Hindawi
Advances in Public Health
Volume 2019, Article ID 7276230, 9 pages
https://doi.org/10.1155/2019/7276230

Research Article

Prevalence of Onchocerciasis and Associated Factors among Adults Aged ≥ 15 Years in Semen Bench District, Bench Maji Zone, Southwest Ethiopia: Community Based Cross-Sectional Study

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Received 21 September 2018; Revised 12 February 2019; Accepted 12 March 2019; Published 28 March 2019

Academic Editor: Carol J. Burns

Background. Though onchocerciasis control and elimination through community directed treatment with ivermectin were conducted for the last fifteen years, prevalence of onchocerciasis and factors associated with it in the study area are yet not known. The aim of the current study is to assess prevalence of onchocerciasis and associated factors among adults aged greater than or equal to fifteen years in Semen Bench district, Bench Maji zone, southwest Ethiopia: community based cross-sectional study 2018. *Methods*. Community based cross-sectional study was conducted on 553 study participants selected by multistage sampling in April 2018. Data were collected using a pretested interviewer-administered questionnaire. Data were entered using EpiData version 3.1 and exported to SPSS version 20 for statistical analysis. Descriptive statistics were done to summarize dependent and independent variables. Bivariate logistic regression was done to select candidate variables. Multivariable logistic regression was performed to identify independent predictors of onchocerciasis infection. Adjusted odds ratios with 95% CI were calculated to assess association and statistical significance, respectively. Confidence interval was used to declare statistical significance. *Result*. The overall prevalence of onchocerciasis infection in the study area was 6.32%. Age category of 35-44 years (AOR: 13.48, 95%CI: 3.51, 51.76), age of 45 years and above (AOR: 9.41, 95% CI: 2.26, 39.06), male sex (AOR 4.568, 95% C.I: 1.622, 12.861), not being compliant with ivermectin treatment (AOR: 3.804, 95%CI: 1.524, 9.49), and residing at less than 2Km from the river (AOR: 9.15, 95%CI: 3.9, 21.49) were significantly associated with onchocerciasis infection. *Conclusion and Recommendation*. After more than a decade of treatment with ivermectin, onchocerciasis in the study area is still hypoendemic. Zonal health department and other stakeholders should evaluate therapeutic coverage and community directed treatment with ivermectin in the study area. Zonal health department with other stokeholds should give community based information education communication, giving due attention to older ages, male residents, and those living near the rivers. Further community based study should also be done to identify factors hindering the community compliance with the treatment.

1. Background

Onchocerciasis or "*river blindness*" is a vector borne disease caused by the bite of infected black fly (*Simulium* species) with filarial parasitic worm *Onchocerca volvulus*. The transmission from person to person is due to the biting of infected black fly with filarial worm stage three larvae. The adult filarial worms reproduce and live in skin nodules of human body for long period of time, even for more than fifteen years [1]. Black flies of *Simulium* species, especially, *Simulium damnosum*, is the vector and reservoir for onchocercal microfilaria [2].

Infection with this nematode filarial worm leads to skin disease and anatomical impairment, which are dermatitis, pruritus or itching, depigmentation of the skin or leopard skin, onchocercomata, hanging groin, and temporary vision loss to blindness [3].

The major strategy to eliminate onchocerciasis from endemic areas was ivermectin (Mectizan) mass drug administration (MDA). Continuous treatment with highly

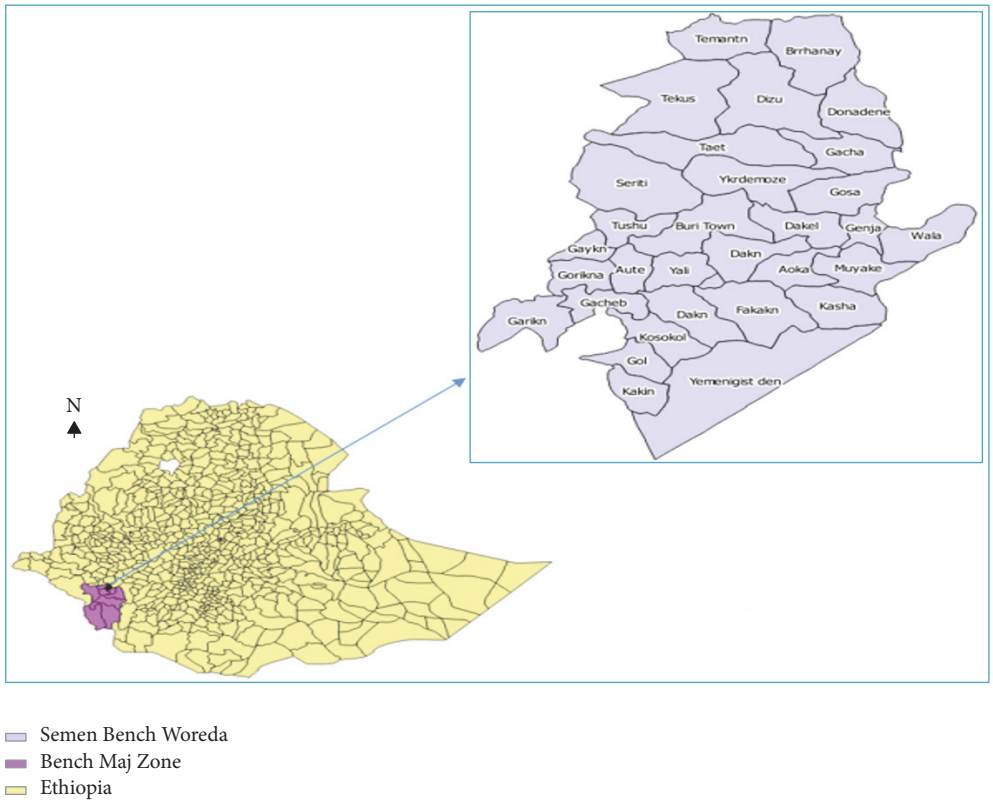

Figure 1: Map of Semen Bench district.

therapeutic drug covering large geographic area is the main strategy to interrupt onchocerciasis transmission [4].

According to Global Burden of Disease Study estimate, there were 20.9 million prevalent *O. volvulus* infections worldwide in 2017: 14.6 million of the infected people had skin disease and 1.15 million had vision loss. More than 99% of infected people live in 31 African countries. The disease also exists in some foci in Latin America and Yemen. In 2017, more than 142 million people were treated in Africa where the strategy of CDTI was implemented, representing approximately 69.6% coverage of the number of people who require treatment globally [5].

Evidence showed that more than 120 million people were at risk of onchocerciasis infection in Africa region, of whom 26 million people were infected and over 265,000 people were blind. People who live in fertile land, extensive agricultural farming area, and people who live and settle near to river banks were more vulnerable for onchocerciasis infection [6].

Onchocerciasis is endemic in coffee growing and large cotton farming areas of southwest and northwest parts of Ethiopia with different prevalence and epidemiological distribution. More than 16.3 million people living in different onchocerciasis endemic areas were estimated to be at risk of contracting the disease [7].

The disease has impacts on socioeconomic and mental health of infected individuals. Prolonged itching of the skin leads to low productivity and absence from work. Chronic skin illness also needs high medical costs. Stigmas and discriminations related to onchocerciasis affect sexual health of infected individuals and hinder social relation and personal confidence [8].

Studies showed that age, sex, educational status, occupation, residence distance from the river, and residence at river banks were predictors of onchocerciasis infection [9, 10].

Federal Ministry of Health of Ethiopia had set a goal to eliminate onchocerciasis and to stop community directed treatment with ivermectin by 2020 [11]. Onchocerciasis control and elimination through community directed treatment with ivermectin had been conducted in the study area for the last fifteen years. However, prevalence of the disease and its risk factors are not well studied in this study area. Therefore, the aim of the current study is to determine the prevalence of onchocerciasis infection and to identify factors independently associated with it among adults aged ≥15 years in Semen Bench district. The findings of the current study are very crucial to decide whether the current intervention strategies are effective or other intervention strategies are needed to meet the goal set by Federal Ministry of Health of Ethiopia to eliminate the disease.

2. Methods

2.1. Study Area and Period. This study was conducted in Semen Bench district, Bench Maji zone, southwest Ethiopia, which is 568 Km far from Addis Ababa, the capital city of the country, in April 2018. Semen Bench district is one of the ten decentralized districts in Bench Maji zone and 17 Km far from zonal administration town of Mizan-Aman (Figure 1).

The district has an altitude of 2000m above sea level. The majority of the area is covered by broad leafed rainforest and predominant coffee growing area. There are many rivers and streams used for agriculture and home consumption. The livelihoods of the residents mainly depend on cultivating crops and breeding livestock. An administrative division of Semen Bench district is comprised of 28 rural and 3 urban kebeles (the smallest administrative unit in Ethiopia). The total 2017/18 projected population size of the district is 138,556; from these, males account for 67,892 and the rest 70,664 were females. There are 28,277 estimated households. More than 85 % of the populations live in rural areas. There are four health centers and 31 health posts in the district. Community directed treatment with ivermectin for onchocerciasis control and elimination had been going in the district for the last 15 years by mass drug administration with varying geographical coverage between 95 and 100% and therapeutic coverage above 80%.

2.2. Study Design and Population. Community based cross-sectional study was conducted. Selected people aged ≥15 years and having stayed in Semen Bench district for one year and above were enrolled in the study.

2.3. Sample Size and Sampling Techniques. Sample size was calculated using single population proportion formula by assuming 6.9% prevalence of onchocerciasis from the study done at southwest Ethiopia [12], 95% C.I, 3% margin of error, 10% nonresponse rate, and design effect of 2. The final sample size was 605 people living in the district whose ages were fifteen years and above.

There are 3 urban kebeles and 28 rural kebeles in Semen Bench district. Kebele is the smallest administrative unit in Ethiopia. Nearly 30% of the kebeles from each, nine rural kebeles and one urban kebele, were randomly selected. The calculated sample size (605) was allocated by probability proportional to size (PPS) to the selected kebeles based on the number of households in each kebele. Study participants were selected by systematic random sampling from each kebele. In a case when there were more than two eligible individuals in a household, one eligible individual was randomly selected by lottery method.

2.4. Data Collection Techniques and Measurements. The independent variables included in this study include age, sex, educational status, occupation, duration of stay in the residency area, compliance with ivermectin treatment, distance from the nearby river, residing at river banks, and accessibility of ivermectin treatment by mass drug administration

Nonbiological data were collected by face to face interview using structured questionnaire adapted from different literature [4, 5, 7, 8]. After face to face interview, clinical presentations of onchocercal skin disease were observed from study participants in separate room with adequate natural illumination. After observing clinical presentations, skin snip samples from each upper iliac crest were collected for parasitological examination from study participants. From each study subject, 2 mg of two bloodless skin snips from both sides of upper iliac crest of body parts were taken using disposable syringe and surgical blade. The skin snip was placed in a 96-well round bottom micro-titrate plate with normal saline labelled with participant's unique code. The snipped area was dressed by antibacterial American plaster. The plate was covered to prevent evaporation. The collected skin snip samples were transported to Mizan-Aman regional diagnostic center for laboratory examination. Before the diagnosis, the skin snips were incubated at room temperature for 24 hours to ensure complete emergence of microfilaria. After blotting to remove excess moisture, each skin snip was weighed using analytical balance. Then the fluid in each plate was thoroughly mixed and pipetted onto a microscopic slide for species identification of onchocercal microfilaria. Slides positive for microfilaria were dried, fixed with methanol, and stained with giemsa stain to identify onchocercal microfilaria from nonpathogenic or low pathogenic microfilaria which is found in the skin and blood. Identification and counting of onchocercal microfilaria under a microscope were conducted. The number of mf from each skin snip was expressed as mf per milligram (mf/mg) of skin snip. The laboratory procedure was done at Mizan-Aman regional diagnostic center.

Nonbiological data were collected by six trained public health officers who were fluent in speaking Amharic and local language, and skin snips were collected by four trained laboratory technologists who were also fluent in speaking Amharic and local language. Two laboratory technologists were assigned for microscopic identification of onchocerciasis microfilaria. Two public health officers were also assigned to oversee the overall data collection process.

Four-day training was given for data collectors and supervisors prior to actual data collection. Before the commencement of actual data collection, pretesting of the tools was done in Guraferda district on 31 people with similar characteristics. Data collection tools were refined based on the results from the pretest. Laboratory technologists were adhered to standard operating procedures (SOPs) during skin snip collection, transportation, storage, and diagnosis to ensure internal quality. Every day, parallel testing of the skin snips from single person was done by two laboratory technologists to check the consistency of the results.

2.5. Data Processing and Analysis. Data were entered using EpiData version 3.1 and exported to SPSS version 20 for statistical analysis. Descriptive statistics like frequency count, measures of central tendency, and measures of dispersion were done to determine the prevalence of onchocerciasis and to summarize other predictor variables. Bivariate logistic regression was performed to identify candidate variables for multivariable logistic regression. Candidate variables with P value < 0.25 in bivariate analysis were entered to multivariable logistic regression to identify independent predictors of onchocerciasis infection and to control confounders. Adjusted odds ratio with its 95% CI was calculated to measure strength of association and its statistical significance, respectively. 95% CI was used to declare statistical significance.

Table 1: Sociodemographic characteristics of study participants in Semen Bench district, Bench Maji zone, Southwest Ethiopia, June 2018 (n=553).

Variable	Category	Total (%)	Onchocerciasis status	
			Positive	Negative
Age	15-24	210(38)	3(1.4)	207(98.6)
	25-34	171(30.9)	5(2.9)	166(97.1)
	35-44	90(16.3)	16(17.8)	74(82.2)
	≥45	82(14.8)	11(13.4)	71(86.6)
Sex	Male	272(49.1)	28(10.3)	244(89.7)
	Female	281(50.9)	7(2.5)	274(97.5)
Ethnicity	Bench	524(94.8)	35(6.7)	489(93.3)
	Others	29(5.2)	0(0)	29(100)
Religion	Protestant	496(89.6)	32(6.5)	464(93.5)
	Others	57(10.4)	3(5.3)	54(94.7)
Educational status	Illiterate	186(33.6)	19(10.2)	167(89.8)
	Reading & writing & above	367(66.4)	16(4.4)	351(95.6)
Occupation	Farmer	352(63.7)	31(8.8)	321(91.2)
	Others	201(36.3)	4(1.9)	197(98.1)
Duration of stay in years	1-20	208(37.8)	7(3.4)	201(96.6)
	21 & +	342(62.2)	27(7.9)	315(92.1)

2.6. Ethical Considerations. Ethical approval letter was obtained from Ethical Review Committee of Institute of Health, Jimma University. Permission to conduct the study was obtained from Bench Maji Zone Health Department, Semen Bench District Health Office, and kebele administration leaders. Verbal informed consent was obtained from study subjects before starting the study. Study participants positive for onchocerciasis *mf* were treated with ivermectin through the treatment protocol.

3. Results

3.1. Sociodemographic Characteristics of Study Participants. A total of 553 study subjects participated in this study with response rate of 91.4%. Nearly half, 50.9%, of the study participants were females. The median age of the study participants was 27 years. 94.8% of the study participants were Bench in ethnicity, and 89.6% of the study participants were protestant Christians. Concerning their educational status, 33.6% of the study participants had not attend any formal education. 63.7% of study participants were farmers by their occupation and the mean duration of stay (±SD) in the study area was 27.61± 13.61 years (Table 1).

3.2. Prevalence of Onchocerciasis Infection. This study revealed that the overall microfilaria carrier rate in the study area was 6.32%. Out of ten kebeles, onchocerciasis was detected in eight kebeles. Among positive study participants, arithmetic mean intensity of microfilaria was 16.47 microfilaria/mg of skin snip. The overall CMFL was 1.22 *mf/mg* of skin snip. The prevalence of onchocerciasis infection in the selected kebeles of the study area ranged from 0 to 11.1%, whereas no onchocerciasis infection was detected in two kebeles.

This study also revealed that the highest, 16 (17.8%), and the lowest, 3(1.4%), onchocerciasis infections were detected in age group of 35-44 and 15-24 years, respectively. The prevalence of onchocerciasis infection among male study participants was 28 (10.3%) whereas it was 7 (2.5%) among females. Similarly, 31 (8.8%) of onchocerciasis infections were detected among farmers and 4 (1.9%) in other occupations. The prevalence of onchocerciasis infection among illiterate participants was 19 (10.2%), and it was 27 (7.9%) among study participants who stayed ≥ 21 years in the village (Table 1).

Onchocerciasis infection prevalence among noncompliant participants with ivermectin treatment was 27 (10.2%). Similarly, the prevalence of onchocerciasis infection in the study participants residing at < 2Km distance from the river and among those residing at river banks was 23 (17.7%) and 21 (18.9%), respectively (Table 2).

3.3. Accessibility of Ivermectin Treatment and Compliance with the Treatment. All of the study participants, 553 (100%) mentioned that ivermectin was given in their village through community directed treatment by community drug distributors. From these, 35 (6.3%) and 518 (93.7%) were onchocerciasis positive and negative, respectively. Regarding compliance with ivermectin treatment, all of the study participants, 553 (100%), had been treated with ivermectin at least once. Two hundred sixty-six (48.4%) of study participants were noncompliant with ivermectin treatment. Three hundred eighty-one (68.9%) of the study participants took ivermectin treatment in the 2017 second round mass drug administration. Two hundred sixty-nine (48.6%) of study participants reported that they had missed ivermectin treatment at least once during mass drug administration given in the study area before commencement of this study. From these, 194 (35.1%) and 31(5.6%) reported that they missed the treatment because

Table 2: Prevalence of onchocerciasis, Semen Bench district, Bench Maji Zone, June 2018 (n=553).

Kebele	Number of participants	Positive#	Negative#	Prevalence %	Compliant for ivermectin treatment		Non-compliant for ivermectin treatment		Residence distance from river <2KM		Residence distance from river ≥ 2KM	
					#	%	#	%	#	%	#	%
Kaiken	40	0	40	0	24	60	16	40	21	52.5	19	47.5
Gazyken	36	4	32	11.1	9	27.8	26	72.2	2	5.6	34	94.6
G/mag	77	7	70	10	41	54.6	35	45.4	15	19.5	62	80.5
Wesheken	76	4	72	5.26	42	55.3	34	44.7	6	7.9	70	92.1
Gacheb	15	1	14	6.66	7	46.7	8	53.3	6	40	9	60
Eusken	69	0	69	0	46	67.6	22	32.4	5	7.4	63	92.6
Y/demos	67	4	63	5.97	34	50	34	50	13	19.1	55	80.9
Kosokol	40	4	36	10	6	15	34	85	10	25	30	75
Gariken	63	5	58	7.93	21	35	41	65	26	41.3	37	58.7
Kasha	70	6	64	8.57	54	77.1	16	22.9	26	37.1	44	62.9
Total	*553*	*35*	*518*	*6.32*	*284*	*51.6*	*266*	*48.4*	*130*	*23.5*	*423*	*76.5*

Table 3: Prevalence of clinical presentation onchocerciasis skin disease, Semen Bench district, Bench Maji Zone, June 2018 (n=553).

Kebele	*No of participant*	*Participants presented with OSD*			
		#Pruritus	%	#L. skin	%
Kaiken	40	7	17.5	0	0
Gazyken	36	3	8.33	1	2.77
G/mag	77	9	11.68	1	1.29
Wesheken	76	4	5.26	2	2.63
Gacheb	15	3	20	1	6.66
Eusken	69	1	1.47	0	0
Y/demos	67	7	10.92	1	1.49
Kosokol	40	2	5.00	1	2.5
Gariken	63	1	1.58	2	3.18
Kasha	70	3	4.28	0	0
Total	*553*	*40*	*7.23*	*9*	*1.62*

of absenteeism during mass drug administration and refusal of treatment, respectively (Table 2).

3.4. Residence Distance from the River. Concerning residence distance from the river, 130 (23.5%) and 423 (76.5%) study participants reside at less than 2Km and at greater than or equal to 2Km distance from the river, respectively. From these, 23 (17.7%) and 12 (2.8%) study participants were positive for onchocerciasis, respectively. One hundred eleven (20.1%) study participants reside at river banks, of whom 21 (18.9%) were positive for onchocerciasis (Table 2).

3.5. Clinical Manifestation of Onchocercal Skin Disease. Study participants were examined for the presence of onchocercal nodule (onchocercomata), hanging groin, pruritus, and leopard skin. The overall prevalence of onchocercal skin disease in the study area was 48 (8.67%). Onchocercal skin diseases observed with the higher prevalence were pruritus, 40 (7.2%), and leopard skin, 9 (1.62%), respectively. No study participants were observed with presence of nodules and hanging groin in the study area (Table 3). The study also showed that prevalence of onchocercal skin diseases was 38 (79.1%) and 10 (20.8%) among male and female study participants, respectively.

3.6. Results of Bivariate Analysis. Bivariate logistic regression was applied to selected candidate variables for multivariable analysis. Accordingly, age, sex, educational status, occupation, duration of stay in the study area, compliance with ivermectin treatment, residence distance from the river, and residence at river banks were significantly associated (p value<0.25) with onchocerciasis and selected as candidate variables for multivariable analysis (Table 4).

3.7. Independent Factors Associated with Onchocerciasis Infection. To identify independent predictors of onchocerciasis infection, multivariable logistic regression was performed. Accordingly, age, sex, compliance with ivermectin treatment, and residence distance from the river were found independently associated with onchocerciasis infection at P value <0.05.

The finding of this study showed that age was independently associated with onchocerciasis infection. An adult in the age group of 35-44 years was 13 times more likely to develop the infection as compared to an adult in the age group of 15-24 years [AOR= 13.486, 95% C.I: 3.5, 51.76]. Similarly, an adult whose age was 45 years and above was nearly nine times more likely to develop the infection as compared to an adult who was in the age group of 15-24 years [AOR=9.41, 95% C.I: 2.27, 39.07].

The study result also revealed that sex was independently associated with onchocerciasis infection. Males were nearly five times more likely to develop the infection as compared to females [AOR= 4.57, 95% C.I: 1.62, 12.86].

Table 4: Results of bivariate analysis on onchocerciasis and associated factors among adults aged ≥ 15 years in Semen Bench district, Bench Maji Zone, Southwest Ethiopia, June 2018 (n=553).

Variable	Category	Total (%)	Onchocerciasis status		COR[95% C.I]	P- value
			Positive	Negative		
Age	15-24	210(38)	3 (1.4)	207(98.6)	1.000	
	25-34	171(31)	5 (2.9)	166(97.1)	2.078 [0.490, 8.823]	0.321
	35-44	90(16.3)	16 (17.8)	74(82.2)	14.919 [4.226, 52.667]	<0.001*
	≥45	82(14.8)	11(13.4)	71(86.6)	10.690 [2.900, 39.412]	<0.001*
Sex	Male	272(49.1)	28(10.3)	244(89.7)	4.492 [1.928, 10.467]	0.001*
	Female	281(50.9)	7(2.5)	274(97.5)	1.000	
Religion	Protestant	496(89.6)	32(6.5)	464(93.5)	1.241[0.368, 4.190]	0.728
	Others	57(10.4)	3(5.3)	54(94.7)	1.000	
Educational status	Illiterate	186(33.6)	19(10.2)	167(89.8)	2.496 [1.252, 4.977]	0.009*
	Read & write & above	367(66.4)	16(4.4)	351(95.6)	1.000	
Occupation	Farmer	352(63.7)	31(8.8)	321(91.2)	4.756 [1.654, 13.677]	0.004*
	Others	201(36.3)	4(1.90)	197(98.1)	1.000	
Duration of stay in years	1-20	208(37.8)	7(3.4)	201(96.6)	1.000	
	21 & +	342(62.2)	27(7.9)	315(92.1)	2.461[1.052, 5.758]	0.038*
Compliance to ivermectin Rx	Non-compliant	266(48.4)	27(10.2)	239(89.8)	3.897[1.716, 8.632]	0.001*
	Compliant	284(51.4)	8(2.8)	276(97.2)	1.000	
Residence distance from river	< 2KM	130(23.5)	23(17.7)	107(82.3)	7.362[3.549, 15.272]	<0.001*
	≥ 2KM	423(76.5)	12(2.8)	411(97.2)	1.000	
Residence existed at river bank	Yes	111(20.1)	21(18.9)	90(81.1)	7.682 [3.709, 15.910]	<0.001*
	No	441(79.4)	13(2.9)	428(97.1)	1.000	

Table 5: Independent predictors of onchocerciasis infection in Semen Bench district, Bench Maji Zone, Southwest Ethiopia, June 2018(n=553).

Variables	Positive n=35(%)	Negative n=518(%)	COR (95% CI)	AOR (95% CI)	P-value
Age in year					
15-24	3(1.42)	207(98.58)	1.000	1.000	
25-34	5(2.9)	166(97.1)	2.078[0.490, 8.823]	3.026[0.667, 13.731]	0.151
35-44	16(17.8)	74(82.2)	14.919[4.226, 52.667]	13.486[3.514, 51.761]	<0.001*
45 and above	11(13.4)	71(86.6)	10.690[(2.900, 39.412]	9.411 [2.267, 39.068]	0.002*
Sex					
Male	28(10.3)	244(89.7)	4.492 [1.928, 10.467]	4.568 [1.622, 12.861]	0.004*
Female	7(2.5)	274(97.5)	1.000	1.000	
Compliance to ivermectin treatment					
Non-compliance	27(10.2)	239(89.8)	3.849 [1.716, 8.632]	3.804 [1.524, 9.495]	0.004*
Compliance	8(2.8)	276(97.2)	1.000	1.000	
Residence distance from river					
< 2 KM	23(17.7)	107(82.3)	7.362[3.549, 15.272]	9.157 [3.901, 21.494]	<0.001*
≥2 KM	12(2.8)	411(97.2)	1.000	1.000	

The study also showed that compliance with ivermectin treatment was independently associated with onchocerciasis infection. People who were not compliant with the treatment were nearly four times more likely to develop the infection as compared to their counterparts [AOR= 3.804, 95% C.I: 1.52, 9.5).

This study also reported that respondent's residence distance from the river was independently associated with onchocerciasis infection. People who were residing at less than 2Km distance from the river were nearly nine times more likely to develop the infection as compared to their counterparts [AOR= 9.16, 95% C.I: 3.9, 21.49] (Table 5).

4. Discussions

This study aimed to assess the current prevalence of onchocerciasis and associated factors in the study area, in order to contribute towards tackling of the burden of the

disease and to assess the progress towards onchocerciasis elimination. In this study, the prevalence of onchocerciasis infection after fifteen years of CDTI was 6.32% and the independently associated factors were age, sex, compliance with ivermectin treatment, and distance of the residence from the river.

The study revealed that the overall prevalence of onchocerciasis infection in Semen Bench district after fifteen years of CDTI was 6.32%. The finding was consistent with the findings of studies conducted in southwest Ethiopia, Cameroon, Senegal, and Equatorial Guinea [10, 12–16]. The study was not consistent with the studies done at Jimma zone and West Welega zone which showed the prevalence of 22.5% and 74.8%, respectively [9, 17]. This difference might be attributed to difference in coverage of community directed ivermectin treatment. Similarly, it was also inconsistent with the finding of a study from West Welega, 40.5%, which was done six years after CDTI; findings of studies done in Nigeria, 18%, 32.8%, and 29.2%, which were conducted fifteen years after CDTI; [13, 14] and findings from studies done in Cameroon, 11.4%, 52.7%, and 43.8,47% [10, 15, 16]. These differences might be attributed to high therapeutic coverage of community directed treatment with ivermectin and low level of precontrol load of onchocercal volvulus microfilaria in the study area.

The study showed that age was independently associated with onchocerciasis infection. Individuals in the age group of 35-44 years were 13 times more likely to develop the infection as compared to respondents in the age group of 15-24 years. Similarly, individuals whose age was 45 years and above were nearly ten times more likely to develop the infection as compared to individuals in the age group of 15-24 years. The finding was in agreement with findings of studies conducted in Jimma zone, West Welega zone, Nigeria, Equatorial Guinea, and Senegal where age was independently associated with onchocerciasis infection [9, 13, 15–18]. This might be due to the fact that adults are most of the time engaged in outdoor activities where they can be bitten by black fly. In addition to this, the long duration of the disease without cure might have contributed to the high prevalence of the disease among adults. The reason may be that older people may have longer time exposure to the disease causing agent than younger people.

This study also showed that sex was independently associated with onchocerciasis infection. Males were nearly five times more likely to be infected by the disease as compared to females. The finding was in agreement with studies done in different parts of Ethiopia, Cameroon, Senegal, and Equatorial Guinea [9, 14–16, 19]. This could be due to the fact that males are frequently involved in outdoor activities and have more probability to be exposed to black fly bites than females.

This study also showed that noncompliance with the ivermectin treatment was independently associated with the disease. The odd of noncompliance among the diseased was nearly four times more probable than the odd of noncompliance among nondiseased. The finding was in line with studies done in Cameroon, which showed that compliance with ivermectin treatment was independently associated with onchocerciasis infection [20].

Residential distance from river was another factor that was independently associated with the disease. Individuals who were residing at less than 2Km distance from the river were nearly nine times more probable to develop the disease as compared to those who resided at greater than or equal to 2 Km distance from the river. This finding was in line with studies done in Cameroon [10]. This could be because those who resided at less than 2Km from the river may be more exposed to black fly bite as compared to their counterparts since black flies breed in the fresh water.

The study has its own limitations. Tests were done using skin snip which has low sensitivity due to low availability and accessibility of diagnostic tests like PCR and immunological Ov-16 which are recommended by the WHO for elimination programs. In the current study, children less than 15 years of age were excluded from the study even though WHO recommends screening of children under 10 years of age for elimination program. Children under 15 years of age were excluded from the study due to the assumptions that they are less likely engaged in outdoor activities and have less exposure to bite of black fly which might undermine the prevalence of the disease in the study area. On the top of this, we had a fear about the issues related to ethics; we thought that we can hardly get assent from children and consent of their family to get skin snip from children. This is because children fear to give skin snip and families do have low levels of awareness.

5. Conclusion and Recommendations

The prevalence of onchocerciasis among adults aged ≥ 15 years in semen bench district is still unacceptably high in spite of the last-fifteen-year control and elimination program through community directed treatment. Ages, sex, compliance with ivermectin treatment, and residence distance from river were independently associated with onchocerciasis.

Zonal health department and other stakeholders should evaluate therapeutic coverage and community directed treatment with ivermectin in the study area. Zonal health department and other stakeholders should provide behavioral change communication (BCC) for adults aged 35 and above and for all adult males to wear preventive cloth during outdoor activities. Zonal health department and other stakeholders should conduct vector control activities especially for indwellers residing nearby the river. Federal Ministry of Health, Ethiopian Public Health Institute, and other stakeholders should strengthen periodic entomological surveillance. Further studies using diagnostic test like immunological Ov-16 should be done for the 2020 onchocerciasis disease elimination. Community based study should also be done to identify factors hindering the community compliance with the treatment.

Acronyms

AOR: Adjusted odds ratio
APOC: African Program for Onchocerciasis Control

CDTI: Community directed treatment with ivermectin
CI: Confidence interval
CMFL: Community microfilarial load
DALY: Disability adjusted life year
HEW: Health extension worker
KM: Kilometer
MDA: Mass drug administration
Mf: Microfilaria
NTD: Neglected tropical disease
OSD: Onchocerciasis skin disease
PPS: Probability proportional to size
REMO: Rapid epidemiological mapping for onchocerciasis
SS: Skin snip
SPSS: Statistical Package for Social Science
SSA: Sub-Saharan Africa
TCCE: The Carter Center in Ethiopia
WHO: World Health Organization.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Disclosure

Bedilu Kifle is principal investigator. Jimma University had no role in the design of the study, data collection, or data analysis and interpretation.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

Authors' Contributions

Bedilu Kifle, Kifle Woldemichael, and Mamo Nigatu made substantial contribution to conception, design, statistical analysis, interpretation of the results, and drafting of the manuscript. Bedilu Kifle also played a vital role in data acquisition.

Acknowledgments

The authors are very grateful to Jimma University for financial support. The authors are also very thankful to Ethiopian Public Health Institute (EPHI) for material support. Bench Maji Zone Administration and Bench Maji Zone Health Department are also acknowledged for their financial and materials support. Lastly, the authors are very grateful to Semen Bench District Health Office, data collectors, Mizan-Aman Regional Laboratory Diagnostic Center, Mizan–Tepi University Teaching Hospital for their unreserved support for this study.

References

[1] A. K. Mitra and A. R. Mawson, "Neglected tropical diseases: epidemiology and global burden," *Neglected Tropical Diseases: Epidemiology and Global Burden*, vol. 2, no. 36, 2017.

[2] WHO, *Progress towards Eliminating Onchocerciasis in the WHO Region of the Americas: Verification of Elimination of Transmission in Guatemala Onchocerciasis*, 2016.

[3] B. Ranganathan, *Onchocerciasis - An Overview*, vol. 8, 2012.

[4] C. Tcc, "African programme for onchocerciasis control (Apoc) report of the thirty-sixth session of the technical," 2013, (March):11–5.

[5] WHO, *Onchocerciasis*, 2018, https://www.who.int/news-room/fact-sheets/detail/onchocerciasis.

[6] O. Lagatie, M. Merino, L. Batsa Debrah, A. Y. Debrah, and L. J. Stuyver, "An isothermal DNA amplification method for detection of Onchocerca volvulus infection in skin biopsies," *Parasites & Vectors*, vol. 9, no. 1, pp. 1–9, 2016.

[7] K. Meribo, B. Kebede, S. M. Feleke et al., "Review of Ethiopian onchocerciasis elimination programme," *Ethiopian Medical Journal*, vol. 55, pp. 55–63, 2017.

[8] O. Ibe, O. Onwujekwe, B. Uzochukwu, M. Ajuba, P. Okonkwo, and S. V. Scarpino, "Exploring consumer perceptions and economic burden of onchocerciasis on households in enugu state, South-East Nigeria," *PLOS Neglected Tropical Diseases*, vol. 9, no. 11, pp. 1–12, 2015.

[9] D. Dana, S. Debalke, Z. Mekonnen et al., "A community-based cross-sectional study of the epidemiology of onchocerciasis in unmapped villages for community directed treatment with ivermectin in Jimma Zone, southwestern Ethiopia," *BMC Public Health*, vol. 15, no. 1, article no. 595, pp. 1–7, 2015.

[10] T. Njim and L. N. Aminde, "An appraisal of the neglected tropical diseases control program in Cameroon: the case of the national program against onchocerciasis," *BMC Public Health*, vol. 17, no. 103, pp. 1–5, 2017.

[11] MoH, *Second Edition of National Neglected Tropical Diseases Master Plan*, 2016.

[12] DRE MoH, *Guidelines for Onchocerciasiselimination in Ethiopia July 9*, Addis Ababa, Ethiopia, 2015.

[13] N. A. Kamalu and F. E. Uwakwe, "Evaluation of different onchocerciass manifestation by age and gender among residents in selected endemic villages in okigwe local government area of imo State, Nigeria," *International Letters of Natural Sciences*, vol. 20, pp. 139–150, 2014.

[14] G.-R. Kamga, F. N. Dissak-Delon, H. C. Nana-Djeunga et al., "Still mesoendemic onchocerciasis in two Cameroonian community-directed treatment with ivermectin projects despite more than 15 years of mass treatment," *Parasites & Vectors*, vol. 9, no. 1, pp. 1–12, 2016.

[15] N. O. Wilson, A. Badara Ly, V. A. Cama et al., "Evaluation of lymphatic filariasis and onchocerciasis in three senegalese districts treated for onchocerciasis with ivermectin," *PLOS Neglected Tropical Diseases*, vol. 10, no. 12, pp. 1–13, 2016.

[16] A. Hernández-González, L. Moya, M. J. Perteguer et al., "Evaluation of onchocerciasis seroprevalence in Bioko Island (Equatorial Guinea) after years of disease control programmes," *Parasites & Vectors*, vol. 9, no. 1, pp. 4–11, 2016.

[17] G. U. Dori, T. Belay, H. Belete, K. N. Panicker, and A. Hailu, "Parasitological and clinico-epidemiological features of onchocerciasis in West Wellega, Ethiopia," *Journal of Parasitic Diseases*, vol. 36, no. 1, pp. 10–18, 2012.

[18] A. U. Ikpo, J. Mbanugo, C. A. Anukwuorji, and I. K. Ugwuanyi, "Study on the prevalence of onchocerca volvulus infection among the inhabitants of awgu and Oji-River Local Government Areas of Enugu State, Nigeria," *International Journal of Tropical Disease & Health*, vol. 18, no. 1, pp. 1–9, 2016.

[19] R. Mu, "Onchocerciasis in different regions of ethiopia," *The Internet Journal of Parasitic Diseases*, vol. 1, no. 2, pp. 1–7, 2015.

[20] S. Wanji, J. A. Kengne-Ouafo, M. E. Esum et al., "Relationship between oral declaration on adherence to ivermectin treatment and parasitological indicators of onchocerciasis in an area of persistent transmission despite a decade of mass drug administration in Cameroon," *Parasites & Vectors*, vol. 8, no. 1, pp. 1–16, 2015.