THE
CARTER CENTER

Waging Peace. Fighting Disease. Building Hope.

SUMMARY
2021 VIRTUAL PROGRAM REVIEW

RIVER BLINDNESS ELIMINATION PROGRAMS

ETHIOPIA, NIGERIA, OEPA, SUDAN, AND UGANDA
FEBRUARY 28 – MARCH 2, 2022
THE CARTER CENTER
ATLANTA, GA

SEPTEMBER 2022

Donors to The Carter Center River Blindness Elimination, Lymphatic Filariasis Elimination, and Schistosomiasis/Soil Transmitted Helminths Control Programs

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The Clarke Cares Foundation

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United States Agency for International Development (USAID)

USAID's Act to End NTDs East Program, led by RTI International

USAID's Achieve Onchocerciasis Elimination in the Americas Project

William R. Hoch Family Foundation

YKK Corporation of America

And to many others, our sincere gratitude.

The Reaching the Last Mile Fund, housed within The END Fund, is a multi-donor fund, initiated and led by His Highness Sheikh Mohamed bin Zayed Al Nahyan, the Crown Prince of Abu Dhabi.

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ACRONYMS

APOC	African Program for Onchocerciasis Control
ARV	At-Risk Village
BMGF	Bill and Melinda Gates Foundation
CAR	Central African Republic
CDD	Community Directed Distributors
CDTI	Community Directed Treatment with Ivermectin
COVID-19	2019 novel coronavirus disease
CS	Community Supervisor
DBS	Dried Blood Spots
DEC	Diethylcarbamazine
DRC	Democratic Republic of the Congo
EOEEAC	Ethiopia Onchocerciasis Elimination Expert Advisory Committee
ELISA	Enzyme-linked immunosorbent assay
ESPEN	Expanded Special Project for Elimination Neglected Tropical Diseases
FLHF	Frontline Health Facility
FMOH	Federal Ministry of Health
FTS	Filarial Test Strip
GLIDE	The Global Institute for Disease Elimination
GIS	Geographical Information System
HDA	Health Development Army
HELP	Human Engagement Learning Platform
HEW	Health Extension Worker
HQ	Headquarters
HW	Health Worker
IACO	InterAmerican Conference on Onchocerciasis
IHA	Indigenous Health Agent
IRB	Institutional Review Board
ITFDE	International Task Force for Disease Eradication
LF	Lymphatic Filariasis
LGA	Local Government Areas
LLIN	Long-lasting Insecticidal (Bed) Nets
MDA	Mass Drug Administration
MDP	Mectizan Donation Program
MMDP	Morbidity Management and Disability Prevention
MMN	Madi-Mid North
MOH	Ministry/Ministries of Health
NGDO	Non-Governmental Development Organization

ACRONYMS *Continued*

NOEC	Nigeria Onchocerciasis Elimination Committee
NTD	Neglected Tropical Disease
OEPA	Onchocerciasis Elimination Program for the Americas
OTS	Onchocerciasis Technical Subgroup/Subcommittee
PAHO	Pan American Health Organization
PCC	Program Coordinating Committee of OEPA
PCR	Polymerase Chain Reaction
PEEL	Plan, Execute and Engage to Learn model
PES	Post Elimination Surveillance
PHC	Primary Health Care
PTS	Post-Treatment Surveillance
QC	Quality Control
RB	River Blindness
RBEP	River Blindness Elimination Program
REMO	Rapid Epidemiological Mapping of Onchocerciasis
RPRG	Regional Program Review Group
RSS	Republic of South Sudan
RTI	Research Triangle Institute
S&C	Slash and Clear
SE/SS	South East/South South
SCH	Schistosomiasis
SIZ	Special Intervention Zone
SNNPR	Southern Nations, Nationalities and People's Region
STH	Soil Transmitted Helminths
TAS	Treatment Assessment Survey
TCC	The Carter Center
UOEEAC	Ugandan Onchocerciasis Elimination Expert Advisory Committee
USAID	United States Agency for International Development
USF	University of Southern Florida
UTG	Ultimate Treatment Goal
WER	Weekly Epidemiological Record
WHO	World Health Organization
YFA	Yanomami Focus Area

GLOSSARY

Definitions of Eradication, Elimination and Control for Neglected Tropical Diseases (NTDs)[1]

Eradication: The permanent reduction to zero of a specific pathogen, as a result of deliberate efforts, with no more risk of reintroduction. The WHO process of documenting eradication is called ***certification***.

Elimination of transmission: The reduction to zero of the incidence of infection caused by a specific pathogen in a defined geographical area, with minimal risk of reintroduction, as a result of deliberate efforts; continued actions to prevent re-establishment of transmission may be required. The WHO process of documenting country-wide elimination of transmission is called ***verification***.

Elimination as a public health problem: Reduction of disease incidence, prevalence, morbidity and/or mortality defined by achievement of measurable global targets set by WHO in relation to a specific disease or pathogen. When reached, continued actions are required to maintain the targets, and additional interventions or assessments are required (if an infectious agent) to achieve zero transmission. The WHO process of documenting country-wide elimination as a public health problem is called ***validation***.

Control: Reduction of disease incidence, prevalence, morbidity, and/or mortality to a locally acceptable level as a result of deliberate efforts; continued intervention measures are required to maintain the reduction. Control may or may not be related to global targets set by WHO.

Phases of Onchocerciasis Transmission[2]

Transmission Suppressed: The absence of infective larvae (L3s) in the *Simulium* vector population. Infectivity can be suppressed through drug (ivermectin) pressure, despite the potential for re-initiation of transmission through the presence of a population of adult worms capable of producing microfilariae if the drug pressure is removed.

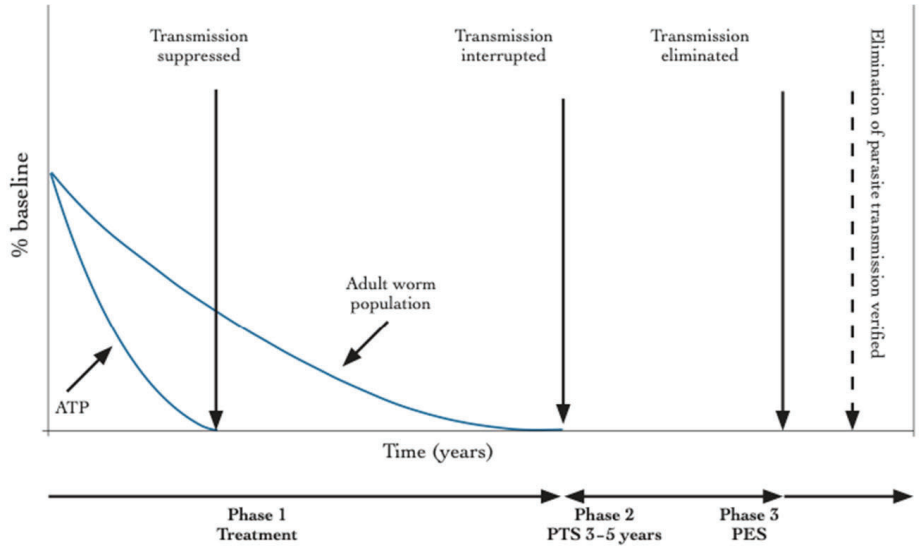
Transmission Interrupted: The permanent reduction of transmission in a defined geographical area after all the adult worms (and microfilariae) in the human population in that area have died, been exterminated by some other intervention, or become sterile and infertile. At this point ivermectin drug pressure may be removed.

Transmission Eliminated: The demonstration through 3-5 years of post (ivermectin) treatment surveillance that onchocerciasis transmission remains interrupted. Continued (post elimination) surveillance is required.

[1] World Health Organization (2016). Generic Framework for Control, Elimination and Eradication of Neglected Tropical Diseases.
[2] World Health Organization (2016). Guidelines for Stopping Mass Drug Administration and Verifying Elimination of Human Onchocerciasis.

Figure 1

Phases of Onchocerciasis Elimination



ATP, annual transmission potential; PES, post-elimination surveillance; PTS, post-treatment surveillance

WHO (2016). Guidelines for stopping mass drug administration and verifying elimination of human onchocerciasis: criteria and procedures (document WHO/HTM/NTD/PCT/2016.1). Geneva, World Health Organization.
http://www.who.int/onchocerciasis/resources/9789241510011/en/

Figure 2

Inventory of 'Stop MDA' for River Blindness (RB) and Lymphatic Filariasis (LF) in Carter Center-Assisted Programs

RIVER BLINDNESS		
Country	Population residing in areas where MDA stopped 2009-2021	Population in areas that qualified to stop MDA in 2021
ETHIOPIA	1,608,000	508,000
NIGERIA	5,400,584	2,781,723
OEPA[1]	538,517	0
SUDAN	264,811	0
UGANDA[2]	2,621,227	0
TOTAL	**10,433,139**	**3,289,723**

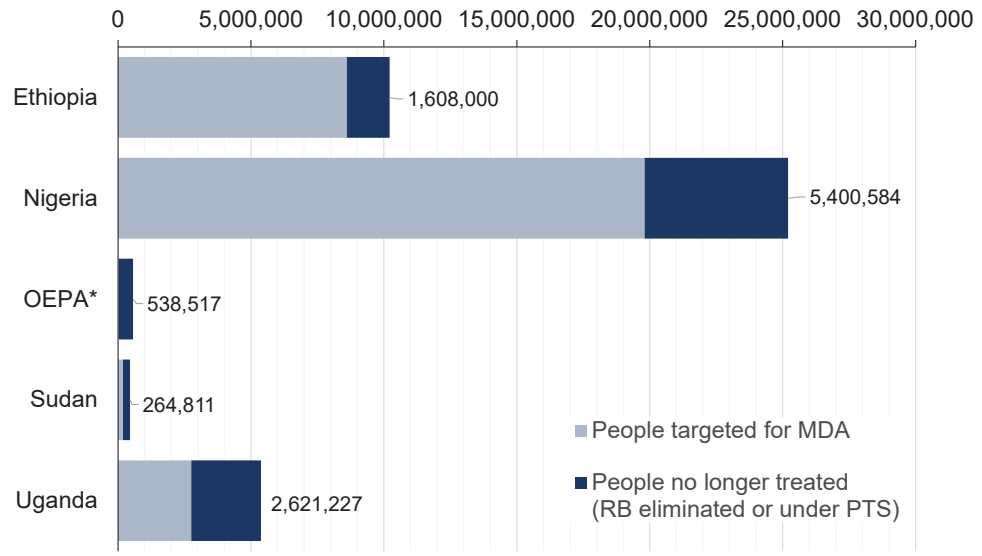
[1]Representing Brazil, Colombia, Ecuador, Guatemala, Mexico and Venezuela.
[2]Excludes the eliminated Victoria focus (not TCC-assisted, eliminated in the 1970s), population 2.8 million.

LYMPHATIC FILARIASIS		
Country	Population residing in areas where MDA stopped 2009-2021	Population in areas that qualified to stop MDA in 2021
ETHIOPIA	1,432,033	260,923
NIGERIA	10,704,506	3,446,199
TOTAL	**12,136,539**	**3,707,122**

Figure 3

Population Currently and Previously Targeted for River Blindness Treatment with Mectizan®, 2021

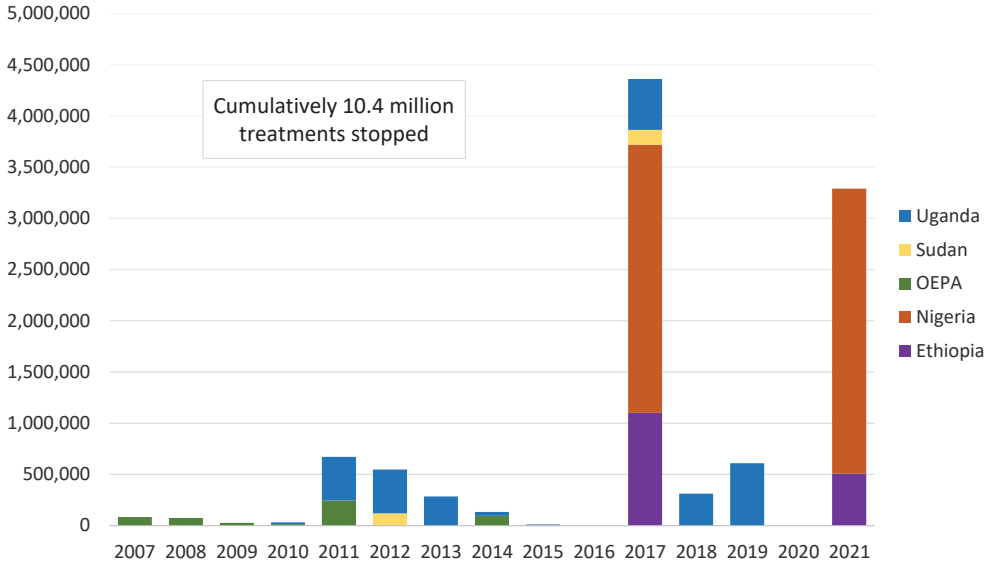
10.4 million people in nine Carter Center-assisted countries no longer need treatment as a result of our river blindness elimination partnership



**OEPA: Representing Brazil, Colombia, Ecuador, Guatemala, Mexico, and Venezuela*

Figure 4

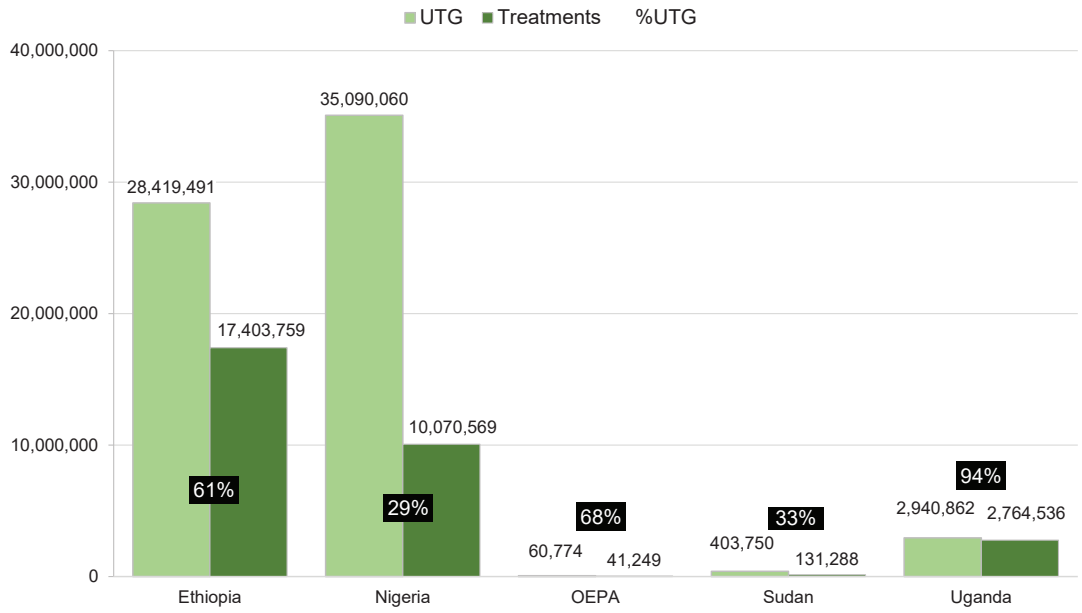
Onchocerciasis Stopped Treatments in Carter Center-assisted areas, by Country and Year, 2007-2021



OEPA: Represents Brazil, Colombia, Ecuador, Guatemala, Mexico, and Venezuela.
UGANDA: Excludes the eliminated Victoria focus (not TCC-assisted, eliminated in the 1970s), population 2.8 million.

Figure 5

2021 Mectizan® Ultimate Treatment Goals (UTG) and Treatments for TCC-assisted Areas



OEPA: Represents Brazil, Colombia, Ecuador, Guatemala, Mexico, and Venezuela.

Figure 6

RBEP-Assisted Programs: Mectizan® Treatments/Targets 1996 – 2021 and 2022 Target

- *The decrease in treatment between 2019 and 2020 is due to the COVID-19 pandemic*
- *The decrease in treatment between 2018 and 2019 is attributable to a Mectizan delay in Ethiopia and Nigeria.*

Figure 7

Carter Center River Blindness Elimination Programs Cumulative Treatments 1996-2021

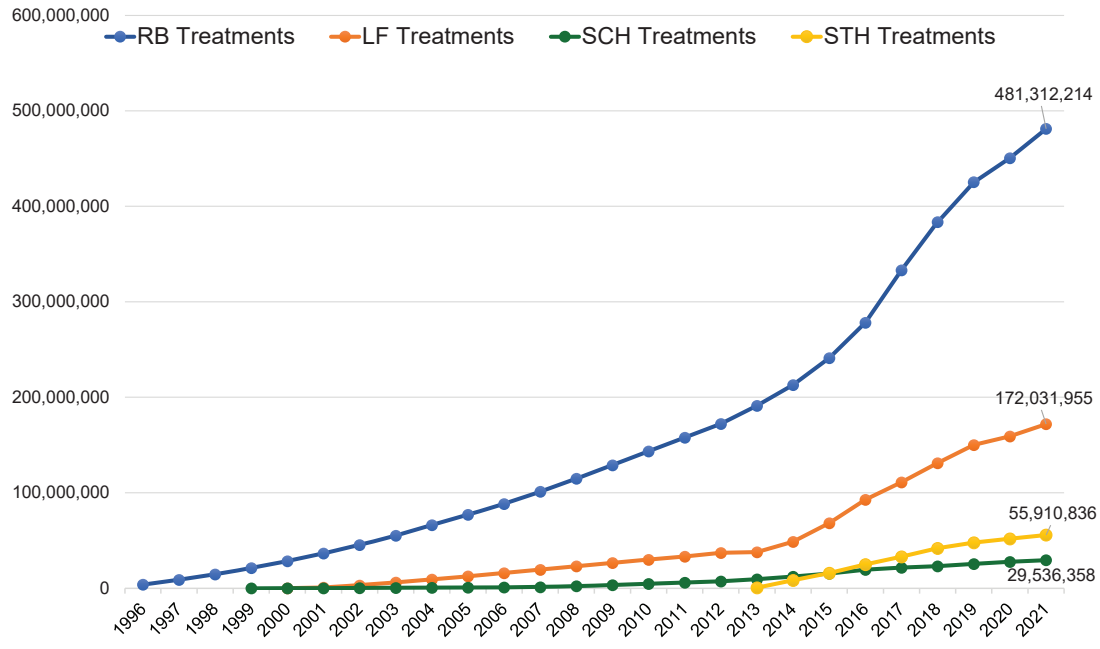


Figure 8

Carter Center-Assisted River Blindness Elimination Program: Mectizan® Treatments by Country/Program 1996 – 2021

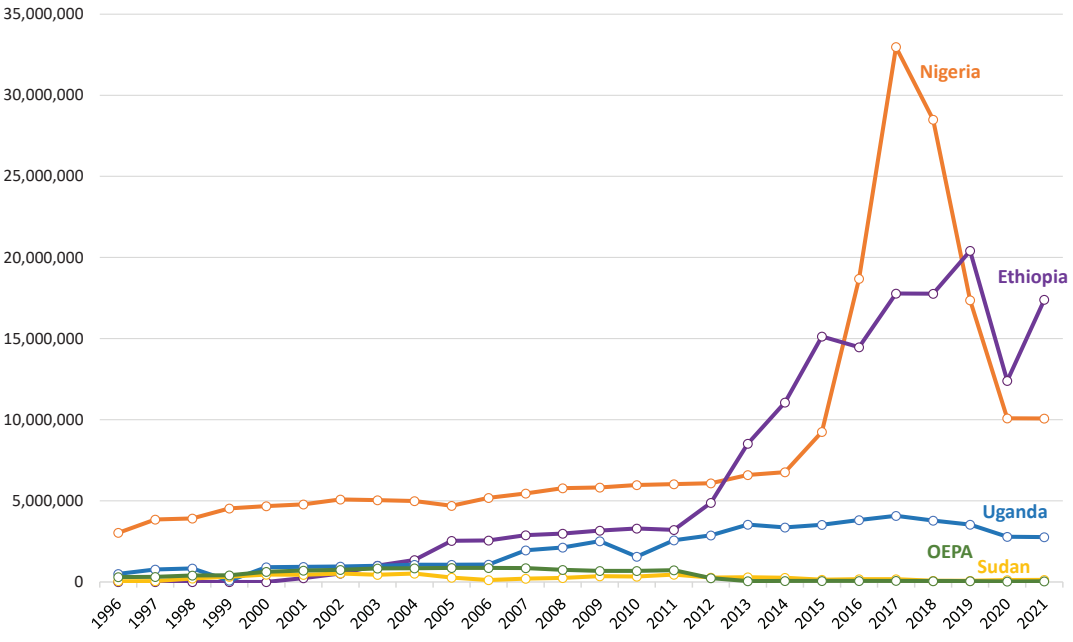
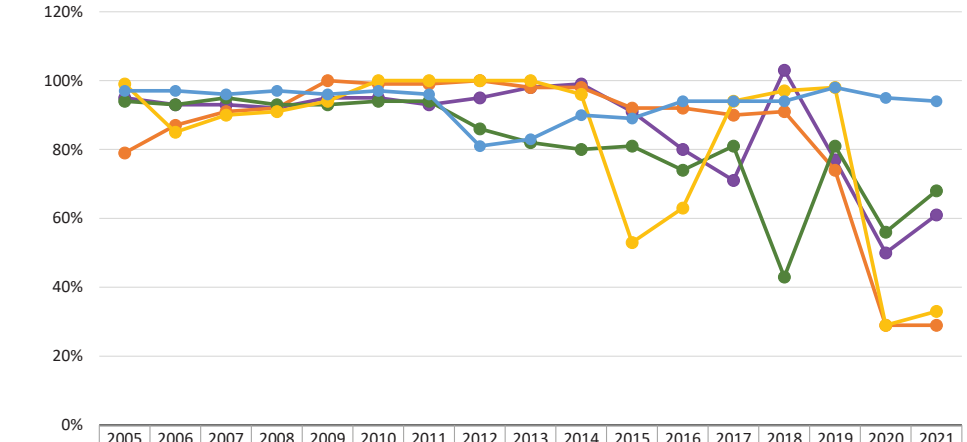


Figure 9

River Blindness Program: Reported Treatment Coverage (Eligible Population) by Country/Program, 2005 – 2021



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Ethiopia	95%	93%	93%	92%	95%	95%	93%	95%	98%	99%	91%	80%	71%	103%	77%	50%	61%
Nigeria	79%	87%	91%	92%	100%	99%	99%	100%	98%	98%	92%	92%	90%	91%	74%	29%	29%
OEPA	94%	93%	95%	93%	93%	94%	94%	86%	82%	80%	81%	74%	81%	43%	81%	56%	68%
Sudan	99%	85%	90%	91%	94%	100%	100%	100%	100%	96%	53%	63%	94%	97%	98%	29%	33%
Uganda	97%	97%	96%	97%	96%	97%	96%	81%	83%	90%	89%	94%	94%	94%	98%	95%	94%

Figure 10

Population Currently and Previously Targeted for Lymphatic Filariasis Treatment

12.1 million people in two TCC-assisted countries no longer need treatment as a result of our elimination partnership

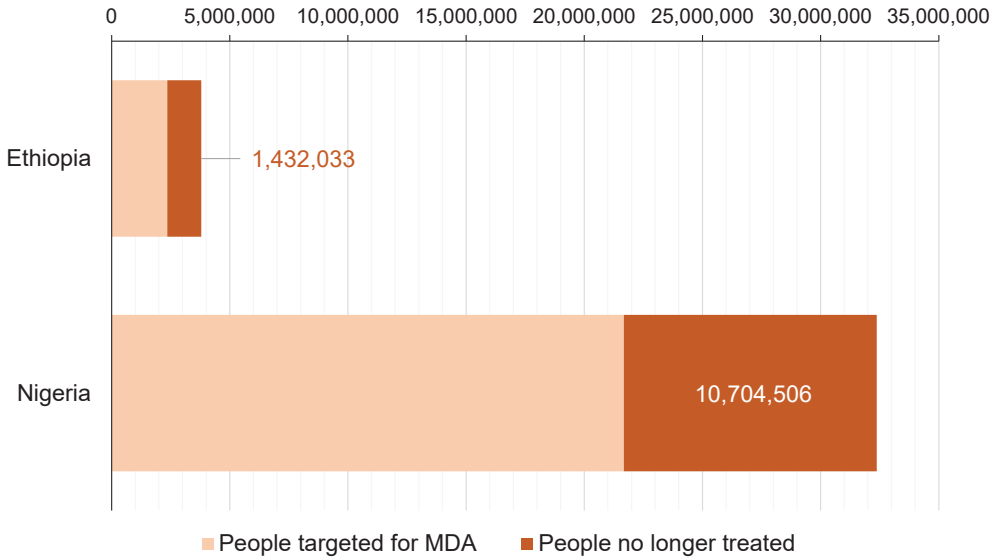


Figure 11

Lymphatic Filariasis Stopped Treatments in Carter Center-assisted areas, by Country and Year, 2016-2021

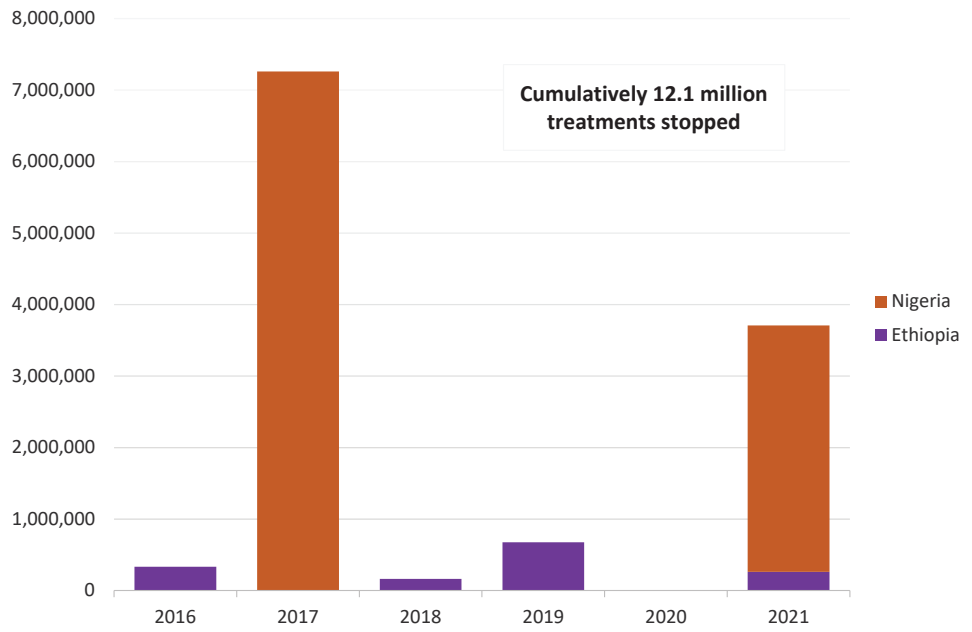
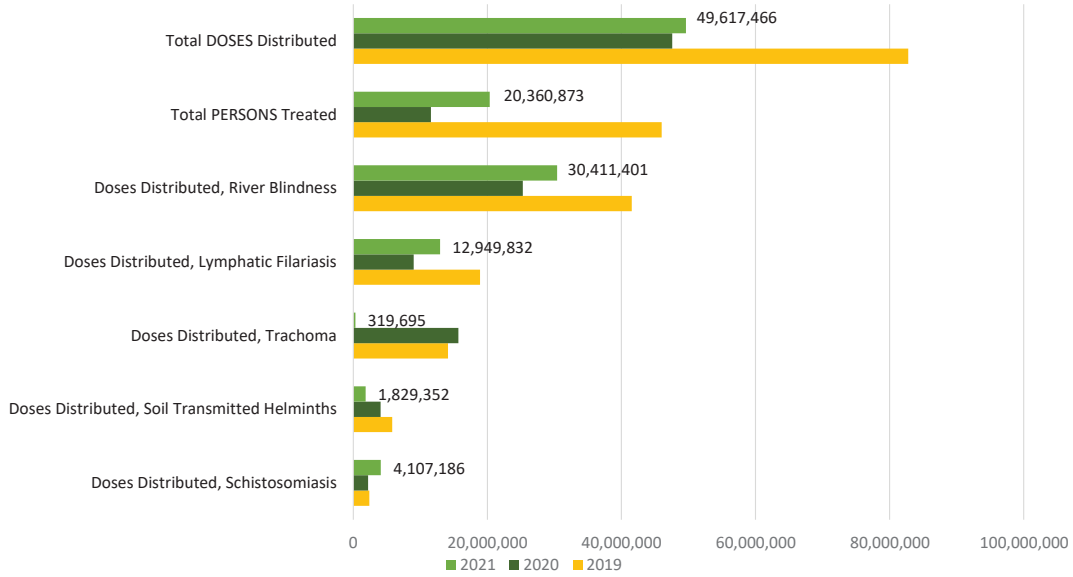


Figure 12

Carter Center-Supported Treatment Doses and Persons Treated for Neglected Tropical Diseases, 2019 – 2021



- *2021 trachoma MDA in Amhara, Ethiopia will be distributed in 2022 – approximately 16,800,000 doses of Azithromycin and Tetracycline Eye Ointment (TEO) will be counted towards 2021 MDA after the distribution period and thus 2021 numbers are provisional.*
- *The decrease in treatment between 2019 and 2020 is due to the COVID-19 pandemic*

The Carter Center is grateful for our Ministry of Health partners and the many donors and pharmaceutical companies who have made financial and in-kind contributions to make these treatments possible.

Figure 13

Community-Directed Distributors (CDDs) Trained 2004 – 2021 and 2022 Targets

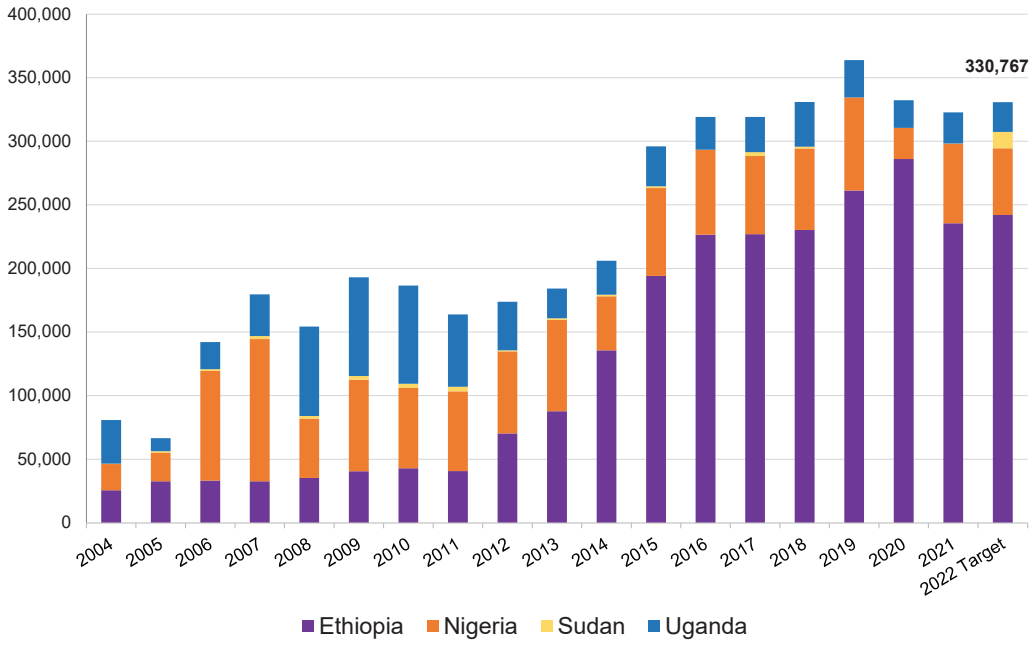
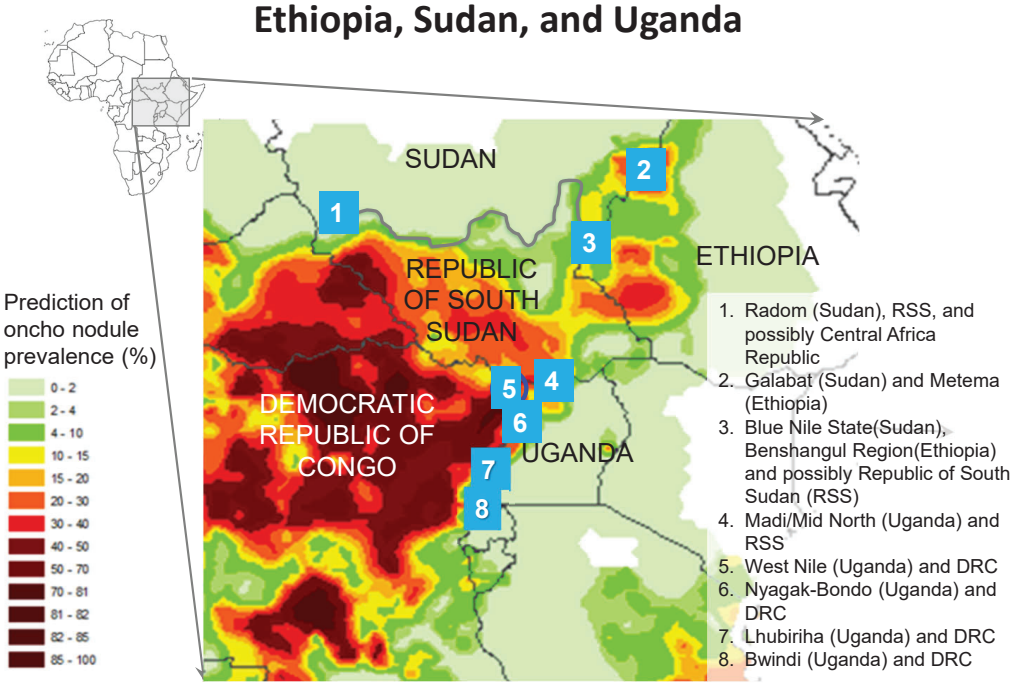


Figure 14

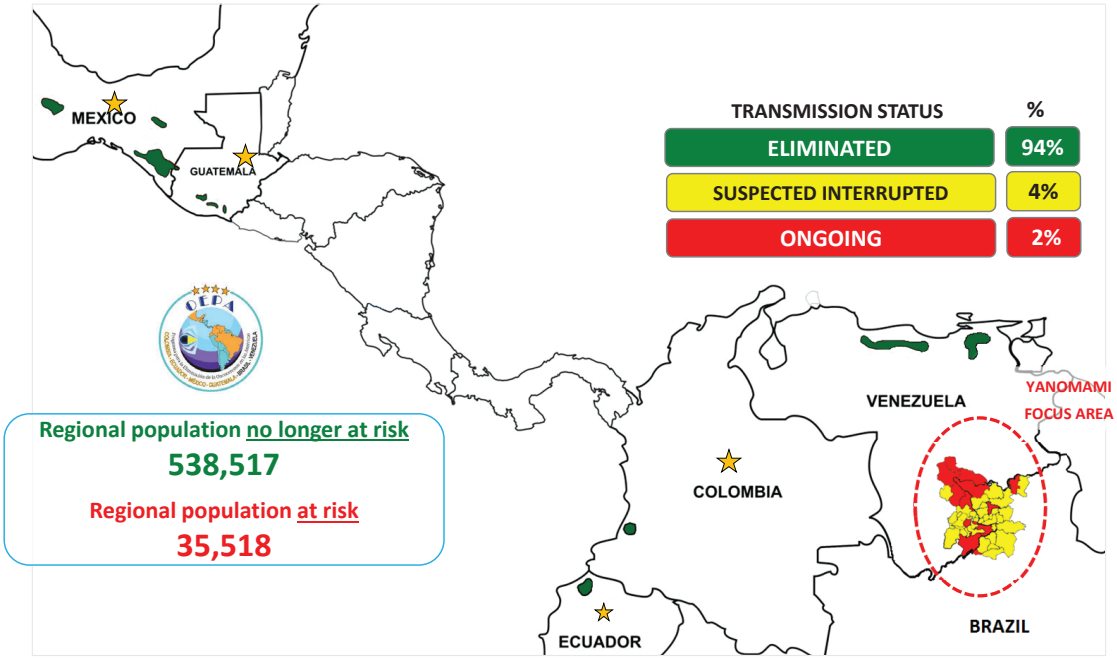
Carter Center-Assisted Special Intervention Zones in Ethiopia, Sudan, and Uganda



Map source: APOC

Figure 15

OEPA: Geographic distribution and transmission status of onchocerciasis in the Americas in 2021



★ WHO has verified the elimination of onchocerciasis in this country

Figure 16

OEPA: Mectizan® Treatment for Onchocerciasis in the Americas 1989 – 2021 and 2022 target

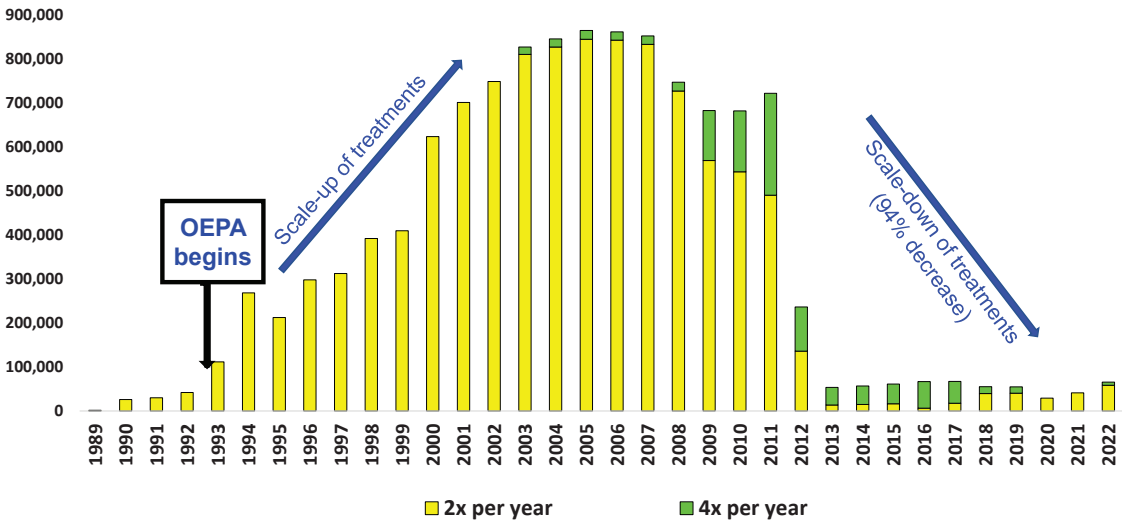


Figure 17

OEPA: Regional Population at Risk, No Longer at Risk and Eligible for Treatment in 2021

	Focus	Number of communities	Population at risk	Population out of risk	Population eligible for treatment	Transmission status
★ COLOMBIA	Lopez de Micay-COL	1		1,366		Eliminated in 2010 Verified in 2013
★ ECUADOR	Esmeraldas-ECU	119		25,863		Eliminated in 2012 Verified in 2014
★ MEXICO	North Chiapas-MEX	13		7,125		Eliminated in 2010, 2011, 2014 Verified in 2015
	Oaxaca-MEX	98		44,919		
	South Chiapas-MEX	559		117,825		
★ GUATEMALA	Escuintla-GUA	117		62,590		Eliminated in 2010, 2010, 2011, 2014 Verified in 2016
	Santa Rosa-GUA	37		12,208		
	Huehuetenango-GUA	43		30,239		
	Central-GUA	321		126,430		
VENEZUELA	Northcentral -VEN	45		14,385		Eliminated in 2013
	Northeast -VEN	465		95,567		Eliminated in 2017
	South-VEN	234	11,571		10,208	Suspected Interrupted
		147	5,947		5,225	Ongoing
BRAZIL	Amazonas-BRA	136	9,917		8,302	Suspected Interrupted
		137	8,083		6,652	Ongoing
	Regional total	**2,472**	**35,518**	**538,517**	**30,387**	

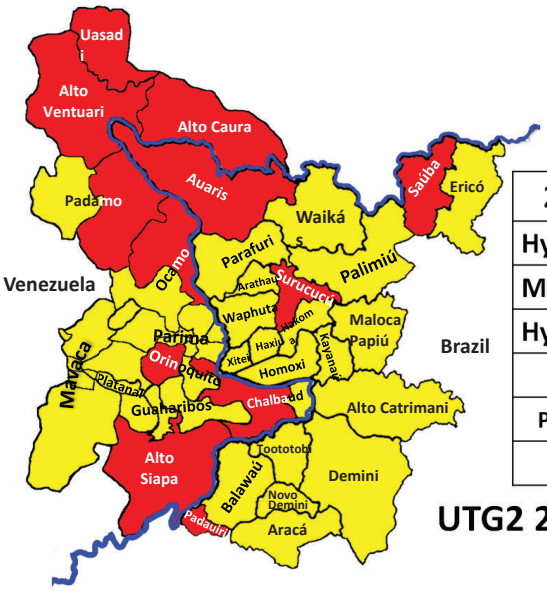
★ *WHO has verified elimination*

Figure 18

OEPA: Yanomami Focus Area (YFA) in 2021

Venezuela

South Focus	
381 communities	
Hyper	260 (68%)
Meso	46 (12%)
Hypo	75 (20%)
Pop. at risk	17,518
Pop. eligible	15,433
UTG2 30,866	



Transmission suspected interrupted

Transmission suspected ongoing

Brazil

273 communities	
Hyper	123 (45%)
Meso	78 (29%)
Hypo	72 (26%)
Pop. at risk	18,000
Pop. eligible	14,954
UTG2 29,908	

UTG2 2021 for the YFA: 60,774

Updated: 12/2021

Ref: Anonymous. Progress in eliminating onchocerciasis in the WHO Region of the Americas: advances towards transmission suppression in parts of the Yanomami focus area. *Wkly Epidemiol Rec*. 2020; 95: 484–487

Figure 19

OEPA: Mectizan® Treatments Distributed in Brazil and Venezuela, 2021

Focus	Pop. at risk	Ultimate Treatment Goal (UTG)	Treated 1st Rd (% UTG)	Treated 2nd Rd (% UTG)	UTG2	Total Treated (% UTG2)	Treatment distribution by gender	
							female	male
Amazonas-BRA	18,000	14,954	**10,743 (72%)**	**9,642 (64%)**	29,908	**20,385 (68%)**	10,092 (50%)	10,293 (50%)
South-VEN	17,518	15,433	**7,252 (47%)**	**13,612 (88%)**	30,866	**20,864 (68%)**	9,933 (48%)	10,901 (52%)
Total	**35,518**	**30,387**	**17,995 (59%)**	**23,254 (77%)**	**60,774**	**41,249 (68%)**	**20,025 (49%)**	**21,194 (51%)**

Figure 20

OEPA: Scorecard method of community prioritization

Venezuela

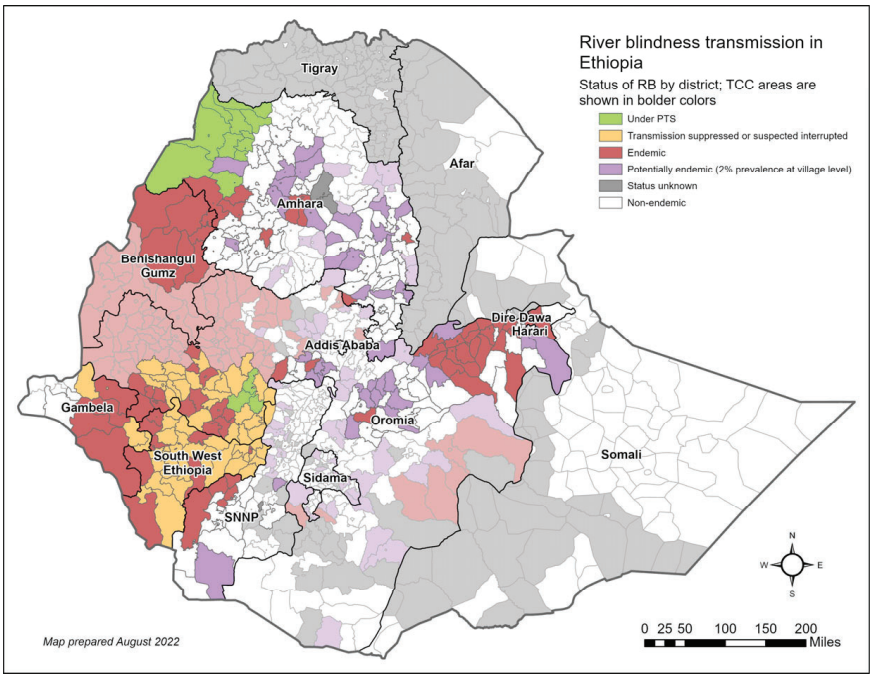
Score Range Established	Color	Priority	# of communities in this priority range	% of communities in this priority range
<=4		Low	260	68%
5 - 8		Medium	33	9%
>=9		High	88	23%

Brazil

Score Range Established	Color	Priority	# of communities in this priority range	% of communities in this priority range
<=10		Low	142	52%
11 - 15		Medium	110	40%
>=16		High	21	8%

Figure 21

Ethiopia: Status of River Blindness Elimination, by District (Woreda), 2021

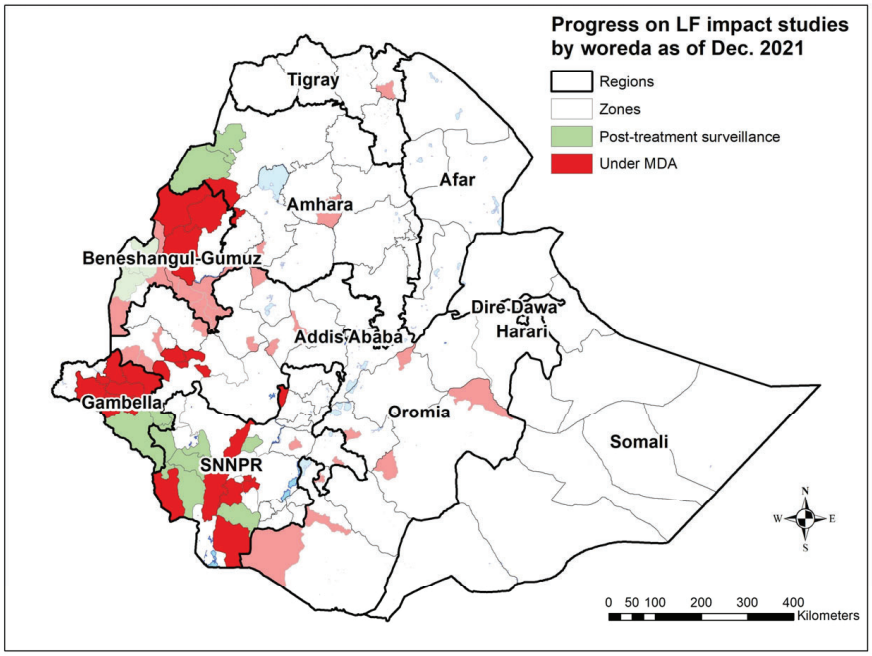


***Note**: woredas supported by The Carter Center are shown in bolder colors.*

Updated 5/9/22

Figure 22

Ethiopia: Status of Lymphatic Filariasis Elimination, by District (Woreda), 2021



***Note**: woredas supported by The Carter Center are shown in bolder colors.*

Updated 5/6/22

Figure 23

Ethiopia: Carter Center Assisted River Blindness (RB) and Lymphatic Filariasis (LF) Treatments and Targets

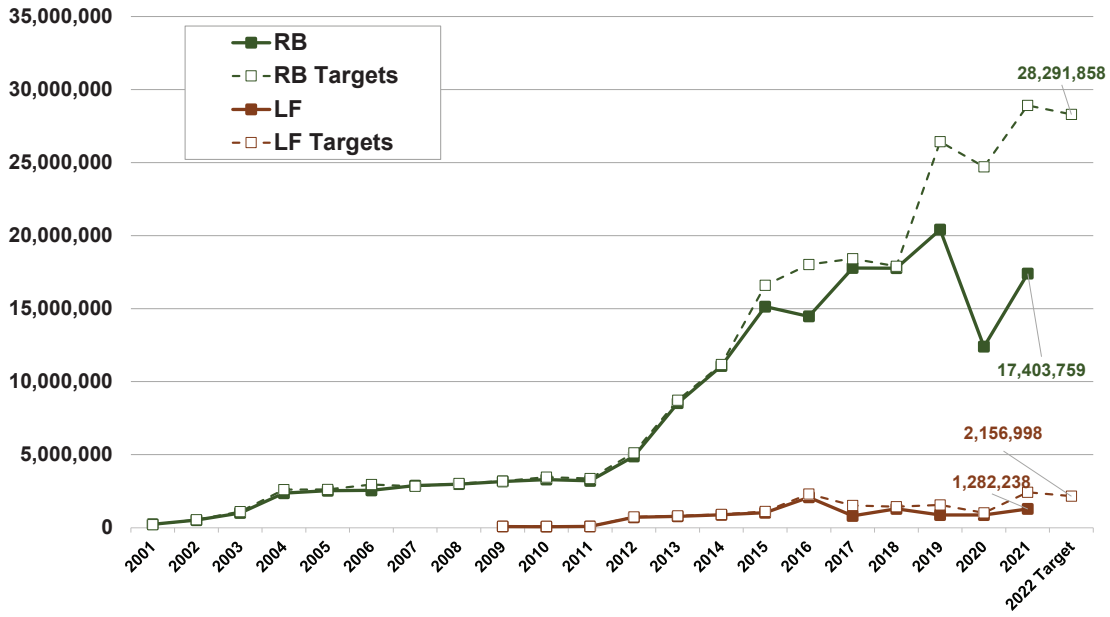


Figure 24

Ethiopia: Annual, Semiannual, and Quarterly Mectizan® Treatments for Onchocerciasis in RBEP-Assisted Areas

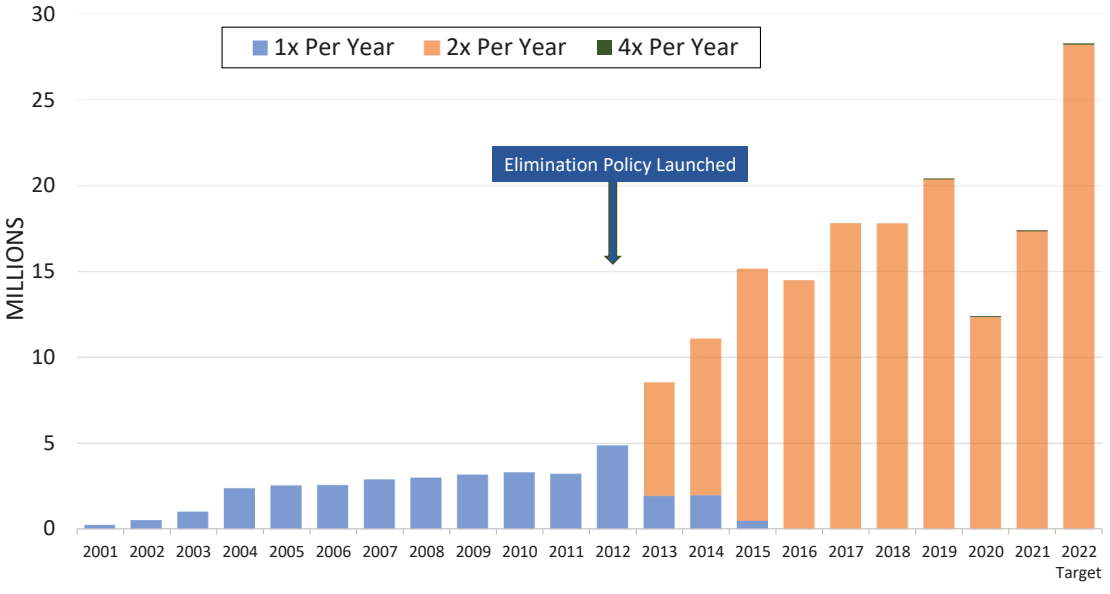
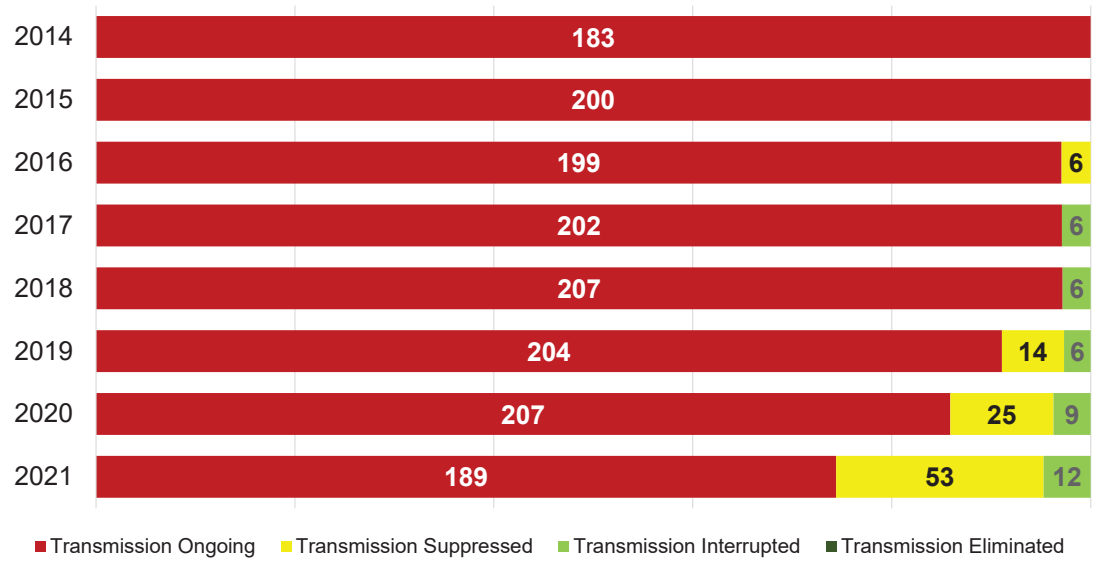


Figure 25

Ethiopia: Progress in Onchocerciasis Elimination, Transmission Status by Woreda (District), 2014-2021



Notes:
1. The increase in total number of woredas over time reflects administrative splitting.
2. In 2020, the number of woredas 'transmission interrupted' increased from 6 to 9 due to administrative splitting in Metema focus.

Figure 26

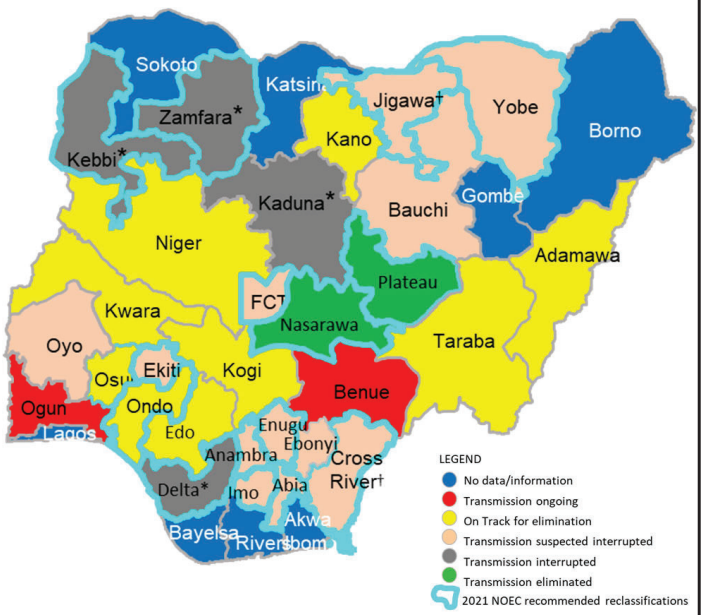
Nigeria: Status of Onchocerciasis Elimination, 2021

May 2021 - NOEC recommended:

1. Plateau/Nasarawa move from "transmission interrupted" to "eliminated" (Ash to Green)
2. Enugu/Anambra/Imo/Abia move from "transmission ongoing" to "suspected interrupted" (Red to Tan) and are to commence stop-MDA entomology surveys
3. Delta, Kebbi and Zamfara move to "transmission eliminated" (Ash) and stop RB MDA

Dec. 2021 - NOEC recommended:

1. Jigawa moves from "no data" to "suspected interrupted" (Blue to Tan)
2. FCT moves from "on track" to "suspected interrupted" (Yellow to Tan)
3. Cross River moves from "transmission ongoing" to "suspected interrupted" (Red to Tan)



* Unable to initiate PTS due to ongoing LF treatment
† Status is provisional pending updated serological assessments

Figure 27

Nigeria: Carter Center Assisted River Blindness (RB), Lymphatic Filariasis (LF), Soil Transmitted Helminths (STH) and Schistosomiasis (SCH) Treatments and Targets

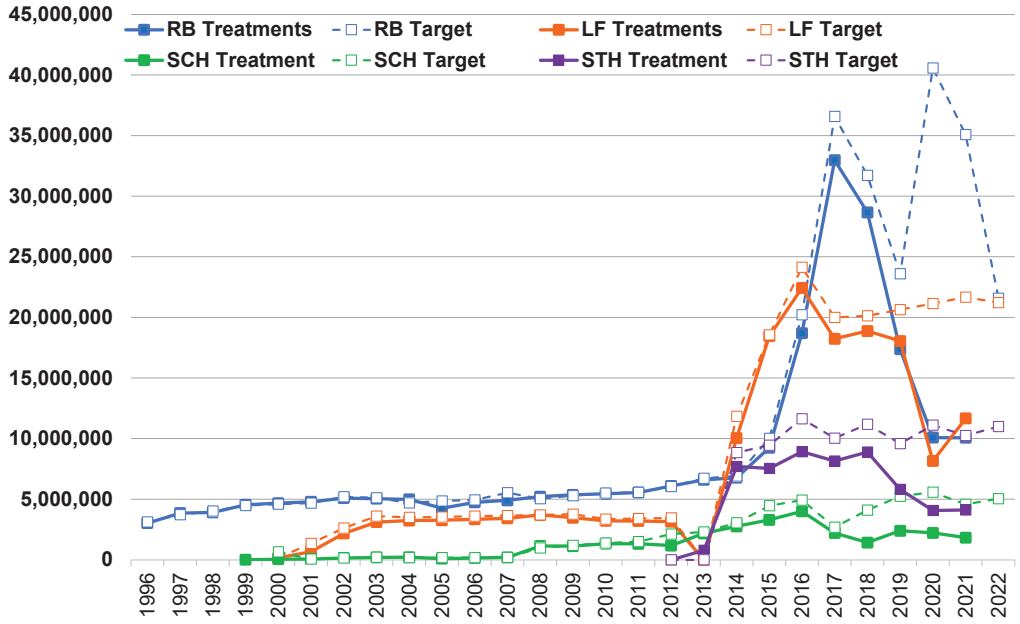
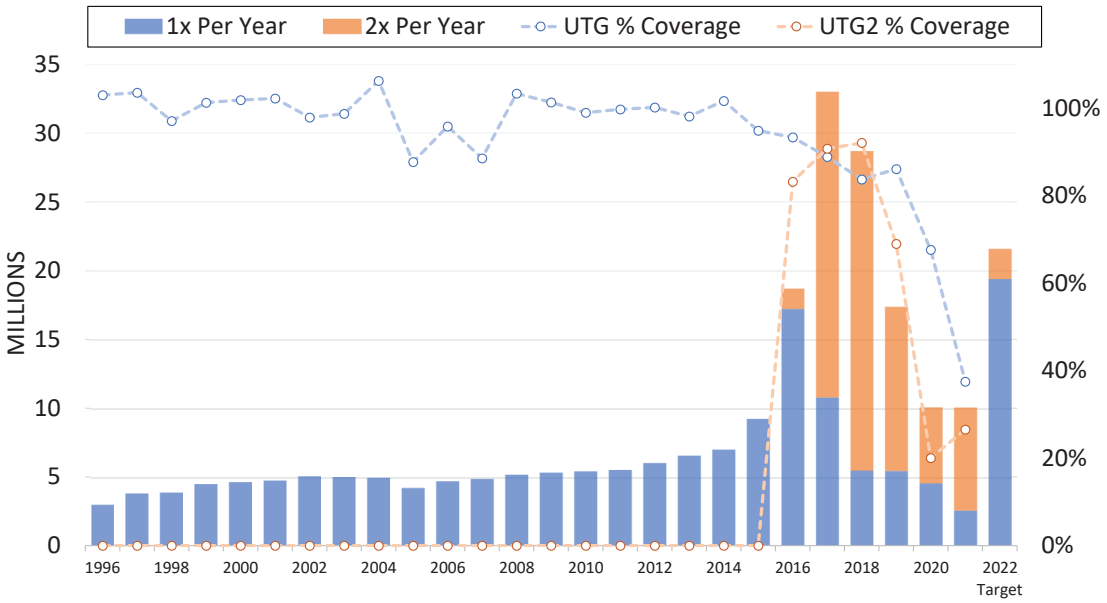


Figure 28

Nigeria: Annual and Semiannual Mectizan® Treatments for Onchocerciasis in RBEP-Assisted Areas



** The decrease in treatment in 2018 is due to Plateau and Nasarawa halting treatment due to transmission interruption, in 2019 is due to delayed arrival of Mectizan, in 2020 is due to COVID-19 pandemic, and in 2021 due to drug delays and COVID-19 pandemic*

Figure 29

Nigeria: Progress in Onchocerciasis Elimination in Carter Center-Assisted Areas: Transmission Status by Local Government Area, 2014 - 2021

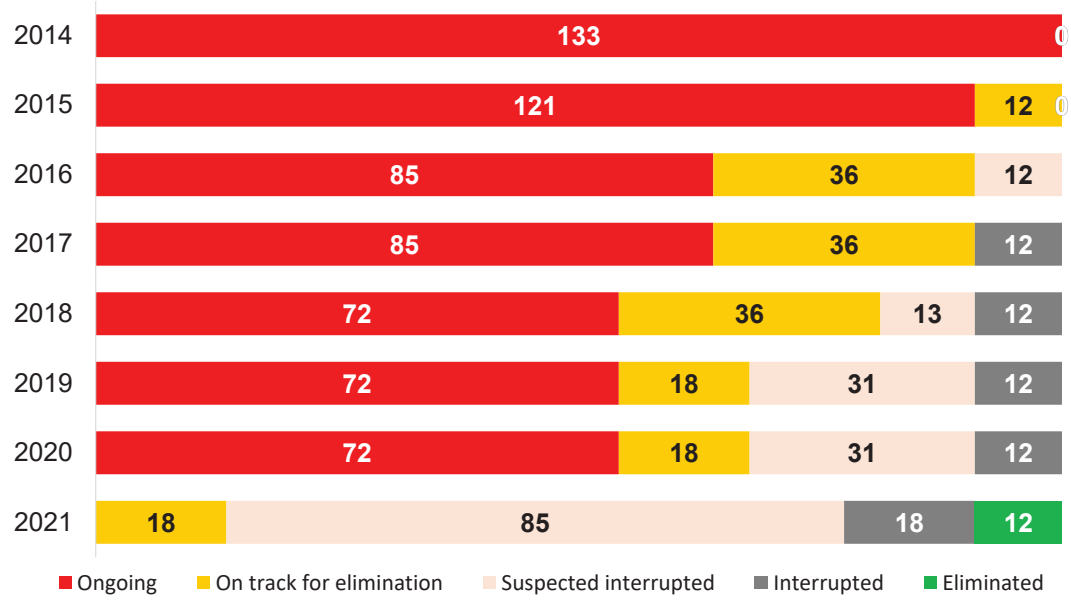
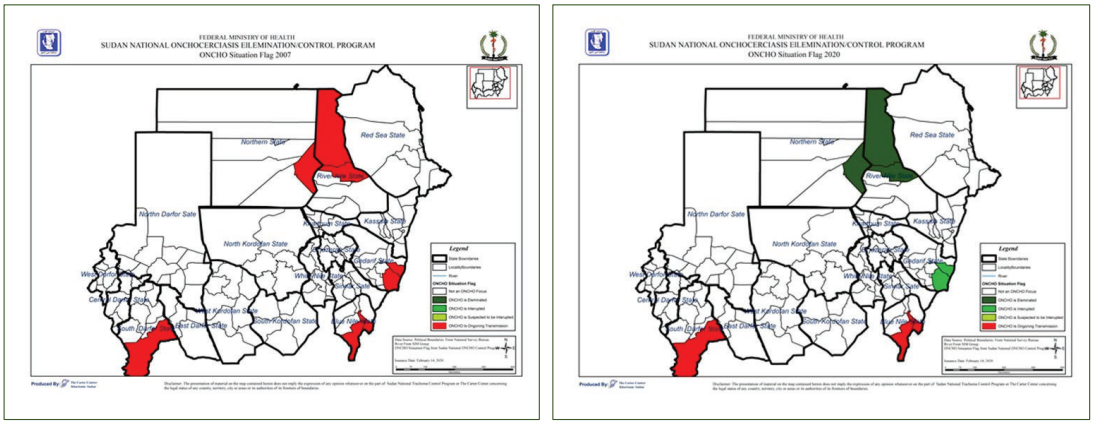


Figure 30

Sudan: Progression of Onchocerciasis Elimination

2007 **2021**



Red = Foci with ongoing transmission

Figure 31

Sudan: Progress in Onchocerciasis Elimination Foci Status 2007-2021

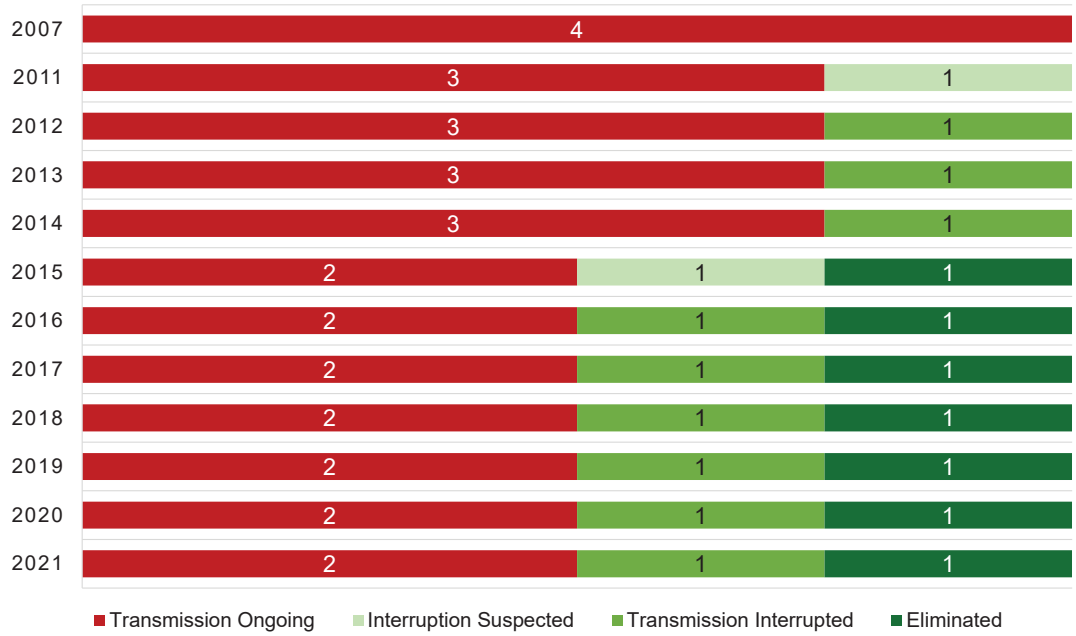
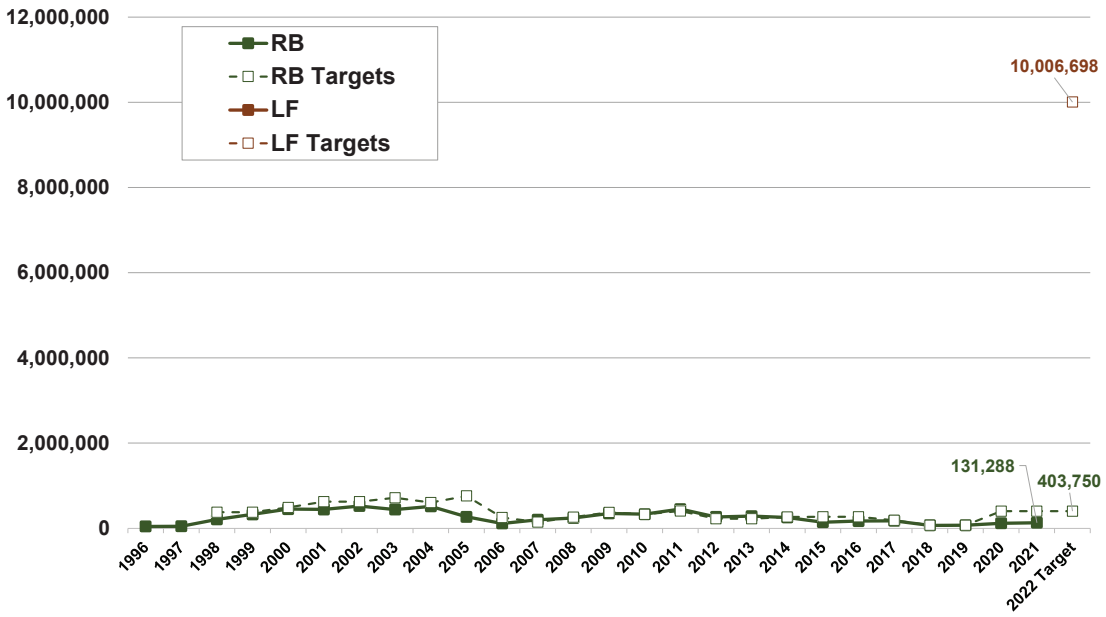


Figure 32

Sudan: Carter Center Assisted River Blindness (RB) and Lymphatic Filariasis (LF) Treatments and Targets



Note: The Carter Center will begin supporting LF MDA in 2022.

Figure 33

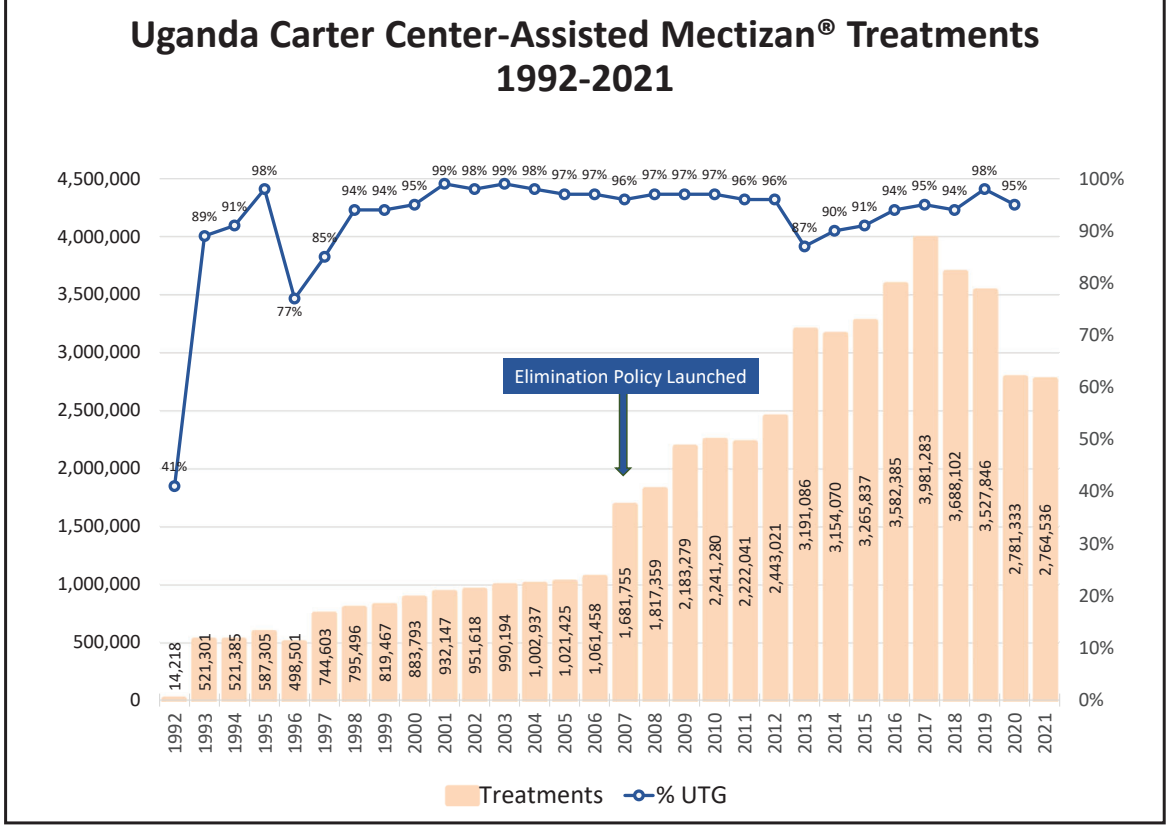


Figure 34

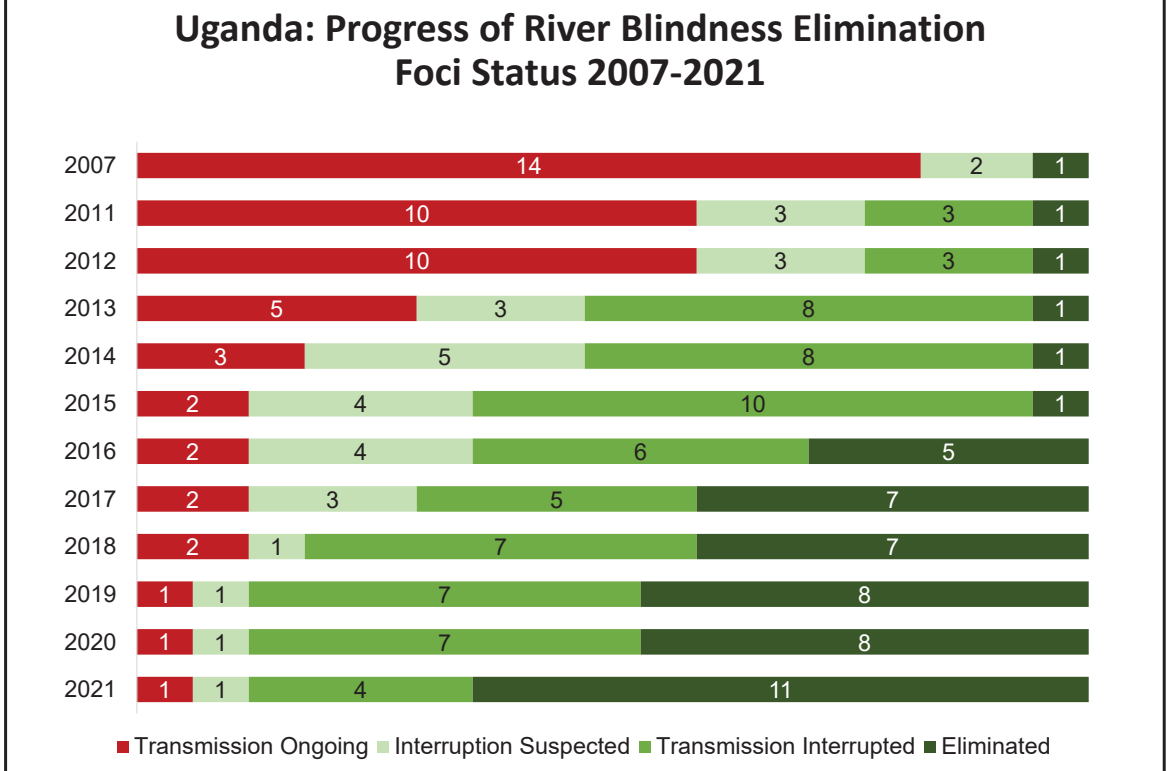
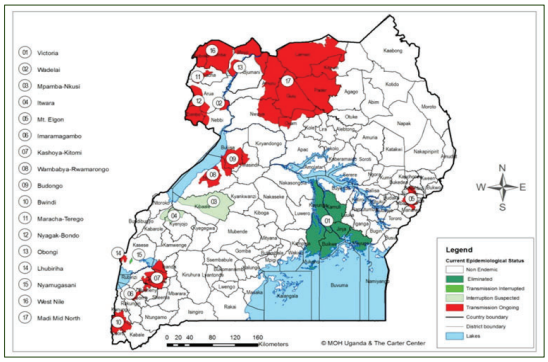


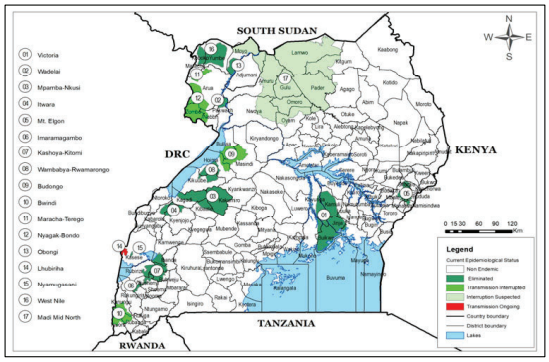
Figure 35

Uganda: Progress of River Blindness Elimination

2007



2021



Ongoing Transmission
Interruption Suspected
Interrupted Transmission
Eliminated

EXECUTIVE SUMMARY

The 26th Annual Review Meeting of the Carter Center (TCC) River Blindness Elimination Program (RBEP) was held virtually from February 28 – March 2, 2022. The RBEP Atlanta-based staff, RBEP-assisted countries' staff, Ministry of Health (MOH) officials, key partners, and donors focused on the 2021 achievements, challenges, operational research, and recommendations for 2022 activities.

The meeting was chaired by Dr. Gregory Noland, Director of the Carter Center's River Blindness, Lymphatic Filariasis, Schistosomiasis, and Malaria programs. The meeting opened with welcoming remarks from Ms. Paige Alexander, Chief Executive Officer of The Carter Center, and Dr. Kashef Ijaz, Vice President of Carter Center Health Programs, and a goodwill message from Dr. Tedros Adhanom Ghebreyesus, Director General of the World Health Organization (WHO).

The goal of the RBEP is to assist MOH in six countries[3] to eliminate river blindness (RB) transmission. The strategy for elimination in RBEP programs is mass drug administration (MDA) with ivermectin (Mectizan®, donated by Merck & Co., Inc., Rahway, New Jersey [known as Merck Sharp & Dohme outside the United States and Canada]), generally given twice-per-year, although in limited areas it is given annually or four times per year. This strategy has been highly successful in the Americas, resulting in WHO-verified national elimination of onchocerciasis from Colombia (2013), Ecuador (2014), Mexico (2015), and Guatemala (2016). The approach to RB elimination is defined by WHO guidelines, which provide three milestones (shown by the vertical lines in Figure 1): 1) transmission suppressed; 2) transmission interrupted and MDA halted; and 3) transmission eliminated after three to five years of post-treatment surveillance (PTS). After transmission elimination, post elimination surveillance (PES) occurs during which time elimination of parasite transmission is verified at the country level by WHO. The Abu Hamad Focus in Sudan was the first focus in Africa to eliminate onchocerciasis transmission in 2015 under WHO elimination guidelines.

In 2021, three foci in Uganda achieved onchocerciasis transmission elimination status, bringing the national total to 11, while the Nigerian states of Plateau and Nasarawa became the first in that country to achieve transmission elimination. As a result of our RB elimination partnership, 10.4 million people no longer need Mectizan treatment in TCC-assisted areas of ten countries (Figures 2-4).

TCC assisted with 30,411,401 Mectizan treatments for RB in the Americas, Ethiopia, Nigeria, Sudan, and Uganda in 2021. This represents 46% of the 2021 treatment target of 67 million due to the continued impact of COVID-19 as well as drug supply issues in Ethiopia and Nigeria. Country-specific treatments are shown in Figure 5. A goal of 58 million treatments has been set for 2022 (Figure 6).

RBEP's cumulative treatments since 1996 have now reached 481 million (Figure 7). Figures 8 and 9 show TCC-assisted treatments and annual coverage, respectively, by country. RBEP aims to exceed 90% reported treatment coverage of the eligible population (which excludes children under five years of age, and pregnant women) in each treatment round, except in the Americas, where the goal is at least 85% coverage.

[3] Brazil, Ethiopia, Nigeria, Sudan, Uganda, and Venezuela.

RBEP is an integrated program that includes lymphatic filariasis (LF) elimination in Ethiopia and Nigeria, and schistosomiasis (SCH) and soil-transmitted helminthiasis (STH) control in Nigeria. As a result of our LF elimination partnership, 12.1 million people in Ethiopia and Nigeria no longer need treatment (Figures 10 and 11). This includes 3.4 million people in 15 districts of Nigeria that qualified to stop treatment in 2021 and 260,923 people in three districts of Ethiopia. In 2021, TCC assisted with the distribution of 12,949,832 Mectizan and albendazole (donated by GSK) treatments for LF (54% of the 2021 treatment target), 1,829,352 praziquantel (donated by Merck KGaA, Germany) treatments for SCH (40% of the treatment target) and 4,107,186 albendazole or mebendazole (donated by Johnson & Johnson) treatments for STH (40% of the treatment target). Cumulatively, TCC has assisted in 172,031,955 LF treatments, 29,536,358 SCH treatments, and 55,910,836 STH treatments (Figure 7). RB treatments represented 62% of the 49.6 million MDA treatments for RB, LF, SCH, STH, and trachoma assisted by TCC in 2021 (Figure 12).

Our work would not be possible without a grassroots network of community-directed drug distributors (CDDs) who provide the treatments along with health education. A combined 322,714 CDDs were trained in 2021, all of whom were trained and mentored by MOH personnel working in affected districts assisted by TCC (Figure 13).

TCC mourns the loss of all those who died in 2021, including Dr. Nabil Aziz Awad Alla, Country Representative for Carter Center Programs in Sudan and Mr. John Umaru, pioneering member of the River Blindness Foundation in Nigeria.

2022 GENERAL RECOMMENDATIONS FOR CARTER CENTER RIVER BLINDNESS ELIMINATION PROGRAMS

Overview of the RBEP mission: In collaboration with the host governments, RBEP helps to interrupt onchocerciasis transmission in TCC-assisted areas in Africa and the Americas. RBEP work includes:

- Helping to empower national onchocerciasis elimination committees to review their data and inform national decisions that demonstrate progress toward elimination, such as: enhancing interventions, expanding treatment, stopping interventions, and conducting PTS. Decisions should be guided by (but not restricted to) the World Health Organization (WHO) guidelines.
- Conducting new assessments to help delimit the precise borders of African onchocerciasis transmission zones ('foci') and buffer zones between transmission zones that can assist our elimination agenda in RBEP-assisted areas.
- Defining areas of active onchocerciasis transmission, including within the so-called 'hypoendemic' onchocerciasis areas that have traditionally not been targeted for Mectizan treatment under previous WHO/African Program for Onchocerciasis Control (APOC) disease control policy.
- Enhancing interventions (two- or four-times-per-year Mectizan treatment, vector control, etc.) where transmission persists or in new foci where treatments have never been given.
- Where active onchocerciasis transmission spans borders, working with authorities on both sides of internal or international boundaries to establish 'Special Intervention Zones' (SIZs) to encourage collaboration and coordination on both sides to stop transmission (Figure 14).
- Monitoring the impact of interventions using sensitive and specific tools. Consider integrated monitoring especially in RB-LF overlap areas when "stop-MDA" or other impact evaluations are needed.

- RBEP program staff are encouraged to develop innovative solutions to local problems. Stay informed of pilot funding opportunities through TCC Innovation Hub. Engage program managers and TCC/Atlanta early to ensure support.
- TCC health programs should continue COVID-19 risk mitigation as recommended by WHO, their national programs, and TCC Atlanta, including the use of masks, hand hygiene, social distancing measures, and modified protocols for trainings, surveys, and other large gatherings.
- As national COVID-19 policies permit, encourage the resumption of in-person national and international meetings, which have suffered from lack of detailed deliberations. Offer virtual options for those unable to attend in person. In particular, maintain a virtual participation option for international staff for TCC Program Review meetings.
- RBEP encourages improved collaboration and transparency among stakeholders and advocates for strengthening national supply chain management to reduce drug supply delays and supply inaccuracies.
- Programs should collect more information to determine reasons for persistently low treatment coverage.
- TCC field offices should conduct treatment coverage surveys in at least two districts in two

subregions/states/zones annually, in consultation with Headquarters (HQ) and Ministries of Health (MOH).

- Include details on MDA activities among refugees, internally displaced persons, and migrants, as well as by gender, in annual reports and presentations.
- RBEP encourages the MOH to submit drug applications to WHO and the Mectizan Donation Program (MDP) as early as possible; timely receipt of drugs is critical, particularly for twice-per-year treatment areas. TCC/RBEP in African countries should actively pursue collaboration with the MOH on application preparation, and submission by April 30. Drug inventories must be submitted with applications. Keep RBEP HQ informed throughout the process.
- Any adverse event associated with MDA must be reported to the Atlanta office within 24 hours.
- Seek to increase training, supervision, involvement of kinship groups, and gender balance among CDDs and CSs.
- TCC website should house key public domain documents from national onchocerciasis elimination committees of Ethiopia, Nigeria, Sudan, and Uganda. The Onchocerciasis Elimination Program for the Americas (OEPA) domain should house InterAmerican Conference on Onchocerciasis (IACO) and Program Coordinating Committee (PCC) meetings' conclusions and recommendations.
- TCC/RBEP will maintain laboratories for OV16 serology, entomology, and parasitology (including O-150 polymerase chain reaction [PCR] testing in vectors and skin snips), with technical support by Dr. Thomas Unnasch and his team at the University of South Florida (USF). In consultation with USF, field laboratories should send samples and/or requested data to USF for quality control purposes. Reagent and supply orders from these labs must be reviewed promptly by Dr. Unnasch or his staff so that TCC HQ can purchase and ship supplies in a timely manner. TCC will continue to use the 'OEPA' OV16 enzyme-linked immunosorbent assay (ELISA) and standard (qualitative) PCR for OV16 and O-150 testing, respectively.
- Change the O-150 PCR testing pool size protocol to 100 flies maximum per pool in the Americas context, in accordance with Dr. Tom Unnasch's recommendation.
- Review and consider, internally and with NOECs, the frequent changes in recommendations being produced by the WHO Onchocerciasis Technical Subgroup (OTS) and the Task Force for Global Health, particularly as these relate to the mapping of onchocerciasis in presumably hypoendemic areas and new diagnostic approaches. The changing recommendations are causing considerable confusion for the programs and imply resource expenditures that TCC is unable to support at this time.
- Through national mechanisms, RBEP offices should monitor government, Expanded Special Project for Elimination of NTDs (ESPEN), and other partners' financial contributions for elimination efforts in RBEP-assisted areas.
- RBEP program staff must complete or renew their Emory Institutional Review Board (IRB) certification if they are to be involved with work that is considered human subject's research. Coordinate with HQ staff regarding all IRB determinations and compliance.
- In fulfillment of the second pillar of the Global Programme to Eliminate LF, ensure that CDDs collect and report LF morbidity data in LF-endemic areas of Ethiopia, Nigeria, and Sudan as part of annual program reports.
- TCC's RB, LF, SCH, and STH Programs aim to assist with the distribution of 108 million treatments in 2022.

2022 Treatments and Training Objectives:

UTG = Ultimate (annual) Treatment Goal
UTG2 = Twice-per-year Treatment Goal
UTG4 = Four-times-per-year Treatment Goal

2022 River Blindness Treatment Targets			
Annual (UTG)	Semiannual (UTG2)	Quarterly (UTG4)	Total
19,379,589	38,810,786	67,200	**58,257,575**

2022 Lymphatic Filariasis Treatment Targets	
Annual (UTG)	Total
33,381,498	**33,381,498**

2022 Schistosomiasis Treatment Targets	
Annual (UTG)	Total
5,038,356	**5,038,356**

2022 Soil-Transmitted Helminths Treatment Targets		
Annual (UTG)	Semiannual (UTG2)	Total
7,716,302	3,277,736	**10,994,038**

2022 Training Objectives	
Total CDDs	Total CSs
330,767	**187,219**

THE AMERICAS

Presenter: Dr. Mauricio Sauerbrey (The Carter Center)

Summary:
OEPA is a coalition led by TCC that includes the ministries of health of the affected countries in the Americas, the Pan American Health Organization (PAHO)/WHO, and other partners. The OEPA initiative has stopped treatments in 94 percent of the population once endemic for the onchocerciasis, and four countries have received WHO verification of elimination: Colombia (2013), Ecuador (2014), Mexico (2015) and Guatemala (2016). In 2017, PTS was completed in the Northeast Focus of Venezuela, once the third largest transmission zone of the region in terms of population. See Figure 15 for a map of the region. The OEPA treatment history over two decades shows a scaling up of MDA treatments followed by a scaling down of treatments as elimination was achieved in an increasing number of areas (Figure 16).

The original and current transmission zones of the Americas can be seen in Figure 17, with transmission status by focus. The last active transmission zone is in the Amazon rainforest bordering Brazil and Venezuela, called the 'Yanomami Focus Area' (YFA) after the indigenous people residing there (Figure 18). Around 35,518 people living in 654 communities are believed to be at risk of onchocerciasis in the YFA. Notable challenges include the remoteness of the YFA, its nomadic populations, the lack of high-level coordination between Brazil and Venezuela, and the political, humanitarian and health crises in Venezuela. OEPA announced a long-awaited achievement: completion of construction of an airstrip in Siapa Valley, Venezuela. This will allow regular access to 16 of the most remote YFA communities, where transmission is still ongoing in about 700 persons.

Due to the COVID-19 pandemic, the annual IACO meeting was held virtually November 3 – 4, 2021, and PCC, which usually meets twice annually, met once, July 22 – 23, 2021.

The OEPA program received financial support from USAID's *Achieve Onchocerciasis Elimination in the Americas* and Merck & Co., Inc., Rahway, New Jersey in 2021.

Treatments:
In 2021, OEPA assisted Brazil and Venezuela with 41,249 Mectizan treatments, representing 68% of the 2021 treatment target of 60,774. Both Brazil and Venezuela achieved 68% of their respective treatment goals. In Brazil, Mectizan treatments were offered primarily alongside essential health services as the COVID-19 pandemic persisted, while Venezuela offered stand-alone treatments. In addition to resource prioritization for the pandemic, the program had challenges with fuel supply and available flight hours to visit many of its endemic communities. Figure 19 shows detailed treatment information from 2021.

The 2022 treatment target for OEPA is 65,450 treatments and includes a four-times-per-year treatment approach in three priority sub-areas of Venezuela.

Training:
Some of the Yanomami people from endemic communities of both Brazil and Venezuela are trained to serve as Indigenous Health Agents (IHAs), who provide health services in the YFA. IHAs delivered 56% of treatments that occurred in Venezuela in 2021. In Brazil, 139 Yanomami people assisted Mectizan treatment activities (six, or 4%, of these are women) while in Venezuela 99 IHAs serve the program (three, or 3%, of these are women). Both countries conducted training and retraining exercises for IHAs; in Brazil this was primarily done by MOH staff, while in Venezuela health staff conducted some training of IHAs directly and also continued work to train

Yanomami Educators who in turn train Yanomami IHAs. In 2022, Venezuela will in prioritize training of female health staff to train female IHAs.

Special Topics:
Eng. Dalila Rios (The Carter Center) presented progress on OEPA's "scorecard" system that has been implemented in Brazil and Venezuela, with the aim of stratifying communities and prioritizing those that are undertreated (Figure 20). The scorecard uses a variety of attributes including number of high coverage treatment rounds (i.e., ≥85% coverage of eligible population), initial level of endemicity, black fly vector species, and means of access to the community. Epidemiological data is also used (serology and parasitology) when possible. Identification of high priority communities using these indicators allows country programs to focus their human and material resources to achieve onchocerciasis transmission elimination.

	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG2	60,774	41,249 (68%)	65,450

THE AMERICAS 2022 RECOMMENDATIONS

GENERAL:

- Deliver a minimum of two effective (≥85% coverage) rounds in all communities of the YFA, maintaining COVID-19 precautions as stipulated by the governments.
- The new WHO NTD Roadmap sets the target year for onchocerciasis transmission elimination in the Americas as 2025. The OEPA PCC takes this to mean that MDA should stop by the year 2025. Completing PTS and obtaining formal verification will take 3-5 years longer.
- Both country programs are encouraged to take advantage of their COVID-19 vaccination campaigns in the YFA to distribute Mectizan treatment for onchocerciasis.
- Continue work to increase involvement of IHAs, Yanomami Educators, and Yanomami women.
- Launch Innovation Hub-funded health education study of the impact of hand-held tablet computers on health workers' (HWs') performance in Venezuela.
- Conduct epidemiological assessments (serology, entomology) in non-sentinel areas when the pandemic allows.
- Continue work to compile previous monitoring results (particularly serology and entomology) into subregion- or community-specific graphs and tables to better track progress over time.
- Continue, as the programs are able, the use of doxycycline treatment as an important ancillary approach in the final stages of elimination.
- The village level scoring system is an ever-stronger tool and should be continually updated. In addition to discrete national scoring based on their information systems, there is value in having a common scoring system for the overall Yanomami Area based on common data variables, such as effective (≥85%) treatment rounds, baseline endemicity, most recent assessment results, and prevailing vector species.
- Hold a midyear PCC meeting, as well as a PCC in tandem with the IACO meeting later in the year.
- Hold the IACO meeting in late 2022. Promote the highest level of political representation at IACO from PAHO, Venezuela and Brazil, assuming the political environment in both countries allows such open collaboration. Encourage the Lions Clubs International Foundation to maintain support to a Lions representative from each of the six countries to attend IACO. Continue to invite all six OEPA country representatives regardless of verification of elimination status. This meeting can be in-person or virtual as the pandemic allows.

VENEZUELA:

- Source airplane fuel for Venezuela to allow program activities and airstrip maintenance to continue.
- Since helicopter flights are not available due to lack of service providers, consider alternatives like additional IHAs, fixed-wing planes, boat, and foot access, etc.
- If four-times-per-year treatment in the 3 selected areas (38 communities) is determined to be effective, add the other 2 sectors (27 communities) in the second half of 2022. Yanomami Educators and IHAs who will take part in treatment activities, helping to alleviate the lack of transportation in remote areas and meet treatment goals. Seek increased involvement of women in these roles. Track the number and gender of IHAs in each program and establish common indices to monitor their performance (such as ratio of IHAs: persons treated, IHAs/community, ancillary program benefits, etc.). Document the participation of each group and track the impact on program treatment coverage. Utilize anthropology consultants, in

agreement with CAICET, to supplement this work with culturally sensitive, effective training materials.

- In the few remaining unvisited “new” communities identified by satellite imaging, conduct a site visit for skin snip assessments and OV16 serology; and if the village is confirmed to be onchocerciasis endemic, quarterly Mectizan treatment should be started immediately.
- Seek new ways to channel funding to support PES entomology activities in NE Venezuela, if the area’s security situation allows.

BRAZIL:

- Continue work to compile historical community-level treatment data to assist in score-card community prioritization.
- Continue entomological assessments in Auaris, Surucucú, Homoxi, and Arathaú in 2022 to determine transmission status in these four subareas, which are of interest for various reasons including recent serology results that indicate a need for current entomology data, and in Surucucu’s case, low treatment coverage.
- Follow Dr. Unnasch’s recommendation to limit the size of fly pools for PCR to maximum 100 flies per pool.
- Seek to understand the high OV16 levels in Auaris. Follow-up to Fiocruz’s providing to USF’s laboratory the requested optical density readings from samples as part of the quality control (QC) process. Hold a special session on this issue at the mid-year PCC meeting and invite Prof Tom Unnasch to discuss options and issues, including potential cross-reactivity with *Mansonella ozzardi* yielding false-positive OV16 results, migration, etc.

ETHIOPIA

Presenters: Dr. Zerihun Tadesse and Mr. Mohammed Hassen (The Carter Center)

Summary:
Since 2001, TCC has assisted the Ethiopian MOH to eliminate transmission of onchocerciasis in the country. Around 25 million people are at risk of the disease in 254 *woredas* (districts)—approximately one quarter of country—with 17 woredas still awaiting mapping (Figure 21). The RBEP currently supports activities in 161 (63%) endemic woredas that includes providing primarily twice-per-year treatments to aggressively reach the FMOH's goal of onchocerciasis elimination by 2030. RBEP first provided semi-annual treatment starting in 2013 supplemented with quarterly treatment in select areas since 2018. Ethiopia is home to the first cross-border focus to interrupt transmission of onchocerciasis—the Metema-Galabat focus in northwestern Ethiopia - eastern Sudan. TCC has assisted the Ethiopian LF program since 2009. Approximately 6.4 million people in 88 (9%) woredas are at risk of infection (Figure 22). Activities in 2021 were limited again by Mectizan availability that prevented semi-annual treatment from occurring in many RB-endemic areas across the country. Nonetheless, several districts achieved their milestones and stopped MDA for RB or LF.

Due to the COVID-19 pandemic, the annual Ethiopia Onchocerciasis Elimination Expert Advisory Committee (EOEEAC) was held virtually in October 2021.

TCC's work in Ethiopia is based on a longstanding partnership with the MOH and receives support from Lions Clubs International Foundation, the Lions-Carter Center SightFirst Program, The Reaching the Last Mile Fund, housed within the END Fund and led by His Highness Sheikh Mohamed bin Zayed Al Nahyan, the Crown Prince of Abu Dhabi, and other donors.

Treatment:
In 2021, Ethiopia delivered a total of 17,403,759 Mectizan treatments for river blindness, representing 61% of the 2021 treatment target (Figures 23 and 24). The TCC-assisted LF program provided 1,282,238 annual treatments with Mectizan and albendazole, representing 58% of the 2021 treatment target. More than 74,000 villages were reached. The program aims to deliver 28,224,658 semi-annual and 67,200 quarterly treatments for RB and 2,156,998 for LF in 2022 (Figure 23).

Training:
A total of 235,507 CDDs were trained in 2021, about 50,000 fewer than in 2020 and 53% of the annual goal. Additionally, 81,873 (57%) CSs and 8,057 (50%) health extension workers (HEWs) received training. The goals for 2022 are 403,897 CDDs and 134,288 CSs.

Impact:
In 2021, three woredas encompassing 508,000 people in Oromia region met WHO criteria to stop-MDA for RB. This brings the total number woredas in PTS to 12 (Figure 25) and the total number of people no longer treated to 1.6 million (Figure 3). Additionally, OV16 seroprevalence in children 5-10 years old was less than 1% in 27 of 34 woredas evaluated, meaning the 27 are reclassified as 'transmission suspected interrupted' and will initiate stop-MDA surveys in 2022.

For LF, three districts (two in Amhara region, one in Southern Nations, Nationalities, and People's Region [SNNPR]) encompassing 260.923 people passed transmission assessment survey (TAS)-1, thus meeting criteria to stop Mectizan-albendazole MDA. Cumulatively, 1.4 million people in Ethiopia no longer need MDA for LF (Figure 11). An additional three woredas under

PTS in SNNPR passed TAS-2 indicating transmission remains interrupted. Conversely, two woredas of Gambella region failed pre-TAS-1 for the third time.

Special Topics:
Aderajew Mohammed (The Carter Center) presented several years' worth of coverage survey data. Results showed that reported coverage was often significantly higher than the surveyed coverage, particularly in SNNPR and Oromia; nonetheless, the majority of *kebeles* (the country's lowest administrative unit) had acceptable coverage above the program's minimums. For example, of 49 kebeles surveyed in 2020 and 2021, 26 (53%) had coverage above 80%.

Ms. Emily Griswold (The Carter Center) presented an alternative way of creating the "oncho flag" for Ethiopia, using historical treatment coverage and its interaction with epidemiology to prioritize districts for evaluation.

River Blindness			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG2	28,358,312	17,342,258 (61%)	28,224,658
UTG4	61,179	61,501 (100%)	67,200
Total	**28,419,491**	**17,403,759 (61%)**	**28,291,858**

Lymphatic Filariasis			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG2	2,430,256	1,282,238 (53%)	2,156,998

Training Objectives			
	2021 Training Targets	2021 Training (%)	2022 Training Targets
CDDs	309,224	235,507 (76%)	241,985
CSs	103,075	81,873 (79%)	83,907
HWs	11,453	8,057 (70%)	7,738

ETHIOPIA 2022 RECOMMENDATIONS

GENERAL:

- Work toward a target ratio of at least 1 CDD:50 people, 1 CS:5 CDDs, and 1 CS per village nationwide.
- Consider publication of the remarkable success in improving gender ratios among CDDs and CSs.

ONCHOCERCIASIS

- Maintain good coverage of four-times-per-year MDA in the Wude Gemzu 'hot spot' of the Metema sub-focus as best as possible given security issues there. Complete the entomology evaluations scheduled to confirm absence of L3 parasites in vectors. Publish findings (a companion paper was promised in the paper by Katabarwa *et al.*, 2020).
- Document the absence of vectors or infected vectors in the buffer zone surrounding the broader Metema sub-focus, per EOEEAC guidance. Remote sensing applications may help here, if available.
- Complete all 'first stage' mapping activities recommended by the WHO Onchocerciasis Technical Subgroup (OTS), as resources and security allow and in consultation with TCC HQ, EOEEAC and FMOH. Leave OTS second-stage random sampling mapping to FMOH, ESPEN or other partners. Only 17 districts need to begin serological investigations. Discuss OTS recommendations at EOEEAC and with donors before further field work or MDA expansion. The current EOEEAC guidance for starting MDA relies on a mean OV16 seroprevalence of ≥2% in adults across a *woreda*, while that of OTS is ≥2% in any single village in the woreda, which considerably expands the number of districts requiring MDA. Work with HQ to resolve issues among donors who are not willing to support district-level expansion under the EOEEAC guidelines.
- Secure the funding needed to establish twice-yearly MDA in 11 new districts.
- Provide financial and administrative support for the 2022 EOEEAC meeting.
- Expand entomological investigation in East and West Hararghe, Oromia region, to appropriately characterize RB transmission.
- Publish findings from East and West Hararghe zones, where dried blood spot (DBS)-positive children were recently found. Entomological surveillance is underway and would be key to include in such a publication. This part of Ethiopia was previously considered by APOC to be ecologically unsuitable for onchocerciasis transmission.
- Encourage EOEEAC to issue a press release following each meeting and the chair to brief the Minister of Health after each meeting.
- The program should provide updates on treatment of refugees in border areas assisted by TCC, especially in Gambella.
- Promote coordinated activities (e.g., MDA) in cross-border areas of Beneshangul-Gumuz region and neighboring areas of Sudan (Blue Nile state) as the security situation allows. Invite Sudan representatives to EOEEAC meetings and seek invitation to Sudan's national RB elimination committee meetings.
- Further develop collaboration between partners assisting West Wollega and Kamashi zones to enhance impact.
- Develop enhanced mobilization strategies for MDA in areas with consistently poor coverage, particularly in Itang special woreda and South Omo zone. Enhance interventions in areas failing impact assessments.
- Stop MDA and begin PTS in TCC-assisted areas approved by FMOH. Continue stop MDA assessments in SNNPR and Oromia in accordance with EOEEAC recommendations.

LYMPHATIC FILARIASIS

- Investigate MDA coverage, community perception, migration patterns, and long lasting insecticidal bed net (LLIN) ownership in woredas that failed pre-TAS, especially in Gambella region. Develop recommendations from findings to increase the impact of interventions on LF.
- In consultation with HQ and FMOH, conduct pre-TAS and TAS studies in eligible areas. Work with FMOH to coordinate the order and delivery of test kits (filarial test strips [FTS]) and positive control.
- Obtain DBS for OV16 testing during TAS-1 studies if the area is co-endemic with RB and a data gap exists. Publish 2019 TAS-OV16 study showing utility of this approach for gathering information on onchocerciasis.
- Await direction from FMOH (preferably after consultation with LF Regional Program Review Group [RPRG]) before conducting further LF remapping/reassessments.
- If the necessary funding can be secured, expand LF MDA to new zones in concert with RB support.

NIGERIA

Presenters: Dr. Emmanuel Miri, Dr. Abel Eigege, Dr. Emmanuel Emukah, Dr. Cephas Ityonzughul and Dr. Adamu Sallau (The Carter Center)

Summary:
Since 1996, TCC has assisted the Nigerian FMOH to eliminate transmission of onchocerciasis in the country. In Nigeria, the RBEP is an integrated NTD program that also works towards elimination of LF, and control of SCH and STH. Nine states, covering 168 districts, called local government areas (LGAs), are assisted by our programs. After more than a decade of an onchocerciasis control approach, Nigeria launched a national onchocerciasis elimination policy in 2013, and the FMOH established the Nigeria Onchocerciasis Elimination Committee (NOEC) in 2015. Two virtual NOEC meetings were held in 2021 (May 18 – 19 and December 8 – 9) with support from TCC. Key recommendations from those meetings are summarized in Figure 26.

RBEP assists with RB and LF treatments in seven southern states in Nigeria; Plateau and Nasarawa states in central Nigeria stopped MDA for LF and RB in 2013 and 2018, respectively. All nine states have active schistosomiasis and soil-transmitted helminth treatment programs. Plateau and Nasarawa states also work to improve the preparedness of the health care system to provide adequate care for those suffering from chronic LF (lymphedema, hydrocele), which persist even when LF transmission has been eliminated. Our objective is to meet or exceed WHO's required level of MMDP work that would support the two states' claim to have 'eliminated LF as a public health problem.'

TCC's work in Nigeria is based on a longstanding partnership with the FMOH and receives support from USAID's Act to End NTD's | East project, led by Research Triangle Institute (RTI) International; the Bill and Melinda Gates Foundation; the IZUMI Foundation; the Task Force for Global Health; Clarke Mosquito Control/Clarke Cares Foundation; and from other generous donors.

Treatments:
The program assisted 27,674,701 million treatments for RB (10,070,569), LF (11,667,594), SCH (1,829,352), and STH (4,107,186) in 2021, representing 29%, 54%, 40%, and 40% of the treatment targets, respectively. Only one round of treatment was provided in areas targeted for semiannual RB treatments. While COVID-19-related interruptions persisted, the primary reason for low treatment was delays in ordering and receipt of drugs combined with restricted availability from FMOH. The 2022 targets for the four diseases total 59 million. Figure 27 shows annual treatments and targets by disease since 1996, and Figure 28 shows RB annual and semiannual treatments versus targets since 1996. Targets for SCH and STH vary by year based on WHO guidelines that alternate years in areas of lower prevalence (See Annex 3 for more detail on these guidelines), as well as a recent decision by the Nigeria national program to target schistosomiasis treatments at the ward level (a geographic region level between community and district/LGA).

Drug delays in 2021 reflect an issue that has perennially affected treatment coverage in TCC-assisted areas in Nigeria. This impact can be seen with semiannual RB treatments in 2019 and 2021, as well as with SCH and STH treatment achievements in 2018, 2019 and 2021 (Figure 27 and 28). Drug supply is managed by the national NTD programs, the drug companies, and WHO, but relies on input from implementing partners. A number of factors can impact drug arrival, including manufacturer capacity, customs delays, changes in legal documentation requirements, delays in inventory reports from other partners that can slow approval of drug applications, and delays in production of or shipment of drugs. The TCC Nigeria office makes all efforts to provide the FMOH with accurate drug inventory reports and drug orders for our assisted areas, and to be

available to support the drug supply chain process however possible. Drug availability will be less of an issue as TCC states rapidly advance towards transmission interruption and the halt of MDA.

Training:
The Nigeria program trained 62,559 CDDs, 12,781 CSs, 6,805 HWs, and 2,230 teachers in 2021. This was a significant improvement over 2020 although it did not meet targets due to reduced overall activities caused by drug delays and the pandemic. Training targets in 2022 for CDDs, Community Supervisors, HWs and teachers are 52,528, 11,840, 6,191, and 4,318 respectively, with some reduction in targets related to RB and LF thanks to reduced treatment areas as states and districts pass impact assessments.

Impact:
In 2021, Plateau and Nasarawa became the first two states in Nigeria to achieve RB transmission elimination status after completing PTS following the halt of Mectizan in 2018. Three additional states, including TCC-assisted Delta state, met WHO criteria to stop Mectizan treatment for RB in 2021 (Figure 26). PTS in these states cannot begin as MDA for LF is still on-going. In total, 7.4 million people no longer require Mectizan treatment for RB in TCC-assisted areas of Nigeria, including hypo-endemic areas of Plateau and Nasarawa that received Mectizan during LF MDA. The progress in transmission status of TCC-assisted LGAs thanks to FMOH-approved NOEC recommendations is shown in Figure 29.

For LF, fifteen LGAs in three states (Anambra, Ebonyi and Imo) passed TAS-1 and qualified to stop LF MDA and begin PTS. Of the 17,803 children tested for LF antigen using FTS, only two children tested positive. Field work in one LGA, Orsu, could not be completed due to insecurity. Cumulatively, 10.7 million people in TCC-assisted areas of Nigeria no longer need MDA for LF (Figure 11).

Special Topics:

Dr. Abel Eigege (The Carter Center) reported progress on LF MMDP work in Plateau and Nasarawa. In 2021, seven new Hope Groups (support groups for persons with LF disease manifestations) were established, bringing the total to 27. Twenty-four health personnel were trained to lead existing and new Hope Groups, bringing total leader numbers to 104. There were 118 new Hope Group members in 2021, bringing total membership to 914. The program also supported 248 hydrocele surgeries in 2021.

Dr. Emmanuel Emukah (The Carter Center) presented on the topic of “mainstreaming” NTD programs. An ongoing study in four-LGAs aims to evaluate the “mainstreaming” of SCH/STH MDA programs, i.e., the transition from NGO partner support to full support by the primary health care (PHC) system. Baseline surveys demonstrated MDA coverage from 57% - 89% in the study LGAs under TCC-assisted MDA. Initial interviews of health and education government personnel in the four LGAs found that these staff felt that the programs are resilient but that more coordination between health and education sectors and more government resources will be needed for a successful the transition. Dr. Emukah then presented the anticipated phase-in of mainstreaming of all SCH/STH programs assisted by TCC over the next several years as those LGAs’ RB and LF programs reach stop-MDA thresholds.

Dr. Cephas Ityonzughul (The Carter Center) also presented progress on RB stop-MDA entomological surveys in Abia, Anambra, Enugu and Imo States. These states are conducting “reclassification” surveys to determine whether they qualify to be moved from “transmission suspected interrupted” (tan color on the NOEC map in Figure 26) to “transmission interrupted”

(ash/grey color on the map), and thus stop Mectizan treatments for onchocerciasis. Two states, Enugu and Imo, collected sufficient flies (at least 6,000 per state) to enable a statistically valid result. In contrast, Abia and Anambra did not collect the minimum number of flies and may require continued collections beyond 12 months or approval from the NOEC and FMOH to use annual transmission potential as an indicator.

Dr. Christy Hanson, Molly Mort, and Erin Stearns (BMGF) and Matt Hallas (DevGlobal) presented the objectives and approach of a new remote sensing project. The goals are to leverage high-resolution remotely sensed datasets and machine learning to create a geospatial model predicting the location of suitable black fly habitats and to develop an application to guide field workers to those sites. TCC will provide historical data to inform the model and undertake field validation and pilot testing for the model and application.

River Blindness			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG	6,948,524	2,603,974 (37%)	19,379,589
UTG2	28,141,536	7,466,595 (27%)	2,194,458
Total	**35,090,060**	**10,070,569 (29%)**	**21,574,047**

Lymphatic Filariasis			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG	21,672,781	11,667,594 (54%)	21,217,802

Schistosomiasis			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG	4,569,589	1,829,352 (40%)	5,038,356

Soil Transmitted Helminths			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG	6,221,671	2,983,217 (48%)	7,716,302
UTG2	4,027233	1,123,969 (28%)	3,277,736
Total	**10,248,904**	**4,107,186 (40%)**	**10,994,038**

Training Objectives			
	2021 Training Targets	2021 Trainings (%)	2022 Treatment Targets
CDDS	54,602	62,559 (115%)	52,528
CSs	12,110	12,781(106%)	11,840
HWs	7,475	6,805 (91%)	6,191
Teachers	7,814	2,230 (29%)	4,318

NIGERIA 2022 RECOMMENDATIONS

GENERAL:

- Program Directors should attend the FY23 drug application package preparation meeting to be held by the FMOH, and work with the different levels of government to effectively track drug supply, including reverse supply logistics. Program monthly reports should include accurate and current drug supply updates.
- Maintain strong focus on communication and security awareness with State MOH, local officials, and community leaders before commencement of community-based activities.
- Rolling coverage surveys should continue, and be targeted to inform programmatic decisions, i.e. areas where there is concern about the quality of MDA or where an epidemiological study is planned. Consider reviewing the data collected from these surveys and preparing an article for publication if warranted.
- Whenever possible, add LF and/or RB sentinel villages (SVs) to the sample in any population-based survey activities being conducted (in these SVs' states or LGAs). This would help us to conduct serial monitoring of SVs.
- Continue providing awards in each state to the best CDD, teacher, Frontline Health Facility (FLHF) worker, village leader and CS.
- The ratio of CDDs per persons treated has increased with treatment expansion far beyond the national 1:250 limit. Increase the number of CDDs as budgets allow, working to reach the target ratio of at least 1 CDD:250 people, 1 CS:5 CDDs and 1 CS per village. When calculating population served per CDD, continue keeping urban populations out of the equation since these are typically served directly by HWs.
- Complete the analysis of the pilot CDD attrition study (based on Kaplan-Meier survival methodology), which was delayed due to the COVID-19 pandemic. Review final analysis with HQ and then make plans to expand the study by establishing the number of CDDs that will be studied (with good gender representation). Explore the relationship of increasingly complicated registers and roll-up forms to CDD attrition rates, perhaps using focus groups of CDDs and their supervisors.
- Report at the next Program Review on the progress of the Community Leaders Action Group Innovation Hub Grant, which is investigating the power of mobilizing highly effective community leaders to engage, encourage and mentor other communities and leaders in order to improve treatment coverage and community support of their CDDs.
- Look for opportunities to transition from paper to electronic data reporting to ease work of HWs, CDDs and report submission.
- Advocate for governments to utilize CDDs for other health activities, as elimination of RB and LF is in sight.

ONCHOCERCIASIS:

- Support two meetings of the Nigeria Onchocerciasis Elimination Committee (NOEC), in May and December. Recommend the FMOH to reduce the number of meetings to once per year beginning in 2023.
- Launch PES in Plateau and Nasarawa States. PTS in Delta State cannot begin until LF MDA is halted.
- Complete entomological assessments in Abia, Anambra, Enugu and Imo, and present results to the NOEC. If results meet criteria, the NOEC could recommend these states be reclassified as "transmission interrupted" status, halt treatment, and launch PTS if the FMOH accepts the recommendation.

- Encourage the NOEC to begin to classify certain states (Ondo, Taraba) by LGA to capture that some LGAs are 'red' (treating twice per year). Begin to show this on the NOEC map.
- Provide lab support to non-TCC states as funding and lab priorities allow. Priority should be given to TCC samples or assessments conducted in states neighboring TCC-assisted states.
- All South East/South South (SE/SS) states should continue refining the entomological sites preselected by the NOEC. Those sites that are not producing sufficient vectors should be replaced by better sites (and permission for site changes made to NOEC) should better sites be identified.
- Partner with BMGF to build models to identify more productive black fly capture sites using high resolution remote sensing data.

LYMPHATIC FILARIASIS/MALARIA:

- The 46 LGAs in SE/SS that passed pre-TAS in 2021 should conduct TAS-1 as soon as possible. So should the 37 LGAs eligible for pre-TAS in 2022. Where TAS-1 and RB surveys indicate all community-based MDA can cease, conduct health education to prepare the populations for MDA halt, and advise the state MOH that TCC support for SCH and STH will cease (see below).
- A pre-TAS should occur within six months for all LGAs that became eligible after the most recent treatment round.
- Prioritize Ebonyi State, particularly LGAs that failed pre-TAS, for Clarke LLIN donations and work with State malaria programs to ensure usage and care for the nets.
- The program in Plateau and Nasarawa should ensure that WHO requirements for morbidity management and disability prevention (MMDP) are met. With IZUMI support and in close consultation with TCC/Atanta, continue MMDP activities in Plateau and Nasarawa States including 1) burden assessment, 2) strengthening of primary care support for patients with lymphedema/elephantiasis/acute attacks and hydrocele, 3) increasing the number of and participation in Hope Clubs, and 4) hydrocele surgical camps that include referral systems for more severe cases to specialized centers. Launch MMDP activities 1 – 4 in Ebonyi State.
- In the SE/SS states, conduct assessments of LF morbidity case burden during LF MDA.
- Publish results of the Plateau State Wb123 and OV16 research sponsored by the Task Force for Global Health.

SCHISTOSOMIASIS (SCH) AND SOIL TRANSMITTED HELMINTHIASIS (STH):

- Due to an anticipated reduction in funding of SCH/STH work by USAID in 2024, TCC has begun to incrementally transition ownership of SCH/STH to the federal, state and local governments. In LGAs where RB or LF community-wide MDA is ongoing, integrate the SCH/STH treatments into the RB or LF platform, co-administering drugs. Where the RB or LF community-wide platform is being lost due to stop-MDA (community level) determinations, the SCH/STH programs should be mainstreamed into a school-based program such that national funds will transition over a short time to fully support the program. Mainstreaming decisions will vary by LGA and/or state; there are different platforms that may be appropriate in different areas to assume SCH/STH responsibilities.
- Complete work on the Task Force for Global Health-supported 'Mainstreaming study' that investigates best practices for the process of transferring full program ownership to the government. Assess treatment coverage before and after the transition. Compile results for publication.
- Discuss new WHO guidelines for SCH with the FMOH, implementing partners in Nigeria,

and donors to determine if programs will be reoriented to respond to the guidelines.

SUDAN

Presenters: Dr. Isam Zarroug (Sudan Federal Ministry of Health)

Summary:
Since 1997, TCC has assisted the Sudanese FMOH to eliminate onchocerciasis transmission in the country. Sudan was the first African country to declare a national onchocerciasis elimination policy in 2006. There are four transmission foci, Abu Hamad (River Nile State), Galabat (Gedaref state), Khor Yabus (Blue Nile state), and Radom (South Darfur state). In 2015, transmission elimination was declared in Abu Hamad under WHO elimination guidelines. The Galabat focus is under PTS. Khor Yabus and Radom foci have ongoing transmission (Figures 30 and 31).

Thanks to a recent grant from The Reaching the Last Mile Fund, housed within the END Fund and led by His Highness Sheikh Mohamed bin Zayed Al Nahyan, the Crown Prince of Abu Dhabi,, TCC will expand support for RB and LF elimination in Sudan in 2022.

Treatments:
In 2021, TCC provided limited technical support to Sudan. The country continued to suffer from political instability, insecurity, hyperinflation, and fuel shortages. In 2021, 131,288 RB treatments, 27% of the targeted goal, were distributed in the Radom focus, including treatments to gold miners and refugees (Figure 32). The Khor Yabus focus continued to be disrupted by insecurity and political instability that prevented MDA. 2022 treatment targets are provided in the data tables below.

Training:
In 2021, due to the pandemic, the program only trained 112 volunteers. (100 CDDs, 10 CSs, and 2 HWs). See the 2022 training goals for RB and LF in the data table below.

Special topics:
Dr. Jenna E. Coalson (The Carter Center) presented results from a serological survey conducted in three localities of North Darfur State thought to be non-endemic for both RB and LF. Dried blood samples were collected for the purposes of baseline trachoma surveys in 2019 by the TCC Trachoma Control Program and Sudan FMOH and analyzed using multiplex bead assays at the U.S. Centers for Disease Control and Prevention. The partners shared results on 1 RB (OV16) and 3 LF (Wb123, Bm14, Bm33) antigens with RBEP. Seroprevalence for OV16 was well below the 2% start-MDA threshold in adults at 0.14% (95% CI 0.05 - 0.39%). Seroprevalence to the three LF antigens was widely variable and discordant, highlighting the challenges of interpreting LF serology. The RBEP concluded that MDA for RB was not warranted, but recommended a mini-TAS remapping survey to ascertain LF transmission status in the three localities.

River Blindness Sudan			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG2	403,750	131,288 (27%)	403,750

Lymphatic Filariasis Sudan			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG1	0	0 (0%)	10,006,698

Training Objectives Sudan RB			
	2021 Training Targets	2021 Trainings (%)	2022 Treatment Targets
CDDs	1,360	100 (7%)	1,360
CSs	86	10 (11%)	86
HWs	40	2 (5%)	40

Training Objectives Sudan LF			
	2021 Training Targets	2021 Trainings (%)	2022 Training Targets
CDDs	0	0 (0%)	11,406
CSs	0	0 (0%)	1,141
HWs	0	0 (0%)	180

SUDAN 2022 RECOMMENDATIONS

GENERAL:

- Work toward a target ratio of at least 1 CDD:100 people, 1 CS:5 CDDs, and 1 CS per village.
- Coordinate with the Republic of South Sudan (RSS), Ethiopia, and Central African Republic (CAR) for cross-border issues.
- (Re-)establish a national RB and LF elimination committee. Provide financial and administrative support for a meeting in 2022.
- Collaborate with the Emory Human Engagement Learning Platform (HELP) team to identify areas where the (Plan, Execute and Engage to Learn model (PEEL) suite of tools could assist RB and LF program implementation.

ONCHOCERCIASIS

- As security allows, conduct re-mapping to verify the absence of RB transmission in the Marra Mountains (South and Central Darfur States), Nuba Mountains (South Kordofan State), Al-Dinder and Al-Rahad Rivers (Sennar State), and Second Cataract (Northern State)
- Conduct planned sensitization and health education in the Galabat and Radom foci.
- Complete PTS entomological and serological assessments in Galabat focus (Gedarif state). Present results at the Sudan RB/LF elimination committee meeting, the 2022 Program Review meeting, and the Ethiopia EOEEAC meeting. If transmission elimination is confirmed, consider a cross-border celebration event with MOH from Sudan and Ethiopia.
- Conduct entomological surveys in the Merowe Dam's spillway (8 km north of the dam) as a part of PES in the Abu Hamad focus.
- Launch twice-per-year MDA in the Radom focus. Conduct assessments to determine the limits and the actual population at risk of the Radom focus.
- Collaborate with TCC Peace Programs to broker dialogue in insecure areas and enable access by HWs for RB/LF assessments. Conduct assessments to determine RB infection rates in humans. Entomological surveys will be necessary given the reports of few breeding sites having been identified. Disease assessment surveys in Khor Yabus focus remain a challenge, with many roads in RSS and Sudan still landmined.
- Unfortunately, TCC does not support work in corresponding areas across the border from Khor Yabus in Ethiopia (Assosa and Kemashi). Sudan and TCC should encourage the Ethiopian FMOH and RTI/Light for the World to conduct surveys in Assosa and Kemashi along the border with Sudan to determine the extent of current transmission.

LYMPHATIC FILARIASIS

- Work with the FMOH to obtain details of disease burden from baseline mapping and history of MDA by locality.
- Identify locations of villages included in the 2016 baseline mapping to establish sentinel monitoring sites.
- Begin geographic scale-up of LF MDA to as many LF-endemic districts in 2022 as resources and security allow.
- Conduct remapping “mini-TAS” surveys in three localities in North Darfur state (Kotom, Sereif, and Saraf Omrah) based on integrated multiplex serology survey results.
- Conduct remapping “mini-TAS” surveys in Al Malha locality in North Darfur state based on low baseline prevalence and absence of transmission in surrounding localities.

- Conduct pre-TAS in two localities in South Darfur (Nyala and Ed Al Fursan), where four to five rounds of MDA have occurred since 2016.

UGANDA

Presenters: David Oguttu (Ministry of Health), Ms. Annet Khainza, and Moses Katabarwa (The Carter Center)

Summary:
Since 1996 TCC has assisted the Ugandan MOH to eliminate transmission of onchocerciasis in the country. In 2007, Uganda declared a goal of RB transmission elimination in all 17 transmission foci nationwide, including the Victoria Nile focus, which achieved elimination in the early 1970s.

TCC's work in Uganda is based on a longstanding partnership with the MOH. It receives support from USAID's Act to End NTDs | East, led by RTI International, and the ELMA Foundation.

Treatments:
In 2021, TCC assisted with distribution of 2,764,536 treatments reaching 94% of the treatment target of 2,940,862 (Figure 33). There were 200,082 passive treatments, and 94,787 refugees from the RSS received treatments. See 2022 treatment targets in the data tables below.

Vector control based on the "slash and clear" (S&C) method was conducted in Amuru district (3 sub-counties), Kitgum district (2 sub-counties), and Nwoya district (4 sub-counties) of the Madi Mid-North focus. The approach relies on community-directed clearing of river vegetation at one to two kilometers up- and down-river from affected communities. This approach works well when the river width is narrow, and the depth is shallow to avoid danger to the community members.

Training:
The Uganda program trained a total of 31,912 Community-Directed Intervention workers in 2021. 24,536 CDDs (48% female), 6,387 CSs (27% female), 107 HWs, and 882 Parish Supervisors received training. The current ratio of CDDs to the population served improved from 1 CDD: 74 persons in 2021 to 1 CDD to 69 persons in 2022. The CS to CDD ratio was 1:4 from the minimum requirement of 5 CDD: 1 CS. See the 2022 training targets in the data tables below.

Impact:
In 2021, three foci, Nyamugasani, Wadelai, and West Nile, were reclassified from "transmission interrupted" to "transmission eliminated." At the end of 2021, there were 11 foci classified as "transmission eliminated", four classified as "transmission interrupted" and under PTS, one focus "transmission suspected interrupted," and one focus as "ongoing transmission." (Figure 34) The Madi Mid-North (MMN) and Lhubiriha foci remain under twice-per-year treatment with Mectizan, and both share cross-border transmission with the RSS and the Democratic Republic of Congo (DRC) respectively (Figure 35).

Special Topics:
Dr. Moses Katabarwa presented results of the completion of delineation mapping for onchocerciasis in MMN. Of 22 sub-counties in question that bordered the MMN boundary, only six contained habitats that were potentially suitable to support *Simulium* breeding. Serological assessments conducted in 2019 (Alebtong, Lira, Otuke and Oyam districts) and 2021 (Adjumani and Pakwach districts) confirmed the absence of OV16 antibodies in samples of at least 150 children aged 5-10 years old per district. In the RSS, PCR-positive *Simulium* fly collection sites are present in Kajo Keji, large areas of Magwi County have not been prospected or samples collected for entomological and serological analysis.

River Blindness Treatments Uganda			
	2021 Treatment Targets	2021 Treatments (%)	2022 Treatment Targets
UTG2	2,940,862	2,764,536 (94%)	3,029,086
Passive	0	200,082	183,536
Refugees	0	94,787 (72%)	256,846

Training Objectives Uganda			
	2021 Training Targets	2021 Trainings (%)	2022 Treatment Targets
CDDs	23,488	24,536 (104%)	23,488
CSs	6,338	6,387 (101%)	6,338
HWs	97	107 (110%)	97

UGANDA 2022 RECOMMENDATIONS

GENERAL:

- Work toward a target ratio of at least 1 CDD: 74 people in all districts and 1 CS: 4 CDDs.
- Continue PTS activities in the four foci currently classified as “transmission interrupted”: Budongo, Bwindi, Maracha-Terego, and Nyagak-Bondo. PTS activities include entomological and serological surveys.
- Provide financial and administrative support for the 2022 Ugandan Onchocerciasis Elimination Expert Advisory Committee (UOEEAC) meeting.
- Conduct a study to determine what the former RB CDDs in eliminated foci are doing now that onchocerciasis interventions have been halted.
- Complete OV16 laboratory analysis for the Budongo focus and write a paper showing the drop in OV16 rates over time in a population where the vector was eliminated (disappeared due to environmental change) over a decade ago.
- Invite representatives from the RSS and DRC to UOEEAC meetings and seek an invitation for the FMOH to attend RSS and DRC national RB elimination committee meetings.

MADI-MID NORTH (MMN) AND LHUBIRIHA

- Report at the 2022 UOEEAC meeting the results from serological and entomological assessments conducted in the border ‘fringe areas’ of MMN, per UOEEAC recommendations. Discuss whether MMN could consider Stop-MDA evaluations and whether the status of the cross-border areas in the RSS precludes stop MDA assessments in MMN.
- Continue supporting MOH in carrying out cross-border surveys and elimination activities in Special Interventions Zones (SIZ) with their counterparts in the DRC and RSS whenever the situation allows.
- Conduct entomological and serological surveys on Lhubiriha-Mutwanga cross-border areas. Push for an in-depth, dedicated review of this focus at the 2022 UOEEAC meeting.
- Continue community-directed S&C activities for *Simulium damnosum* vector control to selected communities in other districts of MMN focus. Advocate for S&C at all levels in each selected district. Finalize S&C national guidelines.

ANNEX 1: River Blindness Elimination Program Background

Human onchocerciasis, an infection caused by the parasitic worm *Onchocerca volvulus,* causes eye lesions that can progress to visual loss or complete blindness. In addition to severe eye disease, onchocerciasis causes papular or hypopigmented skin lesions and intense itching. The parasite is transmitted by certain species of *Simulium* black flies, with the most common vector being *Simulium damnosum* sensu lato (sl). *Simulium* species black flies breed in rapidly flowing rivers and streams, thus leading to the common name for the disease, "river blindness."

In humans, the adult worms cluster in subcutaneous fibrous onchocercomas (commonly referred to as 'nodules') that are often visible and palpable. In these nodules, fertilized females release first-stage larvae (microfilariae [mf]) that migrate into the sub-dermis and eye, causing immune reactions that result in the major morbidities associated with the infection. Some mf are picked up when the vector flies take a blood meal. In the flies, the mf eventually develops into the third stage larvae (L3) infectious to humans on subsequent blood meals. In humans, the larvae then develop into adult worms, continuing the life cycle. There are no known environmental or epidemiologically important animal reservoirs of *O. volvulus*.

The World Health Organization (WHO) estimated in 2017 that at least 220 million people required preventive chemotherapy against onchocerciasis, and 1.15 million had vision loss.[4] Approximately 205 million people live in endemic areas worldwide and are therefore at risk of infection; more than 99% of those at risk live in sub-Saharan Africa. Globally, 1.8 million people live in areas that no longer require onchocerciasis MDA. Onchocerciasis also exists in Latin America. Periodic mass drug administration (MDA) with oral Mectizan tablets prevents eye and skin disease caused by *O. volvulus.* Mectizan may also be used to reduce or interrupt transmission of the disease depending on the duration and frequency of treatment, the efficiency of the vector, the extent of the infected population, the vector, and MDA distribution programs. A WHO update on the global onchocerciasis initiative was provided in the Weekly Epidemiological Record (WER) on October 1, 2021 (No 39, 2020, 96, 477–484).

The Carter Center (TCC) River Blindness Elimination Program (RBEP) is dedicated to safe and sustainable mass distribution of Mectizan (together with health education) to eliminate onchocerciasis transmission. The distinction between control (of disease) and TCC's approach to elimination (of transmission) is important. In the control approach, Mectizan is distributed only once-per-year in areas where the eye and skin disease from the infection is greatest (the so-called 'meso/hyperendemic' areas where nodule rates are ≥20%). In control programs, MDA will likely need to continue indefinitely because onchocerciasis transmission persists, and people continue to get new infections ('open system'); sustainability of control programs and indefinite effectiveness of the drug are vital in this scenario. In the elimination approach, Mectizan treatment is used more intensively to 'close the system' to break transmission eventually. Treatment is given twice per year and is included in areas where nodule rates are <20% (hypoendemic areas). When the residual parasites in the human population are compromised to be unable to recover their reproductive capacity, MDA can be stopped because there is no animal or environmental reservoir of infection. Before 2013, the elimination of onchocerciasis was the program goal in the Americas, Uganda, and Sudan, but not in Nigeria and Ethiopia. By 2013, national onchocerciasis transmission elimination had become the stated goal of all the governments where RBEP assists. At that time, RBEP set a new goal to stop transmission in all its assisted areas.

[4] https://www.who.int/news-room/fact-sheets/detail/onchocerciasis

In some TCC-assisted areas in Nigeria, a historical barrier to treatment has been the co-endemicity of the parasitic worm Loa loa. Mectizan treatment in a person with high *Loa loa* parasite loads (>20,000 *Loa loa* microfilaria per ml of blood) can result in severe central nervous system adverse reactions, with complications that can lead to coma or death. In partnership with Nigeria's federal and local governments, TCC conducted an extensive survey in Nigeria in 2016 using a recently developed technology called the 'LoaScope". It determined that microfilaria levels of *Loa loa* were not sufficient in our supported areas to preclude treatment (of over 10,000 persons examined with the LoaScope, the highest count observed was under 12,000 mf per ml blood). Our results (published in 2018 by Emukah et al. in AJTMH) were reviewed by the Mectizan Expert Committee and the Federal Ministry of Health of Nigeria. Both gave their permission to use Mectizan MDA treatment in *Loa loa* areas in Nigeria that are Mectizan-naïve and hypoendemic for onchocerciasis.

A major focus of TCC is reaching the best possible treatment coverage, monitored through routine monthly reports by assisted programs, periodic coverage surveys, and impact on RB transmission indicators. A discussion of this reporting process and treatment indices used by the program and in this report is below. Important coverage terms include: the Ultimate Treatment Goal (UTG), which is the census-based calculation of treatment-eligible people living in a program area (persons >5 years of age); UTG(2), and UTG(4), which are the multiplication of the UTG by two or by four, respectively, and used by elimination programs in areas where semi-annual or quarterly treatments are required to break transmission; and full coverage, which is defined as >90% achievement of the UTG, UTG(2), or UTG(4) (85% for OEPA). It is important not to confuse coverage reported in this Program Review with coverage calculated based on the Total Population (often called 'therapeutic coverage') that includes children. The difference in the denominators between these two calculations can amount to 10-20%.

Mectizan tablets are distributed in Africa at the community level by grassroots community volunteers known as Community Directed Distributors (CDDs) through a process known as Community Directed Treatment with Ivermectin (CDTI). CDTI was perfected by the Tropical Disease Research Program of WHO and was broadly introduced into the African Programme for Onchocerciasis Control's (APOC) supported project areas throughout Africa in the late 1990s. In some areas, TCC's RBEP focuses on "kinship/family/neighborhood-enhanced CDTI," an approach that seeks to train more CDDs than is done in classic CDTI and which TCC developed and pioneered in Uganda. In kinship-enhanced CDTI, CDDs serve within their kinships/family or neighborhoods, and decisions and treatment activities are provided at the sub-community level. A similar approach is used in Ethiopia, where the Health Development Army (HDA) system is based in communities' Health Development Units, with five households/families of about 30 people served by at least one CDD from the HDA. The ratio of CDDs per population that our programs have pursued historically has been at least 1 CDD per 100 persons to be treated. Using its Health Development Army, Ethiopia has moved towards supporting a ratio of 1 CDD: 50 people. Uganda is steadily increasing its concentration of CDDs with an ultimate goal of 1 CDD: 74 people.

CDDs are supervised by Community Supervisors (CSs). These are often district-level health personnel; they may be more senior CDDs. This grouping may be managed by frontline HWs, similar to Ethiopia, where distributors and supervisors are organized HEWs. The desired ratio is 1 CS:5 CDDs.

Our MDA strategy seeks to increase the active participation of members of affected communities by 1. Training as many inhabitants of endemic villages as possible to serve as distributors. 2. Encouraging the involvement of women. 3. Reducing the demand for financial or other

"incentives." 4. Allowing community members to choose their distributors and the time and location of treatments.

Monitoring indices of the kinship approach include 1. community selection of CDDs in every kinship/neighborhood zone in the community; 2. sustained treatment coverage of at least 90% of treatment-eligible persons; 3. increasing involvement of women as CDDs, and 4. the presence of at least two community-selected supervisors in every community.

The CDDs and community supervisors are often highly engaged in other community-based health interventions, such as water provision and sanitation, malaria control, immunization, and integrated NTD control efforts.

River Blindness Elimination Program Reporting Processes

Treatment areas: An epidemiological mapping exercise is a prerequisite to identifying at-risk villages (ARVs) for mass Mectizan treatment programs. The assessment techniques used in the mapping exercise in Africa varies from those used in the Americas. An overview of the two approaches follows.

In much of Africa, a staged village sampling scheme called Rapid Epidemiological Mapping of Onchocerciasis (REMO) was executed with assistance from the World Health Organization (WHO) to define endemic "zones" that should capture most or all villages having onchocercal nodule rates ≥ 20% in adults (which roughly corresponds to a microfilariae (mf) in skin prevalence ≥ 40%) for mass treatment. The mapping strategy is based on studies that have shown that most ocular and dermal morbidity from onchocerciasis occurs in villages where the nodule prevalence exceeds 20%.

In the first stage of REMO, survey villages are selected based on a review of large-scale maps of areas that appear to be environmentally able to support black fly breeding and, therefore, transmission of *O. volvulus*. In the second stage, villages located closest to what appears on maps to be rapidly flowing rivers (rivers near compressed contour lines on topographical maps) are called 'first line villages' and are priority for visits by field teams. In the first line villages, a convenience sample of 30-50 adults are examined for characteristic onchocercal nodules. The mean nodule prevalence for each village sample is then mapped in geographic information systems (GIS), which is used to define endemic zones where all villages are to be treated by CDTI. As noted, CDTI treatment zones typically are defined to include all sample villages having nodule prevalence of ≥20%.

All villages within the CDTI treatment zone are offered mass Mectizan treatment annually. The approach of REMO excludes those endemic villages from CDTI where nodule rates are under 20% (the so-called "hypoendemic areas"). Here it is important to note again that not all persons infected with onchocerciasis (as defined by their having mf in their skin) have nodules. On average, nodule prevalence is 50% of mf prevalence, although this varies by geographical location. Villages in hypoendemic areas with nodule rates of <20% could still have 30% mf prevalence of onchocerciasis as determined by superficial skin biopsies ('skin snips') to identify *O. volvulus* mf by microscopic examination.

As the policy in Africa is now elimination, the role of hypoendemic areas in *O. volvulus* transmission is being critically re-examined. Any Mectizan-naïve areas are being reassessed based on new mapping guidelines set by that country's national onchocerciasis elimination

committee, typically using OV16 serology. Most recently the new WHO Onchocerciasis Technical Subcommittee (OTS) has suggested that OV16 testing be conducted in samples of adult residents. Proposed serological thresholds launching mass drug administration range from 2% to 5%.[5]

In the Americas, the goal from early on has been to eliminate *O. volvulus* transmission. As a result, all endemic villages are offered mass Mectizan treatment activities every three or six months. The Onchocerciasis Elimination Program for the Americas (OEPA) casts a much broader net for mass treatment, and the African concept of excluding hypoendemic villages has never been accepted. For the Americas, where the endemic foci are characteristically smaller and more defined than in Africa, every village in known or suspected endemic areas has a rapid epidemiological assessment of 50 adults, who have both nodule examinations and skin snip microscopy to identify *O. volvulus* microfilaria in skin. Villages in which one or more persons are positive (sample prevalence ≥2%) are considered "at risk" and are recommended for the twice per year (or four times per year) mass drug administration (MDA) program. Thus, the cutoff prevalence for treatment was much lower for the Americas compared to the original REMO mapping in Africa until elimination of transmission of onchocerciasis in Africa became the focus.

Data Reporting: TCC country program offices report monthly to TCC headquarters in Atlanta. These reports include: 1) number of ARVs and persons treated during the previous month (treatment reports are updated quarterly for the Americas); 2) the status of the Mectizan tablet supply; 3) training and health education activities; 4) epidemiological assessment, research, and program monitoring activities; and 5) administrative issues. Standardized tables and graphs are used across programs. The reported treatment data are recorded by hand in village-level registers during census and directly observed treatment activities by community drug distributors (CDDs) or national Ministry of Health (MOH) personnel. It is important to emphasize that these are MOH programs and MOH data.

The accuracy of these reports is routinely confirmed with random spot checks performed primarily by TCC and MOH personnel, supplemented by treatment coverage surveys, which are based on statistical sampling methods with household questionnaires administered by TCC and MOH staff. Recently, these data have been collected on smart phones or tablets so that results can be rapidly compiled.

Summary reports of numbers of villages and persons treated are compiled from the village registers by the CDDs and their Community Supervisors, then forwarded to the district level. District-level summary reports are forwarded (whenever possible through MOH surveillance and reporting channels) to both the state MOH headquarters and the national TCC offices, which forward the data monthly to RBEP in Atlanta. In the Americas, the MOHs of Venezuela and Brazil report their treatments quarterly to the OEPA office in Guatemala City, which then provides a combined regional report to TCC and to the Program Coordination Committee (PCC), InterAmerican Conference on Onchocerciasis (IACO) and the Pan American Health Organization (PAHO)/WHO in its regular meetings; OEPA updates are provided annually in WHO's *WER* articles (See Annex 5 for references to these publications). African MOHs report their annual results directly to WHO, which produces annual summaries of African programs' onchocerciasis treatments.

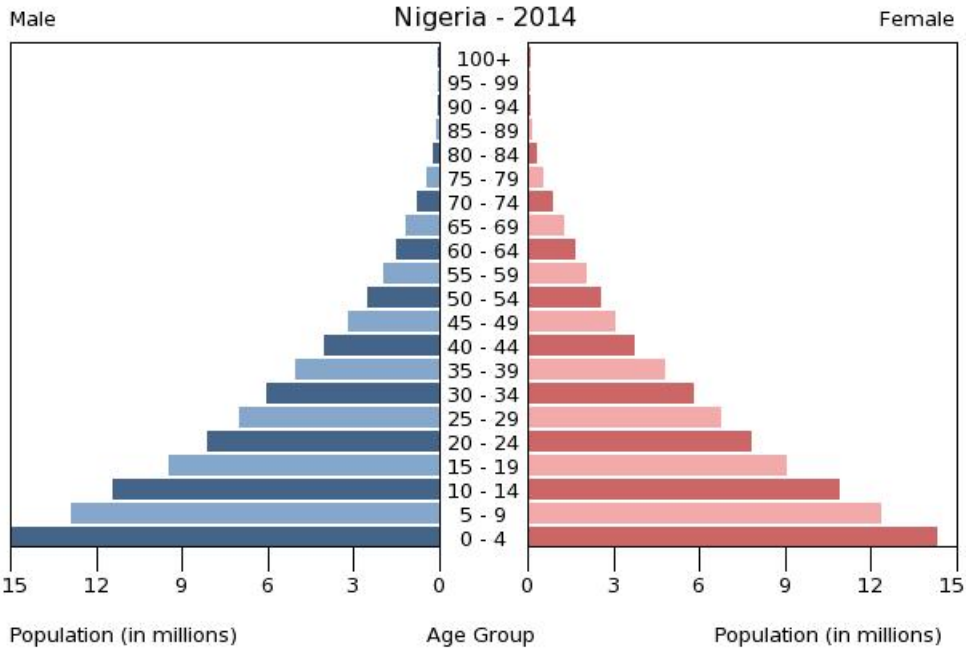
The data from monthly reports are supplemented with additional information at the annual TCC RBEP Review held during the first quarter of the following year. At these reviews, TCC program

[5] WHO Weekly Epidemiological Record 2018; 93(47): 633–648.

directors and partners convene to finalize treatment figures for the previous year, establish new treatment objectives for the coming year, and discuss results from monitoring and research initiatives. TCC reports its final treatment figures to the Mectizan Donation Program (MDP), Merck, and the non-governmental development organization (NGDO) Onchocerciasis Coordination Group.

RBEP Treatment Indices: Treatments are reported (Figure 5) as number of persons and number of ARVs treated for the month by district, focus, region, state, or zone, depending on the MOH's administrative structure of the country program. Cumulative treatment figures for the year are compared to UTGs, i.e., the eligible at-risk population that is targeted for MDA. Treatment coverage is calculated with treatments as the numerator and UTG as the denominator. UTG figures assume full geographic coverage of the targeted area, and typically increase by about five percent annually to account for normal population growth.

The eligible populations of ARVs targeted for mass distribution receive community-wide Mectizan treatment. The eligible at-risk population includes all persons living in ARVs who are eligible to receive Mectizan (i.e., those who are either ≥5 years of age, ≥15 kg in weight, or ≥90 cm in height, and who are in good health). Although RBEP mass treatment activities exclude pregnant women, these women should be treated later during the treatment year, as soon as one week or more after parturition; therefore, all adult women are included in the UTG calculation. In practice, the UTG should be established by census, adjusting from the most recent treatment rounds. The UTG is expected to be the same figure used in the annual request for tablets submitted to the Mectizan Donation Program. RBEP differs from the usual WHO approach which uses <u>total</u> population as their treatment denominator; therefore, for standardization requirements RBEP also routinely reports both coverage of eligible population (UTG) and coverage of total population ("therapeutic coverage") in its tables to satisfy those programs' needs. The rationale for RBEP's focus on the UTG denominator has been published (Richards et al., *American Journal of Tropical Medicine and Hygiene* 2001; 65:108-14). In general, total population coverage is 16-20% less than UTG (eligible) population coverage, in accord with population pyramids in areas being served, where up to 20% of the population is under 5 years of age and so ineligible for Mectizan treatment (see example below, Nigeria, where the under 5 population is 15%).



[6]

The UTG(2) and UTG(4) denominators are used by elimination programs where six-monthly ('semiannual') or quarterly treatments are delivered, respectively. The values are twice or four times the UTG and represent treatments targeted for the year, not persons. Full coverage in once-per-year treatment areas is defined as 90% achievement of the UTG. Full coverage for elimination programs is 90% of the UTG(2) in African projects, and 85% of the UTG(2) or UTG(4) for OEPA. The differences in full coverage thresholds result from varying recommendations by the African and American expert committees.

In post-treatment scenarios, passive treatments with Mectizan are provided when patients present themselves in clinics within towns of endemic districts, or where large sections of the population are highly mobile and are often from non-endemic areas.

[6] Source: CIA Factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html.

ANNEX 2: The Lymphatic Filariasis (LF) Elimination Program

LF in Africa is caused by *Wuchereria bancrofti*, a filarial worm that is transmitted in rural and urban areas by *Anopheline* and *Culex sp*. mosquitoes, respectively. The adult worms live in the lymphatic vessels and cause vessel dysfunction, often leading to poor drainage of lymphatic fluid. Clinical consequences include a collection of lymph (lymphatic fluid) that results in swelling of limbs and genital organs (lymphoedema, "elephantiasis" and hydrocele), and painful recurrent bacterial infections ("attacks" of acute adenolymphangitis). The female worms release mf, which are tiny embryonic worms that circulate in blood at night when the mosquito vectors bite. Mf are picked up by mosquitoes, develop over several days into infective larvae, and are then able to be transmitted to another person when the mosquitoes bite again. Mf are killed by annual single-dose combination therapy, with either Mectizan and albendazole (donated by GSK/The Task Force for Global Health), or diethylcarbamazine (DEC, donated by Eisai pharmaceuticals) and albendazole (in areas where there is no onchocerciasis and/or *Loa loa* infection). Annual MDA prevents mosquitoes from becoming infected and, when given for a period (estimated to be five to six years), can interrupt transmission of *W. bancrofti* (which has no animal reservoir). In 2013, WHO issued a provisional strategy for *Loa loa* areas that includes the dual approach of albendazole monotherapy via MDA twice per year, together with LLIN. Because of RBEP-sponsored research, as of 2017, Nigeria has been excluded from this *Loa loa* policy and combination MDA with Mectizan/albendazole can be used there (see below).

Nigerians suffer in disproportionate numbers from LF. Disease mapping of the country confirms that Nigeria is second globally (behind India) in human suffering from this parasite. With 761 out of 774 LGAs of 36 States and the Federal Capital Territory mapped, 572 LGAs (75%) are endemic and over 130 million Nigerians are at risk.

Elimination of LF as a Public Health Problem in Plateau and Nasarawa States: In Plateau and Nasarawa States, TCC, working with the FMOH of Nigeria and with state and local government ministries, assisted in establishing an LF elimination program. The effort is based on a strategy of two pillars: 1) annual MDA combination therapy consisting of albendazole and Mectizan to interrupt transmission of LF and 2) MMDP programs for those suffering from lymphoedema, elephantiasis, hydrocele and adenolymphangitis. GSK and Merck donations in Nigeria allow pillar 1 MDA activities, which were the focus of the early years of the program. The MDA program was launched in 2000 following disease mapping in 1998-99. After years of high treatment coverage, together with LLIN distribution by the malaria program, LF transmission was broken in the two states in 2012. Subsequent TAS surveys (TAS2 and TAS3) confirmed that children were not becoming reinfected during the PTS period. Additional entomology studies showing no infected mosquitos and LF antigen studies in adults showed that LF transmission had been eliminated. Seven million people are no longer at risk of LF as a result of a successful pillar 1 MDA program. PES continues in the two states, together with ongoing LLIN distribution, which will hopefully prevent reintroduction of the infection since the two states are surrounded by LF-endemic areas (see Figure 1 below).

The focus in Plateau and Nasarawa states is now shifting to the second pillar of the elimination of LF as a public health problem: clinical services to those suffering from LF morbidity. In 2019 RBEP began work with its MOH partners to quantify the burden of morbidity and to help the states strengthen primary care support and referral networks for management of lymphedema and hydrocele surgery, as well as mental health needs (in 'Hope Club' support groups). These tasks are necessary to complete elements of the national dossier for WHO.

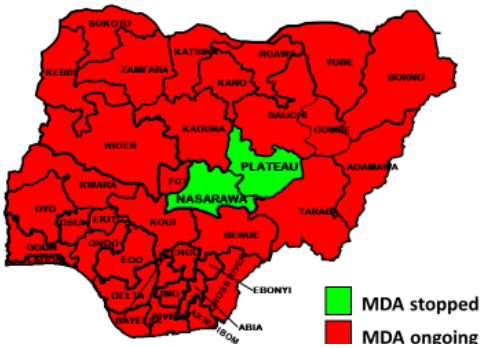


Figure 1: Elimination of LF in Plateau and Nasarawa states in 2017

***Scale-Up the LF Program in the Seven TCC-Assisted States in Southern Nigeria*:** LF treatments in Nigeria expanded to the seven states we assist in southern Nigeria as part of USAID's ENVISION project led by RTI International. Treatments started in 2014 in areas with an existing river blindness program and, in 2015, expanded to address all LF-endemic areas in the nine states. After two years of the provisional six-monthly albendazole-alone monotherapy (together with LLIN) due to *Loa loa* concerns, TCC, in partnership with the federal and local governments of Nigeria, conducted a large survey in 2016. The study determined that levels of *Loa loa* were not sufficient in TCC-supported areas to preclude treatment (Emukah et al., *AJTMH* 2018). Our results were favorably reviewed by the Mectizan Expert Committee; the program is now supporting annual Mectizan and albendazole MDA where needed in the seven states, rather than the less efficient and more costly twice-per-year albendazole-only approach.

LF and Malaria in Nigeria: Through a grant from the Bill & Melinda Gates Foundation, TCC also conducted field research on the use of LLINs alone to combat LF in Imo and Ebonyi States, areas where LF MDA with Mectizan was at that time not possible due to the presence of *Loa loa*. Results showed that the LLINs had significant impact on mosquito infection (Richards et al., *Am J T Med Hyg* 2013). Thanks to The Global Fund Round 8 in the early 2010s, LLINs were distributed at a rate of two per household throughout the majority of Nigeria for malaria prevention; LLIN were shown to be synergistic with the MDA program in Plateau and Nasarawa states. The national malaria and LF programs remain actively involved in TCC-assisted programs, and TCC has assisted (in differing degrees) in the mass distribution of LLINs in all nine states where we work. Due in part to strong TCC advocacy, Nigeria launched its FMOH Guidelines for Malaria-Lymphatic Filariasis Co-implementation in Nigeria in June 2013. We continue to work on this important synergy in TCC-assisted states, although much less so after TCC's Malaria Program closed in 2014.

LF in Ethiopia: The much smaller LF program in Ethiopia was launched in 2008 in tandem with TCC's Malaria Program, which was engaged in assisting the MOH to distribute LLINs. The Ethiopian Malaria Program completed the mass distribution of LLINs throughout the malaria-endemic areas of Ethiopia just before the LF program (the first such program in Ethiopia) was launched. These LLINs undoubtedly have had an impact on LF transmission and the 'killing two birds with one stone' strategy of fighting malaria and LF with LLINs were the primary reason the MOH decided to launch the LF MDA effort. With GSK support, TCC assisted the MOH in launching an LF elimination pilot program in 2009 that provided roughly 75,000 treatments annually. Today, the program is delivering over 800,000 treatments each year, and several passed TAS-1, stopped over 600,000 treatments and begun PTS (TAS-2 and TAS-3).

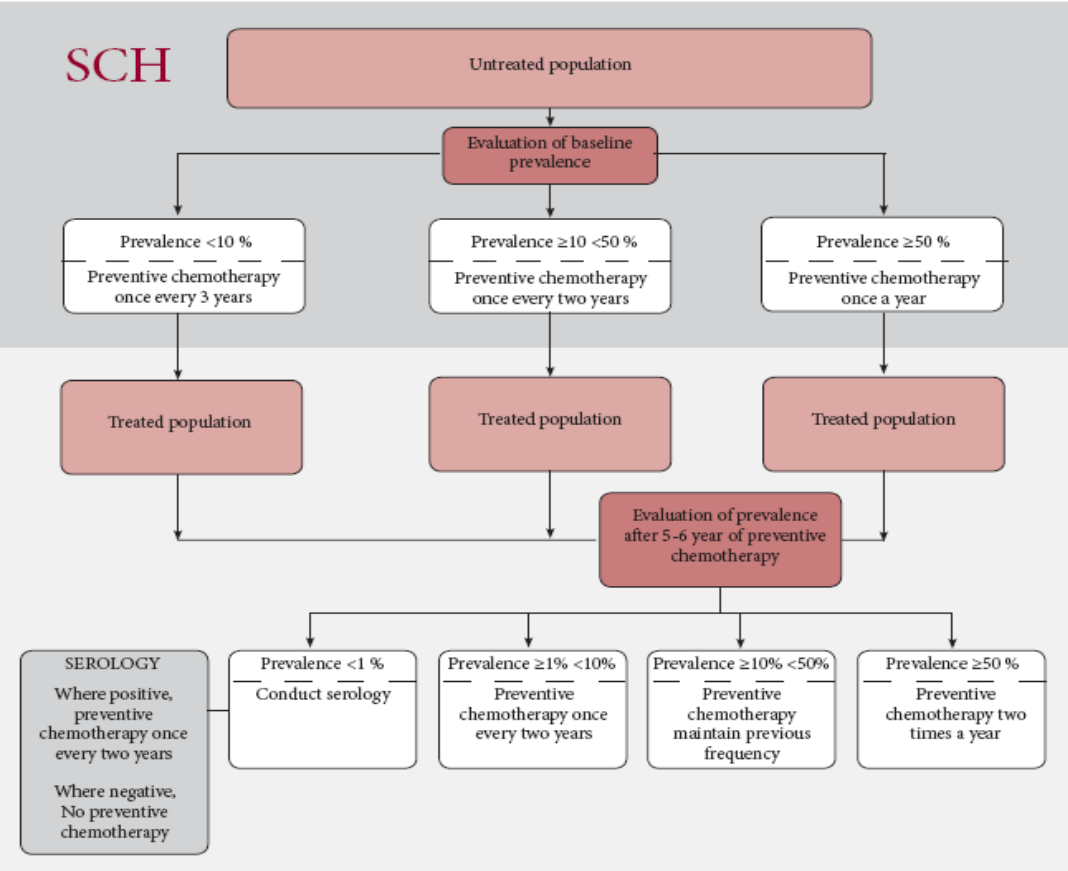
ANNEX 3: The Schistosomiasis/Soil-Transmitted Helminthiasis Control Program

SCHISTOSOMIASIS

Schistosomiasis (SCH) is a parasitic disease acquired from skin contact with fresh-water bodies where snails infected with the parasite are present. The cercarial stages of the parasite leave the snails, and swim in the water until they find an exposed person. The cercaria then penetrate the skin and migrate through the body as 'schistosomula' parasitic forms. They develop into adult male and female worms when they reach the venules of the intestines (intestinal schistosomiasis caused by *Schistosoma mansoni*) or bladder and genitals (urinary schistosomiasis caused by *S. haematobium*). It is important to note that in Africa where TCC is working, SCH exists as these two different infections that have different (and often overlapping) geographical distributions, epidemiology, and disease patterns (morbidity). In both conditions, female worms lay thousands of eggs that exit the body in feces (in the intestinal form) or urine (in the urinary form). If the eggs gain access to fresh water, they hatch and release miracidiae, which swim in search of a specific type of snail (*S. mansoni* infects snails of the *Biomphalaria* species; *S. haematobium* infects *Bulinus* species). The miracidia penetrate and infect the snails, and transform and multiply, resulting in a single snail releasing thousands of cercaria, thus continuing the lifecycle.

Eggs deposited into human tissues by the adult female worms cause inflammation, organ damage, bleeding, and anemia. Although all age groups are infected, persons with the greatest number of adult worms have the greatest number of eggs in their tissues, as well as in their urine and feces. Adults most commonly suffer from liver fibrosis and esophageal bleeding (intestinal schistosomiasis) or bladder and cervical cancer (urinary schistosomiasis). School-aged children (ages 5 to 14) may have abdominal pain, anemia, and (in urinary schistosomiasis) bloody urine. They act as the main disseminators by contaminating water with excreta. Mass Drug Administration (MDA) with the safe and effective oral medicine praziquantel can significantly reduce schistosomiasis morbidity. Praziquantel kills the adult worms, reduces the number of eggs that accumulate in tissues and, as a result, reduces the disease (morbidity) associated with schistosomiasis. The Merck KGaA/World Health Organization (WHO) donation of praziquantel is given only for MDA in school-aged children, although adults and preschool-aged children would also benefit from treatment in endemic areas.

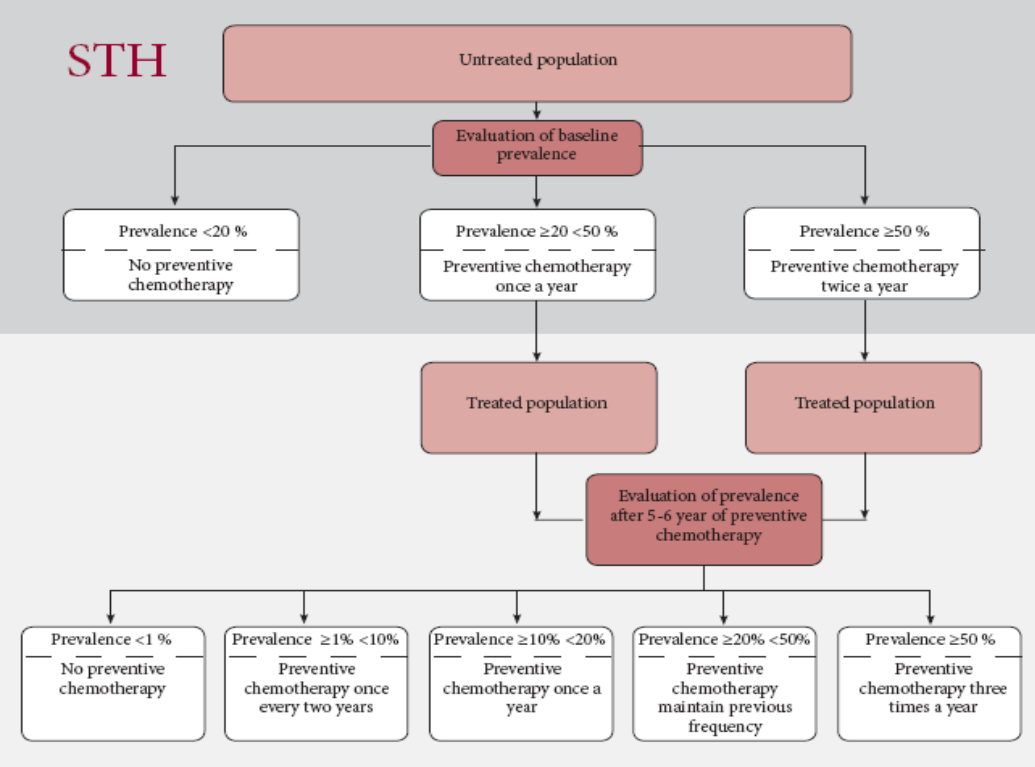
TCC's SCH programs follow 2011 WHO guidelines for disease (morbidity) control (shown below). Note that the guidelines may call for praziquantel preventive chemotherapy once every 2 – 3 years, depending on parasite prevalence in a district. For this reason, treatment numbers in the same state can be very different from year-to-year, and training and logistics become much more complicated compared to annual or twice-per-year treatment. In 2022, WHO released new guidelines, with adjustments to treatment thresholds and a change in strategy to include adults in some areas. Programs await upcoming WHO manuals that will operationalize the new guidelines, and are in discussions about how to adhere to the new guidelines despite a lack of change in Merck KGaA's donation focus on children.



Transmission is unlikely to be interrupted by the paradigm of MDA targeted at school-aged children because: 1) transmission occurs in all age groups; 2) praziquantel does not kill the migrating schistosomula forms, thus single dose treatment in children in highly endemic areas is unlikely to be curative; and 3) until open defecation and urination (or reduction of release of raw sewage into fresh water) are halted through construction and use of sanitation systems, MDA will have little to no impact on infected snails (which live for many months) and infected water. In other words, persons treated are either not cured of their schistosomula (developing) infections, and/or they become reinfected when they reenter the contaminated water.

SOIL-TRANSMITTED HELMINTHS

Soil-Transmitted Helminthiasis (STH) is caused by a group of four different intestinal worms that infect humans: *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), *Ancylostoma duodenale,* and *Necator americanus* (hookworms). STH are among the most common infections worldwide, and heavy infections lead to developmental delay, malnutrition, intestinal obstruction, and anemia (depending on the infecting species). As with SCH, school-aged children are usually the most heavily infected with these worms, with the exception of hookworms, which have their heaviest infections in adults.



Transmission of soil-transmitted helminths occurs through feces. Eggs from the adult females are passed into the environment in feces, where they become infective within days (hookworm and whipworm) or weeks (roundworm). Once in the environment, infective whipworm and roundworm eggs reach their next human host via human ingestion of fecally-contaminated food or water. Hookworm eggs hatch in soil and the resultant larvae infect humans by penetration of the skin (often entering via bare feet).

Once in the human, hookworm larvae migrate through the circulatory system until they reach the lungs. From there, they pass through the trachea and mouth where they are ingested, traveling then to the intestines. They mature, mate, and release eggs within 6-8 weeks. Whipworm and roundworm eggs hatch into larvae in the intestine and remain there through adulthood.

Heavy worm infections result in blood loss which can lead to anemia and hypoproteinemia. In children, this can lead to poor physical and developmental growth, stunting, and decreased mental acuity. In adults, hookworm-associated anemia reduces productivity and can be especially dangerous in reproductive-aged (menstruating) women. Pulmonary complications can occur due to migration of roundworm or hookworm larvae through the lungs and, in the case of ascaris, bowel obstructions can occasionally lead to death.

The current WHO guidelines for STH (see above) focus on providing treatment to school-aged children, and unlike SCH did not experience an update in 2022. STH MDA programs are for morbidity control; transmission will not be interrupted until open defecation is halted through deployment and the use of sanitary systems. Although STH treatments can be given (as with SCH) once every two years in a district, guidelines differ from SCH in that they commonly call for MDA twice per year. As with SCH, the result is that STH treatment numbers in the same state can vary greatly from district to district and from year-to-year.

It is notable that the different species of worms have different sensitivities and cure rates from the MDA regimens provided. Albendazole is superior to mebendazole. Roundworm is most sensitive to treatment, while whipworm is least sensitive. The Mectizan/albendazole combinations given for LF improve whipworm cure rates.

The challenges for TCC Nigeria in implementing schistosomiasis and STH programs include: 1) complex WHO guidelines that result in different regimens tailored to district epidemiology (alternating year treatment schedules for schistosomiasis up to every third year compared with twice-per-year treatment programs for STH in some areas); 2) a focus since 2011 on a Ministry of Education (school-based) approach rather than the traditional Ministry of Health (community-based) platform, which is more experienced at MDA activities; 3) a focus on teachers (in schools) rather than community distributors (house to house); 4) exclusion of potentially infected persons, including preschool children, unenrolled school-aged children (especially girls), and adults; 5) algorithms with thresholds statistically indistinguishable from one another; 6) mapping based on averages resulting in exclusion of communities that need interventions; 7) difficult calculations of coverage due to challenges with denominator determinations; 8) difficulty in justifying the closure of a longstanding distribution infrastructure that works well (community-based) to start a new approach (school-based); and 9) loss of high-quality STH control resulting from community-wide LF MDA with the most potent STH treatment (Mectizan and albendazole) when LF programs that pass Treatment Assessment Surveys (TAS) assessments cease treatment.

SCH/STH work under USAID/RTI Act to End NTDs | East focuses on “mainstreaming” the two diseases into the large health care delivery system, abandoning the vertical MDA approach to control. We believe it is likely that there will be less support in the near future for the TCC SCH/STH program. Accordingly, in Local Government Areas (LGAs) where the River Blindness (RB) or Lymphatic Filariasis (LF) platform does not exist, we are implementing plans to transfer support of MDA fully to the Ministries of Health (MOH) and Education.

ANNEX 4: A Timeline of the River Blindness Campaign at The Carter Center

- **2021:** Two states in Nigeria and three foci in Uganda completed PTS for onchocerciasis and achieved transmission elimination status. Nigeria also qualified to stop RB treatments in Delta State for 2.8m people and stop LF treatments for 3.4m people. Ethiopia qualified to halt 508,000 RB treatments and 260,923 LF treatments. In the Americas, the OEPA program broadened its access to remote Yanomami communities by building a new airstrip in Siapa Valley, Venezuela.
- **2020:** NTD programs worldwide temporarily suspended community-based activities in compliance with WHO recommendations to prevent the spread of COVID-19. As a result, most countries only achieved one round of MDA within the calendar year. RBEP-assisted MDA for onchocerciasis in Uganda was one of the first large scale campaigns to resume globally. Program review and national committee meetings were held virtually (IACO, EOEEAC, UOEEAC) or postponed (PCC, NOEC).
- **2019:** Problems with importation of Mectizan into Nigeria in 2019 resulted in an inability of RBEP-assisted programs to provide twice-per-year MDA for onchocerciasis; all RBEP-assisted Nigeria programs provided a single round of treatments. Just over 600,000 treatments were halted in Uganda after successful stop MDA assessments were conducted. The large MMN focus bordering the Republic of South Sudan was reclassified as 'transmission suspected interrupted.' Cross-border activities between Uganda and the DRC were halted however, because of the DRC Ebola outbreak. Onchocerciasis Elimination Mapping in Ethiopia provided data that led the national committee to recommend treatment be launched in several new areas of the country. The LF elimination program in Ethiopia stopped about 117,000 treatments after successful TAS surveys. The OEPA program held the 29th IACO conference in Brasilia, with the theme "Brazil approaching the elimination of onchocerciasis." The conference praised the IHAs involved in both the Brazil and Venezuela elimination programs. In 2019, RBEP authors published papers on S&C vegetation clearance as non-chemical-based vector control in Uganda, the role of OEPA as a model for Africa RB elimination programs, MDA coverage surveys in Uganda and Cameroon, and use of doxycycline treatment as an endgame strategy in the Americas.
- **2018:** Three papers (on topics of Uganda, OEPA and National Onchocerciasis Elimination Committees) are published by RBEP authors in a special supplement on Onchocerciasis Elimination in the journal International Health. In Nigeria an SCH and STH impact evaluation was conducted among 9,660 children; a reduction in prevalence of infection compared to a 2013 baseline was demonstrated in many areas. In the East and West Harage zones of eastern Ethiopia, a new onchocerciasis focus was identified in OV16 surveys in an area previously believed to be non-endemic. In Uganda, MDA for onchocerciasis was recommended to be halted among more than 335,000 persons with declaration of transmission interruption in two foci. The OEPA program celebrated its 25th anniversary as it struggled to operate in Venezuela amidst political and financial turmoil.
- **2017:** The most successful year ever for numbers of RBEP-assisted Mectizan treatments (over 55 million) delivered. Decisions to stop treatments at the end of 2017 in 3.8 million persons resident in RBEP-assisted areas in three African countries (Ethiopia, Nigeria, and Sudan), believed to be the largest number of persons for whom RB MDA has been stopped in a given year. Sudan and Ethiopia jointly declare a stop Mectizan MDA decision for 1.2 million persons in the cross-border Galabat/Metema onchocerciasis transmission zone. Nigeria halts MDA for onchocerciasis among 2.2 million persons in Plateau and Nasarawa States. Uganda halts MDA among 421,000 persons in two foci. Venezuela completes PTS in its largest focus (the Northeast focus) and transmission there is declared eliminated.

- **2016:** WHO verifies that Guatemala has eliminated onchocerciasis transmission. Uganda declares river blindness transmission eliminated in four foci. TCC celebrates its ½ billionth treatment for NTDs. NOEC releases a plan of action for elimination of river blindness in Nigeria. TCC is selected as a semi-finalist in the MacArthur Foundation's 100&Change grant competition with a proposal to support the NOEC plan, but is not ultimately the grant recipient.
- **2015:** WHO verifies that Mexico has eliminated onchocerciasis, and Guatemala requests verification. TCC provides technical and financial assistance to help establish a national onchocerciasis expert advisory committee in Nigeria. Sudan announces that transmission has been eliminated in Abu Hamad Focus.
- **2014:** WHO verifies that Ecuador has eliminated onchocerciasis. The International Task Force for Disease Eradication (ITFDE) reviews RB/LF in Africa again (*WER* 2014). TCC provides technical and financial assistance to help establish a national onchocerciasis expert advisory committee in Ethiopia.
- **2013:** The name of TCC's River Blindness Program changes to TCC's River Blindness Elimination Program to reflect the paradigm shift to focusing efforts on eliminating RB transmission everywhere we work. Colombia is the first country in the world verified by WHO to be free of onchocerciasis. Ecuador applies to WHO for verification of elimination.
- **2012:** Sudan announces interruption of onchocerciasis transmission in Abu Hamad Focus (Higazi 2013). TCC's River Blindness Program obtains our Board of Trustees' approval for an eight-year plan to interrupt RB transmission everywhere we assist by 2020. WHO sends a verification team to Colombia to determine if the country has eliminated onchocerciasis. Plateau and Nasarawa states in Nigeria qualify to halt MDA for LF.
- **2011:** TCC's ITFDE reviews the RB and LF elimination efforts in Africa, applauds the move by APOC from RB control to elimination, and calls for better coordination of RB and LF interventions as well as with malaria bed net distribution efforts (*WER* 2011). An expert committee (with Frank Richards, the TCC RBP Director, as a member), meeting under the auspices of the World Bank, recommends an elimination goal for ten African countries by 2020, including Nigeria, Uganda, and Ethiopia. In late 2012, the World Bank/APOC governing board recommends onchocerciasis elimination now be APOC's goal.
- **2010:** TCC reports considerable success in RB elimination efforts in the Americas (series of *WER* articles) and parts of Africa. However, Katabarwa (TCC/RBP) notes a need to expand treatment into the so-called hypoendemic areas excluded by APOC's treatment strategies. He also challenges the Diawara report by noting failures of once-per-year treatment with Mectizan alone for 17 years in TCC-assisted North Province, Cameroon; TCC calls for twice-per-year treatment in these areas (Katabarwa 2011). At an international conference, TCC reports an analysis of the impact of annual Mectizan and albendazole (for lymphatic filariasis) on onchocerciasis transmission elimination in many areas of Plateau and Nasarawa States of Nigeria.
- **2009:** A key Gates Foundation-supported WHO/TDR study by Diawara (2009) conducted in Senegal and Mali (derived as an outcome of the 2002 Conference on Eradicability) proves RB elimination is possible with 17 years of Mectizan alone under some conditions in Africa. Gates, MDP, TCC, and APOC all call for "Shrinking the Map" in Africa (WHO 2009). Rakers (TCC/RBP) reports that RB programs in Nigeria would collapse without external support, questioning the 'sustainability' theory (*The Lancet* 2009).
- **2008:** TCC provides technical and financial assistance to help establish a national onchocerciasis expert advisory committee in Uganda with seed support from Mr. John Moores.
- **2007:** TCC's International Task Force for Disease Eradication reviews RB eradicability and notes evidence that Mectizan alone may interrupt transmission in Africa, but that the challenge of *Loa loa* needs to be resolved. (WHO 2007). TCC/RBP agrees to assist Uganda in its new goal of national RB elimination.

- **2006:** TCC agrees to assist Sudan's declaration of national elimination, starting with enhanced efforts in the Abu Hamad focus on the River Nile (Higazi 2011, 2013).
- **2005:** Paper published by Hopkins, Richards, and Katabarwa ("Whither Onchocerciasis Control in Africa?") challenges the feasibility of indefinite RB control in Africa without continued external support; calls for governments to do more to fund their programs; and calls for further research into RB elimination in Africa (Hopkins 2005).
- **2003:** Richards co-authors a paper on mass treatment decision-making in *Loa loa* areas where onchocerciasis occurs (Addis 2003).
- **2002:** TCC and WHO (with Gates Foundation support) co-host the Conference on RB Eradicability that concludes RB can be eliminated in the Americas but not yet throughout Africa with current tools (Mectizan alone). The challenge is noted of the parasite *Loa loa*, which occurs in some areas that have RB: Mectizan given to a person having *Loa loa* infection can result in severe nervous system reactions, including coma. The conference calls for further study in Africa and for implementers to 'go for transmission elimination' in Africa where feasible (Dadzie 2003). The Gates Foundation, in part as a result of the findings of the conference, shortly thereafter provide major grants to TCC in support the OEPA program and TDR to study using Mectizan alone to eliminate onchocerciasis transmission in Mali and Senegal.
- **2000:** OEPA needs a 'definition of success' endorsed by WHO; with a push from President Carter to WHO DG H Gro Brundland, WHO agrees to hold an important meeting to establish certification criteria for onchocerciasis elimination (WHO 2001), which had great utility for programs in the Americas and Uganda. Richards, writing in *The Lancet*, notes the importance of the LF program in advancing the RB elimination agenda and challenges the African program to move toward onchocerciasis transmission elimination in a model similar to that in the Americas.
- **1998:** Richards, with other TCC authors (Miri and Sauerbrey), writes about opportunities for RB elimination in a special edition of the Bulletin of WHO entitled "Global Disease Elimination and Eradication as Public Health Strategies". He also writes about the history of launching of the OEPA initiative (Bull PAHO).
- **1997:** TCC Vice President of Health Programs, Dr. Donald Hopkins, and Richards publish "Visionary Campaign: Eliminating River Blindness" in the 1997 Encyclopedia Britannica Medical and Health Annual.
- **1996:** TCC assumed country program activities of RBF in the Americas, Nigeria, Cameroon, Sudan, and Uganda. (Ethiopia started in 2001.) Dr. Frank Richards is seconded from CDC to TCC as its RB technical director. RBF formally closes, and program funding in Africa becomes the responsibility of the newly launched African Programme for *Onchocerciasis* Control (APOC), which was jointly developed by NGOs (including RBF and TCC), WHO, and the World Bank with bilateral and multilateral donors.
- **1991:** The River Blindness Foundation (RBF) is launched by philanthropists John and Rebecca Moores of Houston, TX. RBF quickly becomes the largest source of support for Mectizan distribution activities, funding NGOs such as Sightsavers, Helen Keller International, the International Eye Foundation, CBM, and others. It also launches the OEPA initiative in the Americas and supports the WHO-NGO coordination office for onchocerciasis in Geneva.

ANNEX 5: Publications by Year Authored or Coauthored by RBEP Personnel

2021 publications shown in bold.

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ANNEX 6: 2021 RBEP Program Review Agenda

River Blindness, Lymphatic Filariasis, and Schistosomiasis Program Review Agenda			
Monday, February 28, 2022			
Start	**End**	**Title**	**Speaker**
7:00 AM	7:05 AM	Day 1 Welcome and Introduction	Dr. Gregory Noland
7:05 AM	7:10 AM	Welcoming Remarks	Dr. Kashef Ijaz
7:10 AM	7:15 AM	Welcoming Remarks	Paige Alexander
7:15 AM	7:20 AM	Goodwill Message	Dr. Tedros Ghebreyesus
7:20 AM	7:45 AM	RBEP Overview	Dr. Gregory Noland
7:45 AM	7:50 AM	Ethiopia River Blindness Film	
7:50 AM	8:15 AM	Uganda: Treatments and Impact	Mr. David Oguttu
8:15 AM	8:30 AM	*Discussion*	
8:30 AM	8:45 AM	Uganda: Training, Integration, and Community Ownership	Ms. Annet Khainza
8:45 AM	9:00 AM	*Discussion*	
9:00 AM	9:15 AM	*BREAK*	
9:15 AM	9:30 AM	Uganda: Delineation of Madi-Mid North Focus	Dr. Moses Katabarwa
9:30 AM	9:40 AM	*Discussion*	
9:40 AM	10:00 AM	Sudan: Treatments, Impact, Assessments and Training	Dr. Isam Zarroug
10:00 AM	10:10 AM	*Discussion*	
10:10 AM	10:25 AM	Sudan: Serology Results	Dr. Jenna Coalson
10:25 AM	10:35 AM	*Discussion*	
10:35 AM	10:50 AM	Sudan: Peace-Health Updates	Dr. Buthaina El-Naiem
10:50 AM	11:00 AM	*Discussion*	
11:00 AM	11:00 AM	Day 1 Closure	Dr. Gregory Noland

River Blindness, Lymphatic Filariasis, and Schistosomiasis Program Review Agenda			
Tuesday, March 1, 2022			
Start	**End**	**Title**	**Speaker**
7:00 AM	7:05 AM	Day 2 Introduction	Dr. Gregory Noland
7:05 AM	7:35 AM	Ethiopia: RB Treatments, Impact, Training, Integration, and Community Ownership	Dr. Zerihun Tadesse
7:35 AM	7:45 AM	*Discussion*	
7:45 AM	8:00 AM	Ethiopia: LF Treatments and Impact	Mr. Mohammed Hassen
8:00 AM	8:10 AM	*Discussion*	
8:10 AM	8:25 AM	Ethiopia: New Approaches in Assessing Progress Toward Elimination	Ms. Emily Griswold
8:25 AM	8:35 AM	*Discussion*	
8:35 AM	8:50 AM	Ethiopia: MDA Coverage Results	Mr. Aderajew Mohammed
8:50 AM	9:00 AM	*Discussion*	
9:00 AM	9:15 AM	*BREAK*	
9:15 AM	9:55 AM	OEPA Overview	Dr. Mauricio Sauerbrey
9:55 AM	10:10 AM	*Discussion*	
10:10 AM	10:25 AM	OEPA: Brazil and Venezuela Scorecard System	Eng. Dalila Rios
10:25 AM	10:35 AM	*Discussion*	
10:35 AM	10:50 AM	Support for National RB Labs: Experience and Outlook	Mr. Hassan Hassan
10:50 AM	11:00 AM	*Discussion*	
11:00 AM	11:00 AM	Day 2 Closure	Dr. Gregory Noland

River Blindness, Lymphatic Filariasis, and Schistosomiasis Program Review Agenda			
Wednesday, March 2, 2022			
Start	**End**	**Title**	**Speaker**
7:00 AM	7:05 AM	Day 3 Introduction	Dr. Gregory Noland
7:05 AM	7:30 AM	Nigeria: Treatments and Impact	Dr. Emmanuel Miri
7:30 AM	7:40 AM	*Discussion*	
7:40 AM	8:00 AM	Nigeria: Training and Costs	Dr. Adamu Sallau
8:00 AM	8:10 AM	*Discussion*	
8:10 AM	8:25 AM	Nigeria: LF Pre-TAS and TAS Report	Dr. Cephas Ityonzughul
8:25 AM	8:35 AM	*Discussion*	
8:35 AM	9:00 AM	Nigeria: LF MMDP	Dr. Abel Eigege
9:00 AM	9:10 AM	*Discussion*	
9:10 AM	9:25 AM	*BREAK*	
9:25 AM	9:30 AM	Nigeria World NTD Day Video	
9:30 AM	9:45 AM	Nigeria: SCH/STH Mainstreaming Study and Mainstreaming Plans	Dr. Emmanuel Emukah
9:45 AM	9:55 AM	*Discussion*	
9:55 AM	10:10 AM	Nigeria: RB Stop-MDA Entomology in Enugu, Anambra, Imo and Abia	Dr. Cephas Ityonzughul
10:10 AM	10:20 AM	*Discussion*	
10:20 AM	10:35 AM	Nigeria: RB Black Fly Environmental Habitat Sustainability Modeling Project	Ms. Erin Stearns Ms. Molly Mort Dr. Christy Hanson Mr. Matt Hallas
10:35 AM	10:45 AM	*Discussion*	
10:45 AM	11:00 AM	Closing Discussion and Remarks	Dr. Gregory Noland

ANNEX 7 List of Program Review Participants

The Carter Center Atlanta
Ms. Paige Alexander
Ms. Nina Benard
Ms. Lauri Bernard
Dr. Eve Byrd
Ms. Kelly Callahan
Ms. Jenna Coalson
Mr. Yohannes Dawd
Mr. Matthew De Galan
Mr. Yasir Deafalla
Mr. Don Denard
Ms. Andrea Echols
Ms. Cassandra Grant
Ms. Emily Griswold
Ms. Ursula Hamilton
Ms. Madelle Hatch
Dr. Donald Hopkins
Ms. Dottie Hunt
Dr. Kashef Ijaz
Ms. Molly Ison
Ms. Kim Jensen
Ms. Reet Kapur
Dr. Moses Katabarwa
Mr. Jim Kavanagh
Mr. Curtis Kohlhaas
Ms. Nicole Kruse
Ms. Abby Miller
Ms. Emily Mooney
Dr. Scott Nash
Dr. Gregory Noland
Ms. Jayden Pace-Gallagher
Ms. Lindsay Rakers
Ms. Faith Randolph
Dr. Frank Richards
Ms. Angelia Sanders
Ms. Elaina Sinclair
Ms. Emily Staub
Ms. Shandal Sullivan
Mr. Marc Tewari
Ms. Lauren Thrash
Mr. Adam Weiss
Ms. Jenny White
Mr. Craig Withers

The Americas
Dr. Carlos Botto (SACAICET)
Dr. Sharley Ceballos (SACAICET)
Dr. Andreia de Pádua (MOH)
Dr. Alfredo Dominguez (OEPA)
Mr. Luis Erchila (OEPA)
Ms. Alba Lucia Morales (OEPA)
Dr. Oscar Noya-Alcaron (SACAICET)
Mr. Joao Luiz Pereira (MOH)
Ms. Dalila Rios (OEPA)
Ms. Silvia Sagastume (OEPA)
Dr. Mauricio Sauerbrey (OEPA)

Ethiopia
Mr. Abdo Aliyi (The Carter Center)
Mr. Yewondwosen Bitew (The Carter Center)
Mr. Tekola Endeshaw (The Carter Center)
Mr. Yohannes Eshetu (The Carter Center)
Mr. Mohammed Hassen (The Carter Center)
Mr. Desalegn Jemberie (The Carter Center)
Dr. Fikreab Kebede (FMOH)
Mr. Yemane Kejela (The Carter Center)
Mr. Aragaw Lamesgin (The Carter Center)
Mr. Kadu Meribo (FMOH)
Mr. Abey Mezgebu (The Carter Center)
Mr. Fetene Mihretu (The Carter Center)
Mr. Aderajew Mohammed (The Carter Center)
Mr. Okocha Ndudi (The Carter Center)
Mr. Fanta Nigussi (The Carter Center)
Mr. Birhanu Reta (The Carter Center)
Mr. Fikresilasie Samuel (The Carter Center)
Mr. Tewodros Seid (The Carter Center)
Mr. Fikre Seife (FMOH)
Mrs. Hiwot Solomon (FMOH)
Dr. Zerihun Tadesse (The Carter Center)
Mr. Abebual Yilak (The Carter Center)

Nigeria
Dr. Nsep Akpan (FMOH)
Mr. David Alheri (The Carter Center)
Prof. Uche Amazigo (PACIEH)
Mr. George Chiedo (The Carter Center)
Ms. Philomena Dikedi (The Carter Center)
Mr. Emmanuel Davies (FMOH)
Mrs. Attamah Egeonu (The Carter Center)
Dr. Abel Eigege (The Carter Center)
Dr. Josephine Ekeanyanwu (The Carter Center)

Nigeria - *continued*
Dr. Emmanuel Emukah (The Carter Center)
Mr. Michael Igbe (FMOH)
Dr. Cephas Ityonzughul (The Carter Center)
Mr. Barminas Kahansim (The Carter Center)
Mr. Bulus Mancha (The Carter Center)
Dr. Emmanuel Miri (The Carter Center)
Mr. Suleyman Mutuwa (The Carter Center)
Dr. Obiageli Nebe (FMOH)
Mr. Lazarus Nweke (The Carter Center)
Prof. B.E.B Nwoke (Imo State University Owerri)
Mr. Emmanuel Obikwelu (State MOH – Anambra)
Mrs. Stella Obiukwu (State MOH – Imo)
Mr. Solomon Offor (State MOH – Abia)
Ms. Hope Ogiku (The Carter Center)
Ms. Patience Saleh (The Carter Center)
Dr. Adamu Sallau (The Carter Center)
Mrs. Nnena Ukairo (The Carter Center)

Sudan
Dr. Abdalla Ahmed (FMOH)
Ms. Maymoona El Tayeb (The Carter Center)
Mr. Mazin Elsanosi (The Carter Center)
Dr. Isam Zarroug (FMOH)
Miss Wigdan Elmubark (FMOH)

Uganda
Mr. Alex Arinaitwe (The Carter Center)
Mr. Edson Byamukama (The Carter Center)
Mr. Samuel Dramuke (The Carter Center)
Ms. Annet Khainza (The Carter Center)
Dr. Gabriel Matwale (MOH)
Dr. Edridah Muheki (MOH)
Mr. David Oguttu (MOH)
Mr. Justin Ocaka (The Carter Center)
Ms. Harriet Sengendo (The Carter Center)

Other Countries
Mr. Julius Coles (Consulate of Senegal)
Dr. Sebastiao Mavitidi (Angola Ministry of Health)
Dr. Tony Ukety (CRMY, DRC)

Accenture
Ms. Nicole Julal

Bayer AG
Dr. Ulrich Madeja

Brain & Behavior Research Forum
Ms. Lauren Duran

CDC
Dr. Subomi Adeyemo
Dr. Vitaliano Cama
Capt. Monica Parise
Dr. Kimberly Won

Corus International
Dr. Abdel Direny

DevGlobal
Mr. Matthew Hallas

Drugs & Diagnostics for Tropical Diseases
Dr. Marco Biamonte

Emory University
Dr. Hope Bussenius
Dr. Michelle Grek
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Erasmus University Medical Center Rotterdam
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