MDA) programs is critical for all five Preventive Chemotherapy Neglected Tropical Diseases (PC-NTDs) programs.[1–4] When the expected impact on disease prevalence and transmission is not attained after many years of MDA, poor treatment coverage is the first suspect, even if the official reports of the treatment coverage have been satisfactory.[5,6] Conducting routine treatment coverage surveys has become an accepted approach to "validating" program reports, or the first step in diagnosing the reason for treatment failure before undertaking more expensive studies of potential epidemiologic and entomological factors that may be threatening progress.

Community-directed treatment with ivermectin (CDTI) for onchocerciasis control in Africa was launched by the African Program for Onchocerciasis Control (APOC) in 1996.[7,8] For many years, the Carter Center–assisted programs in Cameroon and Uganda conducted CDTI monitoring surveys annually that included a question on coverage.[9,10] The purpose of this study was to analyze these survey data by comparing them statistically with their corresponding district coverage reports. Our hypothesis, based on other reported experiences comparing surveyed with reported coverage, was that the treatment coverage officially reported by Cameroonian and Ugandan districts would be statistically significantly higher than surveyed coverage.[3]

MATERIALS AND METHODS

In this study, we compared 8 years of district-level treatment coverage reports with their corresponding district's monitoring coverage surveys conducted within 2 months of the MDA exercise. The programs' coverage goal was to reach ≥ 90% of the treatment eligible population (e.g., the population aged > 5 years).

In Cameroon, monitoring took place from 2004 to 2011 in West and North regions (although surveys were not conducted in the North in 2011 because of funding constraints). In Uganda, surveys were conducted from 2003 to 2011, except in 2008 because of time constraints. Surveys were conducted in 38 distinct districts. Cameroon surveys included 10–17 households per community, whereas Uganda surveys included 5–19 households. Uganda selected five households per community from 2003 to 2005 because of financial constraints.

District-level MDA coverage reports by the Uganda and Cameroon health system. The official MDA coverage figures used in this study were compiled by the districts' health services. Starting at the community level, the community-selected volunteers (known as community-directed distributors [CDDs]) kept a written household register in which each page was dedicated to a particular household. The household page would list each member's name, age, gender, and treatment outcome, including the number of tablets of ivermectin ingested by that individual. Several years of treatment rounds could be recorded in different columns on a single household page. The treatment dose was based on height using a dosing pole, and then, treatment was directly observed by the CDD and immediately recorded in the register.[9,11] At the end of the treatment round, the CDDs with their community supervisor would prepare the "roll-up" community summary form from the register (or from multiple registers if the community supervisor had several independently operating CDDs). The summary would provide the total community population, eligible population, number of persons treated, and ivermectin usage. Populations of most communities ranged from approximately 200 to 500 people. The completed community form was collected by a salaried ministry of health (MOH) worker based at the health facility responsible for providing care and outreach to

*Address correspondence to Moses N. Katabarwa, The Carter Center, 453 Freedom Parkway, One Copenhill Ave., Atlanta, GA 30307. E-mail: moses.katabarwa@cartercenter.org

that community. The MOH worker in turn completed the next level of summary reporting forms for those communities under his/her jurisdiction. The "roll-up" process thus continued for subdistrict, district, region (in Cameroon), and national levels. Each of these levels offered opportunities for inconsistencies or errors to occur.

We collected district-level treatment coverage figures for the years 2003–2011 for the districts and years that corresponded to the Carter Center–supported random monitoring surveys.[9,11] District-reported coverage was calculated as a percentage: (the number of persons treated divided by the number of eligible people to be treated) × 100.[12]

Treatment coverage surveys. All Carter Center–assisted districts were eligible to be sampled at random each year. A multistage random sampling process was used as described in previous published reports.[2,9,11,13] Surveys were conducted a month after the submission of district reports, which was no more than 2 months after MDA completion. Communities were randomly sampled as follows: The district health services provided a list of all communities targeted for MDA with their corresponding population size. Communities then were randomly selected by the program statistician, and the number of persons to be interviewed in each was determined using the table for sample sizes.[14,15] The selected community was visited and a list of households was generated from the community's household registers. The first household to be interviewed was selected using a random number table and additional households were selected systematically with a computed interval per community.[15] Between 5 and 19 households were selected per community. Interview teams were supervised by the program statistician or social scientist and two or three independent university staff, and district and central MOH program staff.

The two adult heads of household (male and female) were interviewed in every selected household. If household heads were not present, interviewers would return at least once to complete the interview. In the case where the team learned that one or both of the individuals selected for interview would be absent for more than 3 days, the interviewer would pick another randomly selected household to interview.

The questions used in the interviews had been previously field-tested to assure they were understood and elicited appropriate responses. When required, the questionnaire was translated into the local language, but in most cases, interviewers were comfortable translating English (Uganda) or French (Cameroon) to local languages during interviews when necessary.

The questions focused on seven key CDTI issues: 1) "Did you and your neighbors decide on the method of treatment (house-to-house or community center)?" 2) "Did you and your neighbors select the CDD?" 3) "Did CDDs demand monetary incentives from you?" 4) "Did you attend health education meetings?" 5) "Were you treated (with ivermectin)?" 6) "Will you be available to take the treatment next year?" and 7) "If not, why?"[16,17] This study focused only on responses to the question on most recent MDA treatment (question 5). Surveyed coverage was reported as a percentage and calculated as (the number of heads of household who said they had been treated divided by the number of heads of households surveyed) × 100.

Data management and analysis. The monitoring summary data sets were combined into a single data set and analyzed for the acceptance of treatment by adult heads of households by district and year. The data were entered in Epi Info 6.04d and analyzed in Epi Info 6.04d and Epi Info 7.0 (CDC, Atlanta, GA), and Open Epi (www.openepi.com). 95% CIs were calculated for the survey data using the following formula.

$$\mathrm{CI} = 100 \times \left(\mathrm{Estimate} \pm 1.96 \times \sqrt{\frac{6 \times \mathrm{Estimate} \times (1 - \mathrm{Estimate})}{\mathrm{Number\ surveyed}}} \right).$$

A highly conservative design effect of six was applied to the variance estimate to account for the relatively small community sizes, the number of sampling stages, and the tendency for the

TABLE 1

Sample of districts, health areas, communities, households, and interviewees selected every year from 2003 to 2011 in Cameroon and Uganda

Country	Year	No. of districts	Health areas/ subcounties	Communities selected	Households per selected community	Households interviewed	Interviewed		Total sample size (*n*)
							Male	Female	
Cameroon (60 surveys)	2003	–	–	–	–	–	–	–	–
	2004	8	67	147	13	1,912	1,911	1,912	3,823
	2005	8	58	174	11	1,884	1,883	1,884	3,767
	2006	8	68	191	10	1,961	1,960	1,961	3,921
	2007	8	31	178	11	1,966	1,965	1,966	3,931
	2008	6	6	21	17	347	347	347	694
	2009	9	11	31	17	533	532	533	1,065
	2010	8	12	40	13	513	513	513	1,026
	2011	5	5	21	12	255	255	255	510
Subtotal		60	258	803	104	9,371	9,366	9,371	18,737
Uganda (38 surveys)	2003	6	38	134	5	675	675	675	1,350
	2004	5	33	110	5	550	550	550	1,100
	2005	5	34	110	5	600	600	600	1,200
	2006	4	25	90	19	1,723	1,723	1,723	3,446
	2007	5	25	115	15	1,725	1,725	1,725	3,450
	2008	–	–	–	–	–	–	–	–
	2009	5	30	105	19	1,950	1,950	1,950	3,900
	2010	5	21	100	15	1,500	1,500	1,500	3,000
	2011	3	17	74	15	1,125	1,125	1,125	2,250
Subtotal		38	223	838	98	9,848	9,848	9,848	19,696
Total		98	481	1,641	202	19,219	19,214	19,219	38,433

MDA coverage to be relatively homogenous within communities.[18] CIs were adjusted to a maximum limit of 100% and a minimum limit of 0%. CIs were not calculated around the reported treatments because these data were not the result of a sample.

Coverage surveys and their 95% CI results were matched with their corresponding reported coverage by district and year. The key outcome was to determine if the CIs from the coverage survey included the district's reported coverage; if so, the reported coverage was considered to have been "verified" as being correct. If not, the reported coverage was considered to be either low (if it was below the lower 95% CI of the survey) or high (if it was above the upper 95% CI of the survey). The hypothesis of the study that district treatments are overreported would be supported if > 50% of coverage surveys had an upper 95% CI that excluded the coverage reported by the district.

The second key outcome was a comparison of the percentage of districts achieving the program's coverage goal of 90% of the eligible population. To examine this outcome, we compared the number of surveys having ≥ 90% coverage within their 95% CIs with the corresponding district report achieving 90% in reported coverage. The χ^2 test was performed to compare the proportion of districts including/attaining 90% and above by the measurement method.[15] We also performed the same analysis on the mean ("point estimate") district survey coverage result, without regard to the CI. All were tested with the Chi square statistic $= \sum \frac{(O_{rc} - E_{rc})^2}{E_{rc}}$, where O_{rc} is the observed frequency (percent treatment coverage) at level *r* for reported and level *c* for surveyed, and E_{rc} is the expected frequency (percent treatment coverage) at level *r* for reported and level *c* for surveyed. The hypothesis of the study that district treatments are overreported would be supported if a statistically significantly lower percentage of coverage surveys achieved ≥ 90% within their CIs compared with district reports of ≥ 90% coverage.

Ethical approval. The protocol for the monitoring surveys (that included both treatment coverage surveys and other CDTI indicators) was approved by the ministries of health. Emory University's Institutional Review Board classified the study as "non-research" (a periodic program performance assessment). Oral consent was obtained first from community leaders and then from a meeting of community members held before interviews were conducted. Last, interviewees provided oral consent before the household interview. In all these meetings, leaders, community members, and participants were informed about the purpose of the study, that participation was voluntary, and that there would be no repercussions for giving particular answers or for refusing to participate.

RESULTS

A total of 38,433 persons in 19,219 households were interviewed in 98 surveys (Table 1). Sixty surveys took place in Cameroon in 23 health districts, in which 18,737 persons were interviewed. In Uganda, there were 38 surveys in 15 districts with 19,696 interviews. As per study design, the gender ratio was 1:1.

Reported versus surveyed treatment coverage. *Aggregate results.* The overall mean coverage generated by either assessment method was excellent. Reported coverage was 96.5% (range: 68–100%) and surveyed coverage was 92.5% (range: 75–99.6%, 95% CI: 91.9–93.2%). Cameroon reported a mean of 95.0% (range: 68–100) and a surveyed coverage of 92.3% (range: 75–99%, 95% CI: 91.3–93.2%) (Figure 1, Table 2). Uganda reported a mean of 97.9% (range: 85–100%) and a surveyed coverage of 92.8% (range: 79–100%, 95% CI: 91.9–93.7%) (Figure 2, Table 3). Note that the upper 95% CI for all surveys combined was below the overall mean reported treatment figures by the programs, supporting the hypothesis that the reported treatment coverage is usually higher than the surveyed coverage.

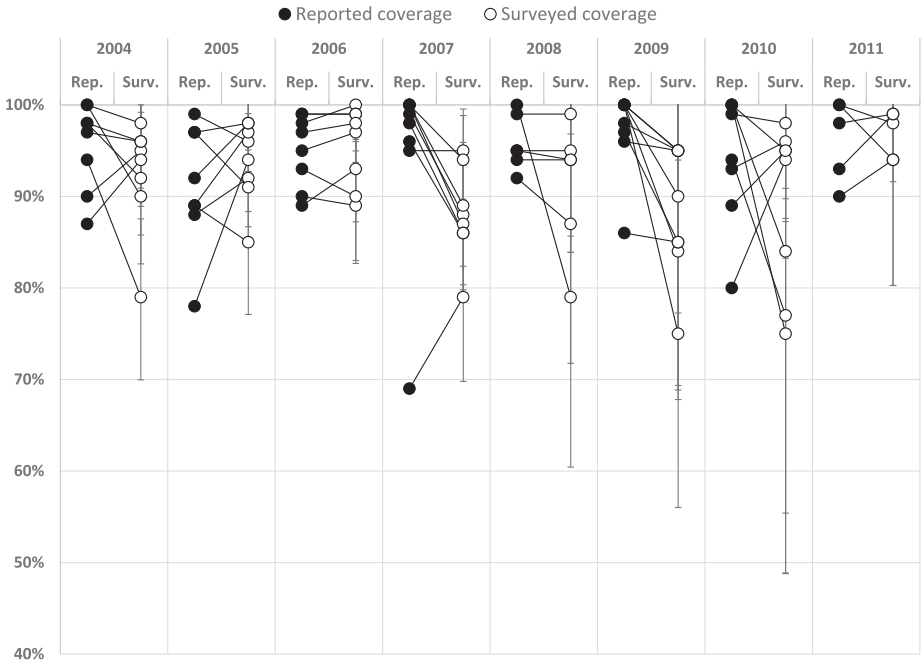

FIGURE 1. Comparing reported and surveyed coverage by year in 60 districts of Cameroon (2004–2011).

TABLE 2
Annually reported and surveyed treatment coverage by district in Cameroon (2004–2011) (n = 60)

		Reports				Surveys				
Year	District	Population	Treatment goal	Treated	Coverage (%)	Sample size	Treated	Coverage (95% CI)	Statistically significant from reports	Estimate above (↗) or below (↘) reported coverage
2004	Bamendjou	28,600	24,024	21,622	90.0	484	462	95.5% (90.9–100%)	*	↗
	Batcham	60,676	50,968	49,439	97.0	476	458	96.2% (92%–100%)	NS	–
	Dschang	72,910	61,244	61,244	100.0	431	421	97.7% (94.2–100%)	NS	–
	Kekem	27,325	22,953	22,494	98.0	490	470	95.9% (91.6–100%)	NS	–
	Lagdo	56,987	47,869	46,912	98.0	505	463	91.7% (85.8–97.6%)	*	↘
	Penka Michel	63,099	53,003	46,113	87.0	488	459	94.1% (88.9–99.2%)	*	↗
	Poli	40,145	33,722	31,698	94.0	499	393	78.8% (70–87.5%)	*	↘
	Tcholliré	61,728	51,852	51,852	100.0	450	403	89.6% (82.6–96.5%)	*	↘
2005	Bamendjou	29,560	24,830	22,198	89.4	438	426	97.3% (93.5–100%)	*	↗
	Bandja	36,400	30,576	30,270	99.0	476	456	95.8% (91.4–100%)	NS	–
	Batcham	61,200	51,408	49,866	97.0	472	463	98.1% (95.1–100%)	NS	–
	Kekem	28,500	23,940	22,025	92.0	443	436	98.4% (95.6–100%)	*	↗
	Lagdo	59,450	49,938	43,945	88.0	489	452	92.4% (86.7–98.2%)	NS	–
	Penka Michel	64,440	54,130	42,438	78.4	476	446	93.7% (88.3–99%)	*	↗
	Poli	41,230	34,633	30,824	89.0	484	411	84.9% (77.1–92.7%)	NS	–
	Tcholliré	62,300	52,332	50,762	97.0	489	447	91.4% (85.3–97.5%)	NS	–
2006	Bafang	67,540	56,734	55,599	98.0	493	491	99.6% (98.5–100%)	*	↗
	Bandjoun	88,961	74,727	71,290	95.4	480	467	97.3% (93.7–100%)	NS	–
	Dschang	165,501	139,021	137,075	98.6	482	477	99% (96.7–100%)	NS	–
	Kekem	32,840	27,586	27,310	99.0	481	477	99.2% (97.2–100%)	NS	–
	Mbouda	129,880	109,099	105,826	97.0	498	488	98% (95–100%)	NS	–
	Poli	64,906	54,521	49,123	90.1	497	444	89.3% (82.7–96%)	NS	–
	Tcholliré	90,846	76,311	71,045	93.1	491	440	89.6% (83–96.2%)	NS	–
	Touboro	137,425	115,437	102,739	89.0	499	463	92.8% (87.2–98.3%)	NS	–
2007	Banja	37,840	31,786	31,468	99.0	489	428	87.5% (80.4–94.7%)	*	↘
	Foumbot	68,319	57,388	54,519	95.0	484	458	94.6% (89.7–99.5%)	NS	–
	Massagam	32,530	27,325	27,325	100.0	488	435	89.1% (82.4–95.9%)	*	↘
	Mbouda	139,632	117,291	116,704	99.5	494	462	93.5% (88.2–98.8%)	*	↘
	Ngong	34,361	28,863	28,863	100.0	488	425	87.1% (79.8–94.4%)	*	↘
	Rey Bouba	80,430	67,561	46,415	68.7	496	390	78.6% (69.8–87.5%)	*	↗
	Santchou	24,727	20,771	20,355	98.0	498	428	85.9% (78.5–93.4%)	*	↘
	Touboro	149,061	125,211	120,203	96.0	494	426	86.2% (78.8–93.7%)	*	↘
2008	Baham	43,160	36,254	36,254	100.0	117	92	78.6% (60.4–96.8%)	*	↘
	Bandja	38,620	32,441	30,819	95.0	120	113	94.2% (83.9–100%)	NS	–
	Batcham	77,016	64,693	61,459	95.0	108	103	95.4% (85.7–100%)	NS	–
	Dschang	170,473	143,197	134,605	94.0	120	113	94.2% (83.9–100%)	NS	–
	Foumban	160,089	134,475	123,717	92.0	109	95	87.2% (71.8–100%)	NS	–
	Kouoptamo	45,770	38,447	38,062	99.0	120	119	99.2% (95.2–100%)	NS	–
2009	Baham	46,660	39,194	39,194	100.0	120	90	75% (56–94%)	*	↘
	Bandjoun	98,640	82,858	82,858	100.0	114	96	84.2% (67.8–100%)	NS	–
	Foumbot	69,310	58,220	58,220	100.0	119	113	95% (85.3–100%)	NS	–
	Kekem	34,800	29,232	28,355	97.0	118	100	84.7% (68.9–100%)	NS	–
	Mbouda	141,820	119,129	114,364	96.0	120	114	95% (85.4–100%)	NS	–
	Ngong	35,600	29,904	29,904	100.0	115	104	90.4% (77.3–100%)	NS	–
	Penka Michel	74,000	62,160	60,917	98.0	120	114	95% (85.4–100%)	NS	–
	Tcholliré	110,945	93,194	80,147	86.0	120	102	85% (69.4–100%)	NS	–
	Touboro	156,600	131,544	130,886	99.5	119	113	95% (85.3–100%)	NS	–
2010	Bandjoun	112,400	94,416	94,416	100.0	106	80	84% (48.8–100%)	NS	–
	Banja	39,340	33,046	33,046	100.0	25	21	75.5% (55.4–95.5%)	*	↘
	Dschang	171,230	159,120	159,120	100.0	200	190	95% (87.6–100%)	NS	–
	Kouoptamo	52,500	44,100	41,454	94.0	52	40	76.9% (48.9–100%)	NS	–
	Lagdo	64,250	53,970	43,176	80.0	104	98	94.2% (83.3–100%)	*	↗
	Penka Michel	74,860	62,882	62,254	99.0	123	120	97.6% (90.9–100%)	NS	–
	Poli	46,830	39,337	36,584	93.0	208	200	96.2% (89.8–100%)	NS	–
	Tcholliré	116,800	98,112	87,320	89.0	208	197	94.7% (87.3–100%)	NS	–
2011	Baham	76,560	64,310	64,310	100.0	78	73	93.6% (80.3–100%)	NS	–
	Bangourain	44,073	37,903	34,113	90.0	78	73	93.6% (80.3–100%)	NS	–
	Batcham	85,600	71,904	71,904	100.0	104	102	98.1% (91.6–100%)	NS	–
	Galim	65,591	56,408	52,459	93.0	104	103	99% (94.4–100%)	*	↗
	Mbouda	149,800	125,832	123,315	98.0	146	144	98.6% (94–100%)	NS	–

NS = not significant.
* Yes.

District-level results. The arrows in the far right columns of Tables 2 and 3 indicate the direction of a significant difference when the reported district coverage was outside of the 95% CIs of the sample survey conducted in that district. Only 20% of districts reported a coverage figure above the corresponding sample survey's upper 95% CI (Table 4). Sixty-eight percent of district program reports fell within the 95% CIs of the corresponding year's surveys, and so were judged as

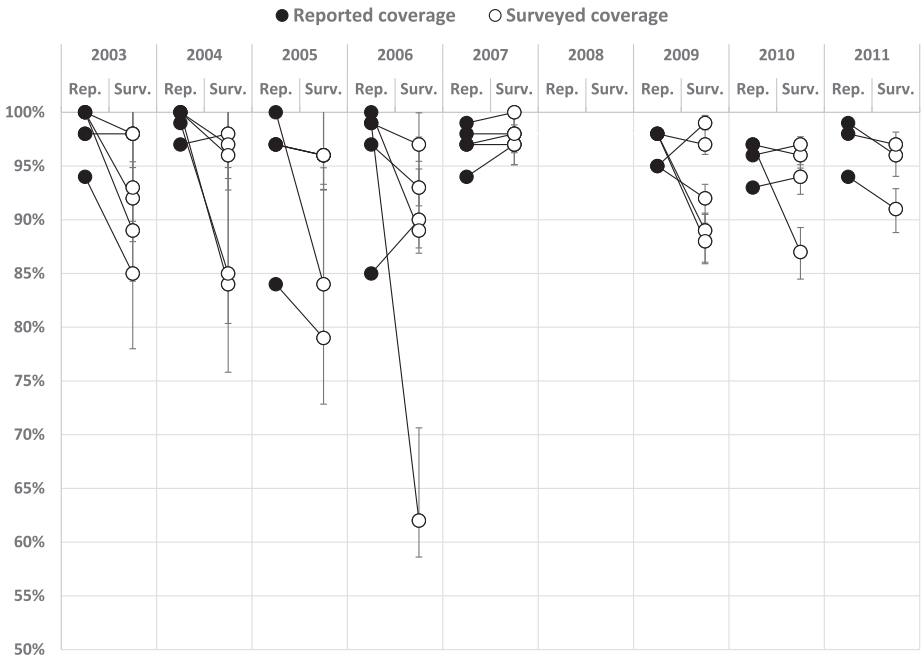

FIGURE 2. Comparing reported and surveyed coverage by year in 38 districts of Uganda (2003–2011).

accurate. Twelve percent of districts reported lower coverage than determined by the survey (i.e., were below the lower 95% CI). Therefore, 80% of surveys demonstrated that district reports were either accurate or below surveyed coverage, disproving our hypothesis that district reports would be more frequently higher than surveyed coverage.

Reported versus surveyed treatment coverage at the district level as related to the 90% treatment coverage goal. *Point estimates.* Overall 89% of districts reported coverage of ≥ 90%, which was considerably higher than the 68.4% of district surveys whose mean reached or exceeded the 90% goal. In Cameroon, 83.3% of districts reported reaching 90% coverage compared with only 66.7% of surveys, and for Uganda, 94.7% of districts reported reaching 90% or more coverage, whereas only 71.1% of surveys had such results. All these differences were highly statistically significant ($P < 0.01$).

Analysis based on CIs. In contrast to survey point estimates, when 95% CIs were considered, reported results could not be distinguished from surveys. In this analysis, 96.9% of all survey CIs included 90% coverage, not significantly different from a reported 89% attainment of the 90% treatment goal ($P = 0.258$). In Cameroon, 96.7% of surveys included 90% in their 95% CIs (versus 83.3% of district reports, $P = 0.198$) (Table 2). In Uganda, 97.4% of surveys had ≥ 90% coverage in their CIs (compared with 94.7% reported, $P = 0.811$) (Table 3).

DISCUSSION

The prevailing opinion among assisting institutions and independent researchers is that the treatment coverage reported through MOH "roll-up" reporting systems is inaccurate and overstated–in other words, not to be trusted. More than 30 two-stage cluster household surveys carried out across Africa, the Americas, and Asia by the CDC and collaborators showed that figures from programmatic reports were likely to be higher than those from corresponding surveys.[3] A study carried out in Cameroon reported the immunization program overestimating the vaccination coverage by 1–29%.[19] In Plateau State, Nigeria, the reported treatment coverage in MDA for trachoma control was 76%, but only 60% of the respondents said they had been treated.[20,21]

Our results, by contrast, showed that, at the district level, the surveyed treatment coverage largely validated the reported coverage in Cameroon and Uganda onchocerciasis MDA programs when surveys were analyzed statistically. Only 20% of districts reported significantly higher coverage than surveys. Eighty-eight percent of districts reported coverage greater than the 90% threshold for success, compared with 97% of surveys that included 90% in their 95% CIs. These were surprising findings that did not support our original hypothesis (the prevailing opinion) that the reported coverage would be higher than surveyed coverage.

Our findings have several qualifications: 1) We would indeed have concluded that the reported coverage is higher than the surveyed coverage if we only considered country-level data, or if our analysis had been performed without considerations of 95% CIs. 2) We used a highly conservative design effect of six that resulted in expanded 95% CIs. The CI was especially important in the analysis of the 90% coverage threshold; an analysis of only survey means ("point estimates") showed the reported coverage to be significantly higher than surveyed coverage. This pattern of lower point estimates in the surveyed coverage is most obvious in Figures 1 and 2. Knowing the true degree of clustering or other data about the statistical efficiency of the survey's design could have tightened CIs and substantially changed the results.[15,18] 3) Our survey obtained treatment coverage data only from older heads of households, whereas the reported coverage was based on treatment data of eligible persons of all ages. That may have imparted a source of bias toward higher coverages if we assume older persons are more likely than teenagers and young adults to take treatment.[22]

TABLE 3
Annually reported and surveyed treatment coverage by district for Uganda (2003–2011) (n = 38)

		Reports				Surveys				
Year	District	Population	Treatment goal	Treated	Coverage (%)	Sample size	Treated	Coverage (95% CI)	Statistically significant from reports	Estimate above (↗) or below (↘) reported coverage
2003	Adjumani	166,954	140,241	139,961	99.8	250	222	88.8% (79.2–98.4%)	*	↘
	Kanungu	45,315	38,065	37,189	97.7	250	244	97.6% (93%–100%)	NS	–
	Kisoro	20,795	17,425	16,403	94.1	100	85	85% (67.9–100%)	NS	–
	Mbale	175,365	147,307	147,307	100.0	250	245	98% (93.7–100%)	NS	–
	Nebbi	276,604	232,347	232,115	99.9	250	230	92% (83.8–100%)	NS	–
	Sironko	58,331	48,998	47,969	97.9	250	234	93.2% (85.6–100%)	NS	–
2004	Kanungu	46,448	39,016	37,768	96.8	250	244	97.6% (93–100%)	NS	–
	Kisoro	21,315	17,905	17,869	99.8	101	85	84.2% (66.7–100%)	NS	–
	Mbale	179,749	150,989	150,838	99.9	250	243	97.2% (93.5–100%)	NS	–
	Moyo	177,788	140,069	139,019	99.3	250	212	84.8% (73.9–95.7%)	*	↘
	Nebbi	283,519	238,156	237,441	99.7	249	239	96% (90–100%)	NS	–
2005	Kanungu	47,609	39,992	38,872	97.2	250	240	96% (90–100%)	NS	–
	Kasese	98,110	82,412	79,693	96.7	250	240	96% (90–100%)	NS	–
	Kisoro	21,848	18,352	15,489	84.4	200	158	79% (65.2–92.8%)	NS	–
	Mbale	184,243	154,764	150,431	97.2	250	241	96.4% (90.7–100%)	NS	–
	Moyo	182,233	143,571	142,858	99.5	250	209	83.6% (72.4–94.8%)	*	↘
2006	Hoima	100,609	84,512	83,666	99.0	750	466	62.1% (53.6–70.6%)	*	↘
	Kisoro	22,394	18,811	15,989	85.0	450	407	90.4% (83.8–97.1%)	NS	–
	Manafwa	141,950	119,238	118,642	99.5	748	668	89.3% (83.9–94.7%)	*	↘
	Moyo	186,789	156,903	155,648	99.2	750	727	96.9% (93.9–100%)	NS	–
	Nebbi	297,872	250,212	243,457	97.3	748	698	93.3% (88.9–97.7%)	NS	–
2007	Kamwenge	35,856	30,119	28,191	93.6	450	437	97.1% (93.3–100%)	NS	–
	Kanungu	48,231	40,514	39,177	96.7	750	733	97.7% (95.1–100%)	NS	–
	Kasese	115,472	96,996	94,669	97.6	750	732	97.6% (94.9–100%)	NS	–
	Mbale	41,834	35,141	34,613	98.5	750	747	99.6% (98.8–100%)	*	↗
	Moyo	191,459	160,826	155,518	96.7	750	725	96.7% (93.5–99.8%)	NS	–
2008	–	–	–	–	–	–	–	–	–	–
2009	Adjumani	174,165	146,299	143,373	98.0	750	664	88.5% (82.9–94.1%)	*	↘
	Bududa	142,548	119,740	116,986	97.7	750	731	97.5% (94.7–100%)	NS	–
	Hoima	140,229	117,792	111,667	94.8	900	825	91.7% (87.2%–96.1%)	NS	–
	Kanungu	50,798	42,670	40,707	95.4	750	745	99.3% (97.9%–100%)	*	↗
	Nebbi	316,177	265,589	260,277	98.0	750	663	88.4% (82.8%–94%)	*	↘
2010	Amuru	151,098	126,922	123,115	97.0	750	653	87.1% (81.2–92.9%)	*	↘
	Bushenyi	130,855	109,918	105,851	96.3	750	725	96.7% (93.5–99.8%)	NS	–
	Kabale	27,604	23,187	21,634	93.3	750	707	94.3% (90.2–98.3%)	NS	–
	Kasese	130,585	109,691	106,401	97.0	750	723	96.4% (93.1–99.7%)	NS	–
2011	Kamwenge	42,457	35,664	35,022	98.2	750	729	97.2% (94.3–100%)	NS	–
	Kasese	126,785	106,499	104,902	98.5	750	718	95.7% (92.2–99.3%)	NS	–
	Moyo	165,550	139,062	130,857	94.1	750	683	91.1% (86.1–96.1%)	NS	–

NS = not significant.
* Yes.

The literature comparing the reported and surveyed MDA coverage in public health programs such as immunization and PC-NTDs is still insufficient. The challenge of attaining and maintaining believable optimal treatment coverage was a major concern for the APOC and still remains so.[4] Studies on treatment compliance have been published, but have not compared reported and surveyed MDA coverage.[14,15] A study that attempted to understand the use of reported immunization reports referred to as administrative data by district health services in Burkina Faso in 1999 applied a cluster survey method.[16] Tally sheets were used in capturing immunization reports, and the population denominators were unknown. The results showed that administrative coverage estimates did not allow districts with moderate coverage to be distinguished from those with high coverage. Similar studies in Cameroon reported the immunization program overestimating vaccination coverage by 1–29%, whereas in Zimbabwe, the underreported coverage was 4–10%.[17,18] Also, more than 30 two-stage cluster household surveys carried out across Africa, the Americas, and Asia by the CDC and collaborators showed that the reported coverage was likely higher than that surveyed.[6] In Plateau State, Nigeria, the reported treatment coverage in MDA for trachoma control from village registers was compared with cluster survey results. Both did not attain

TABLE 4
Summary of comparison of reported coverage with surveyed coverage (N = 98)

Country	No significant difference between reported and surveyed coverage (%)	Survey below reported coverage (%)	Survey above reported coverage (%)	Total surveys conducted
Cameroon	39 (65.0)	12 (20.0)	9 (15.0)	60
Uganda	28 (73.7)	8 (21.1)	2 (5.3)	38
Total	67 (68.4)	20 (20.4)	11 (11.2)	98

the desired treatment coverage of 80%, but the reported coverage indicated 76%, whereas 60% of the respondents in the survey were treated.[19] Although the study considered surveyed as more authentic and believable, both the reported and surveyed MDA coverage were deficient in their knowledge of the population involved.

Although the present study had a good grasp of the population involved as well as reported and surveyed treatment coverage, it was not a longitudinal coverage study. Communities and districts were surveyed randomly every year, and, therefore, trends over time in the same places were not measured. Districts were sampled on average only twice over the 8-year period and many Ugandan districts split into new districts over the study interval. It is necessary in future to survey selected districts over a period of time to determine if coverage trends are steady, improving, or decreasing. However, the assumption is that it would remain relatively stable and unaffected by migrations or other factors that may result in displacement of communities.

The reality is that reported and surveyed treatment coverage are equally important in understanding the dynamics and trends of community MDA programs, and both can provide important information needed to strengthen program implementation. Program data provide information on the overall scope of the effort in reaching all targeted villages ("geographic coverage"). Regular coverage surveys can verify the program reports and provide other specific information for program improvement.[3,16,17] Coverage surveys are more beneficial when carried out immediately after the completion of the MDA exercise to minimize recall bias among respondents.[18,23] In this study, surveys were conducted a month after the submission of district reports, which was within 2 months of MDA completion.

One reason for selecting districts randomly every year was to make it clear to all health workers that their respective areas were always potential candidates for validation of the reported treatment coverage and CDTI practice. This motivated workers throughout the program to always pay close attention to all the communities in their charge. In addition, we found that involving MOH workers in coverage surveys was important for their development, mentorship, and ownership of the coverage data, and, ultimately, improved MDA performance. On the other hand, having MOH personnel alone conduct coverage surveys could be a source of bias, given the understandable desire to show excellent (high coverage) outcome. To avoid such bias, the coverage surveys involved independent researchers and partners' participation at every stage of sampling, training of interviewers, and close supervision in following set procedures and analysis. Interviews were conducted by locally trained interviewers from outside sampled communities and supervised by MOH staff, independent researchers from universities, and the program statistician and social scientist.

In 2009, APOC and its Joint Action Forum called for a programmatic shift in African programs from onchocerciasis disease control to transmission elimination.[24] The APOC paradigm for onchocerciasis elimination in Africa included the imperative that all onchocerciasis elimination programs reach 100% of affected communities and achieve at least 80% therapeutic coverage (TC).[25–27] Therapeutic coverage is calculated as the number of persons treated divided by the total population, including children younger than five years who are ineligible for ivermectin.[28] The 2015 United Nations estimated Cameroon's population of children younger than five years comprised 16% of the total population, and 19% in Uganda.[29] In this example, to reach the APOC goal of 80% TC, 95% of the eligible population would need to be treated in Cameroon and 99% in Uganda. These are staggering programmatic requirements that require almost perfect function. By contrast, the 90% coverage of the eligible population would be the equivalent of 76% and 73% of the total population in Cameroon and Uganda, respectively, a more reasonable target. Additional modeling studies are urgently needed to determine a more programmatically achievable total population coverage goal than 80% TC for the interruption of onchocerciasis transmission.

CONCLUSION

In this study conducted with data generated over an 8-year period by Cameroonian and Ugandan onchocerciasis MDA programs, district-level treatment coverage determined by sample surveys compared favorably with district-level MDA coverage reports when the survey 95% CIs were considered. Sixty-eight percent of district coverage reports were considered "accurate" because they fell within the 95% CIs determined by their year's district sample survey. Similarly, 88% of districts reported reaching the goal of ≥ 90% coverage of the eligible population compared with 97% of surveys having 90% within their 95% CIs. CIs around survey estimates should be considered when validating district treatment reports.

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Authors' addresses: Moses N. Katabarwa, Emily Griswold, Lauri Bernard, Paul Weiss, and Frank O. Richards, Health Programs, The Carter Center, Atlanta, GA, E-mails: moses.katabarwa@cartercenter.org, emily.griswold@cartercenter.org, lauri.bernard@cartercenter.org, pweiss2@emory.edu, and frank.richards@cartercenter.org. Peace Habomugisha, Edson Byamukama, and Annet Khainza, Health Programs, The Carter Center, Kampala, Uganda, E-mails: peace.habo@cartercenter.org, edson.byamukama@cartercenter.org, and annet.khainza@cartercenter.org. Albert Eyamba, Clinic, Odza Center, Yaounde, Cameroon, E-mail: eyamba09@hotmail.fr. Philippe Nwane, Health Program, Centre de Recherche sur les Filarioses et Autres Maladies Tropicales (CRFilMT), Yaounde, Cameroon, E-mail: philino07@yahoo.fr.

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