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Prevalence of Schistosomiasis (S. mansoni and S. haematobium) and its association with gender of school age children in Ethiopia: A systematic review and meta-analysis

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Background: Schistosomiasis (S. mansoni and S. haematobium) is an important neglected tropical disease in sub-Saharan Africa including Ethiopia. In Ethiopia, Schistosomiasis has been prioritized as neglected tropical disease and remained among major public health burden on school age children of the country. Few studies conducted on the association between prevalence of Schistosomiasis and gender of school age children have inconclusive finding about the association between these two variables. Therefore, this systematic review and meta-analysis was done to determine the pooled prevalence of Schistosomiasis and its association with gender of school age children in Ethiopia.

Methods: In this systematic review and meta-analysis, databases such as: Medline/PubMed, EMBASE, CINAHL, Cochrane Central library, Google Scholar, and HINARI were systematically searched. STATA version 14 was used to estimate pooled prevalence of Schistosomiasis using random effects model with 95% confidence interval. The results were presented by using forest plot and statistical heterogeneity was checked by using the Cochran Q test (chi-squared statistic), I^2 test statistic and by visual examination of the forest plot.

Results: From the total of 427 studies identified for this review, 50 studies were included in the final analysis. The analysis noted that pooled prevalence of Schistosomiasis in Ethiopia was 28.78% (95% CI: 23.81, 33.74). The subgroup analysis indicated that extreme variability was observed in the prevalence of Schistosomiasis across the regions of the country. The highest (39.77%) prevalence of Schistosomiasis was reported from the southern region, whereas the lowest (14.95%) prevalence of Schistosomiasis was reported from Afar region. Male school age children were 58% more likely infected with Schistosomiasis than female school age children in Ethiopia (OR: 1.58, 95% CI: 1.33, 1.83).

Conclusions: The Prevalence of Schistosomiasis was higher than the 2018 report of the Ethiopian federal ministry of health. The prevalence of Schistosomiasis was predominant among male gender of the school age children. Therefore, sustainable control of Schistosomiasis requires the approaches that must go beyond current deworming program. Complementary prevention strategies including health education, safe water and adequate sanitary facilities provision should be simultaneously implemented. The underlining causes of variation in risk factors of Schistosomiasis among males and females should be further studied.

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1. Introduction

Neglected tropical diseases including Schistosomiasis are a group of chronic parasitic diseases and related conditions that are among the common illnesses of the world's poorest people (Amenu et al., 2017).

The burden of disease associated with Schistosomiasis and soil-transmitted helminthes (STH) infections is enormous, with at least 2 billion people affected globally. This is being progressively more recognized as a significant public health problem, particularly in developing countries where poverty, poor nutrition, inadequate sanitation, lack of clean drinking-water and minimal health care prevail. The highest rates of infection are often in children between the ages of 5 and 15 years (Organization WH and UNICEF, 2004).

Schistosomiasis is widely spread in South America, Middle East, Brazil and in many African countries including the Sudan, Kenya, Ethiopia and Madagascar. Facts show that the significant improvement in preventive chemotherapy (PC) coverage related to Schistosomiasis is continued being a challenge. Nowadays, it is believed that fewer than 10% of eligible populations, which might not contribute a significant figure for the reduction of Schistosomiasis, living in endemic regions of Africa are receiving PC for Schistosomiasis, intestinal helminthes infections, and/or trachoma (Hotez and Fenwick, 2009).

In Ethiopia, Schistosomiasis is most prevalent in agricultural communities along streams in the altitudes between 1300 and 2000 m above sea level and it is reported from all administrative regions (Kassa et al., 2005). Intestinal form of Schistosomiasis is broadly distributed while the uro-genital form is more restricted in distribution primarily to foci in the rift valley regions. There are an estimated 38.3 million people living in Schistosomiasis endemic areas, comprising 4.4 million preschool children, 12.3 million school-aged children, and 21.6 million adults (Ministry of Health, 2016).

Studies conducted in different time in Ethiopia showed different results: Schistosomiasis surveys carried out by the Institute of Pathobiology, Addis Ababa, in all 14 administrative regions between 1978 and 1982 found 15% of people infected with Schistosomiasis haematobium and the national S. mansoni survey of 1988–89 reported an overall prevalence of 25% (Deribe et al., 2012).

Preventive chemotherapy (PC) can reduce morbidity caused by schistosomiasis. According to the assessment of population requiring PC report in 2010, in addition to PC further efforts are required to control distribution of the disease among different social strata (Chala and Torben, 2018).

Prevalence of Schistosomiasis infection is higher in children and adolescents, because children have higher risk of contamination for different sanitation and hygiene problems like polluted water contact. Prevalence in males and in females is quite different, and not consistent in different studies. It was reported 42.4% and 26.5% for males and females respectively, and the prevalence of Schistosomiasis infection in another study using Kato-Katz method in Sanja primary school was high among male (79.5%) children but it was high among female (75%) children in Ewket Amba primary school (Deribe et al., 2012; Abera et al., 2013; Alebie et al., 2014).

Ethiopia has developed Schistosomiasis elimination strategic plan which may last 2016 to 2020. Yet, different facts of prevalence have been reported from different corners of the country (Ministry of Health, 2016).

The common assumption that men and boys are more heavily infected and affected than women and girls in endemic areas is not always correct. Despite social aspects of female and male genital schistosomiasis in school age children is understudied, particularly with regard to consequences, illness perceptions and social factors influencing access to treatment, controversial and inconsistent findings are reported about the gender as a risk factor for schistosomiasis. Otherwise, constructing pooled evidence on gender relation with the occurrence of the disease impacts the exposure and access to treatment and other control strategies (World Health Organization, 2008).

Therefore, the literature was systematically reviewed on the prevalence of Schistosomiasis among school age children and its association with gender in Ethiopia with the objective of bringing different individual studies together and compute pooled estimate (Ministry of Health, 2016). Particular attention was given to the influence of gender as different studies showed inconsistent association on prevalence of Schistosomiasis between male and female. Further, the significance of this research was to show pooled estimate for controversial evidences from different studies so that gender specific interventions may be required to augment the national prevention and control strategies on schistosomiasis.

2. Method

2.1. Searching strategies

This systematic review and Meta-analysis was conducted to estimate the pooled prevalence of Schistosomiasis and its association with gender of school age children in Ethiopia. The protocol for this review was registered in the International Prospective Register of Systematic Reviews (PROSPERO), University of York Centre for Reviews and Dissemination (Registration Number CRD42019129843) on the 7th of June 2019.The following databases were systematically searched to identify the literatures: Medline/PubMed, EMBASE, CINAHL, Cochrane Central Library, Google Scholar, and HINARI (Health Inter Network Access to Research Initiative) from November 1 to December 30, 2018. The reports were accessed using the following key terms: "Prevalence", "Magnitude", "determinants", "associated factors", "factors" "Schistosomiasis", "S. mansoni" and "S. haematobium", "sex", "Gender" and "Ethiopia". The key terms were used individually and in combination by using Boolean operators like "AND" and "OR" 1. ("Prevalence of schistosomiasis" OR "prevalence of schistosomiasis" OR "magnitude of schistosomiasis" AND "school age children" OR "5-14 years old children") 2. ("Prevalence of schistosomiasis" OR "prevalence of schistosomiasis" OR "magnitude of schistosomiasis" AND "Ethiopia" 3. "Effect of gender" OR "Effect of gender" AND "Prevalence of schistosomiasis" OR "schistosomiasis" OR "prevalence of schistosomiasis" OR "magnitude of schistosomiasis" AND "school age children" OR "5–14 years old children" 4. "Effect of gender" OR "Effect of gender" OR "schistosomiasis" OR "mass drug administration" AND "school age children" OR "5–14 years old children" AND "Ethiopia". The guideline followed was The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). In addition, after identification of studies and review articles, their lists of references were searched to identify more eligible studies. This systematic review and meta-analysis used the CoCoPop (Condition, Context, and Population) framework to determine the eligibility of the articles included. The condition was schistosomiasis (Co), the context was Ethiopia (Co), and the Population was school age children (Pop).

2.2. Study selection and eligibility criteria

The eligible studies for this systematic review and meta-analysis were selected after screening at four stages: screening for duplications, titles alone, abstracts, full-text articles, and based on inclusion criteria. All quantitative studies reported in English language, published and unpublished articles, and revealed the prevalence of Schistosomiasis as well the association between prevalence of Schistosomiasis and gender of school age children (Ministry of Health, 2016; Deribe et al., 2012; Abera et al., 2013; Alebie et al., 2014; Newcastle-Ottawa, n.d.; Modesti et al., 2016; Hardy and Thompson, 1998; Higgins et al., 2003; Knapp and Hartung, 2003; Tadesse et al., 2009) were included in this review. However, the studies which did not either report the prevalence of Schistosomiasis or did not report the association between Schistosomiasis and gender of school age children were excluded from this systematic review and meta-analysis. Moreover, articles which were not fully accessible, after at least two-email contact with the primary authors were excluded from this review. Exclusion of these articles was because of the inability to assess the quality of articles in absence of full text.

Potentially eligible articles were identified by two reviewers (DW and ZH), through independent reading of the titles and abstracts, which were searched and accessed broadly. Those two reviewers (DW, ZH) were independently reviewed the finally included articles against the inclusion criteria. In case of any discrepancies, a third reviewer (BS) was consulted.

2.3. Data extraction and quality assessment of the studies

Two authors (DW and BS) independently extracted all necessary data using the Microsoft excel sheet. Any disagreements at the time of data extraction were resolved by consulting the third author (YT). From each included study, features such as: (i) publication details (primary author's last name and year of publication), (ii) study setting, (iii) sample size and response rate, and (iv) prevalence of Schistosomiasis were extracted. The Newcastle-Ottawa Scale for cross-sectional studies quality assessment tool was adapted and used to assess the quality of each study (Newcastle-Ottawa, n.d.). The tool has three major sections: The first section graded from five stars focuses on the methodological quality of each study. The second section of the tool deals with the comparability of the study. The last section deals with the outcomes and statistical analysis of each original study. Two authors (DW and YT) independently assessed the quality of each original study using the tool. Disagreements between the two authors were resolved by taking the mean score of the two authors. Finally, article with a scale of greater than or equal to 6 out of 10 were included in this systematic review and Meta-analysis.

2.4. Statistical analysis

Data extraction were done using Microsoft Excel spread sheet, then analysis was done using STATA version 14 statistical software. For the analysis, standard error (SE) values were extracted from the studies, since they are more commonly reported with 95% confidence interval. When both SE and 95% CI were not provided, SE was calculated using the formula ($SE = \sqrt{(P \times (1 - P)/N)}$, where P is the proportion of the cases reported and N is the denominator of the prevalence estimate (Modesti et al., 2016).

Statistical heterogeneity was assessed by using the Cochran Q test (chi-squared statistic), I^2 test statistic and by visual examination of the forest plot (overlap of confidence intervals). Cochran's Q test was used to test the null hypothesis of no significant heterogeneity across the studies (Hardy and Thompson, 1998). Cochran's Q is calculated as the weighted sum of squared differences between individual study effects and the pooled effect across studies, with the weights being those used in the pooling method. Cochran's Q statistic follows a chi-squared distribution with $k - 1$ degree of freedom where k is the number of studies. Cochran's Q statistical heterogeneity test is considered as statistically significant.

The I^2 statistic was also estimated because of the fact that the percentage of variation (inconsistency) in the measures of association across studies is due to heterogeneity rather than chance (Higgins et al., 2003). The I^2 statistic is equal to the quantity of Cochran's Q minus its degree of freedom (df) divided by Cochran's Q times 100%, $I^2 = 100\% \times (Q - df)/Q$. The value of I^2 ranges between 0 and 100%, where 0% indicates no observed heterogeneity and large values indicate increasing heterogeneity (Higgins et al., 2003). An I^2 value of 25%, 50%, and 75% is considered as low, moderate, and high heterogeneity respectively (Higgins et al., 2003). Egger's weighted regression and Begg's rank correlation tests were used to check for the publication bias ($P < 0.05$ is considered statistically significant).

In this review, test statistic showed there was a significant heterogeneity among the included studies ($I^2 = 99.5\%$, $p < 0.001$) as a result a random effects model was used to estimate the Der Simonian and Laird's pooled effect. To identify the possible source of heterogeneity, meta-regression was undertaken by taking the sample size and year of publication but none of them were found to be statistically significant($p = 0.246$ and $p = 0.587$) (Table 2). The pooled effect was articulated in the form of odds ratio. (See Fig. 1.)

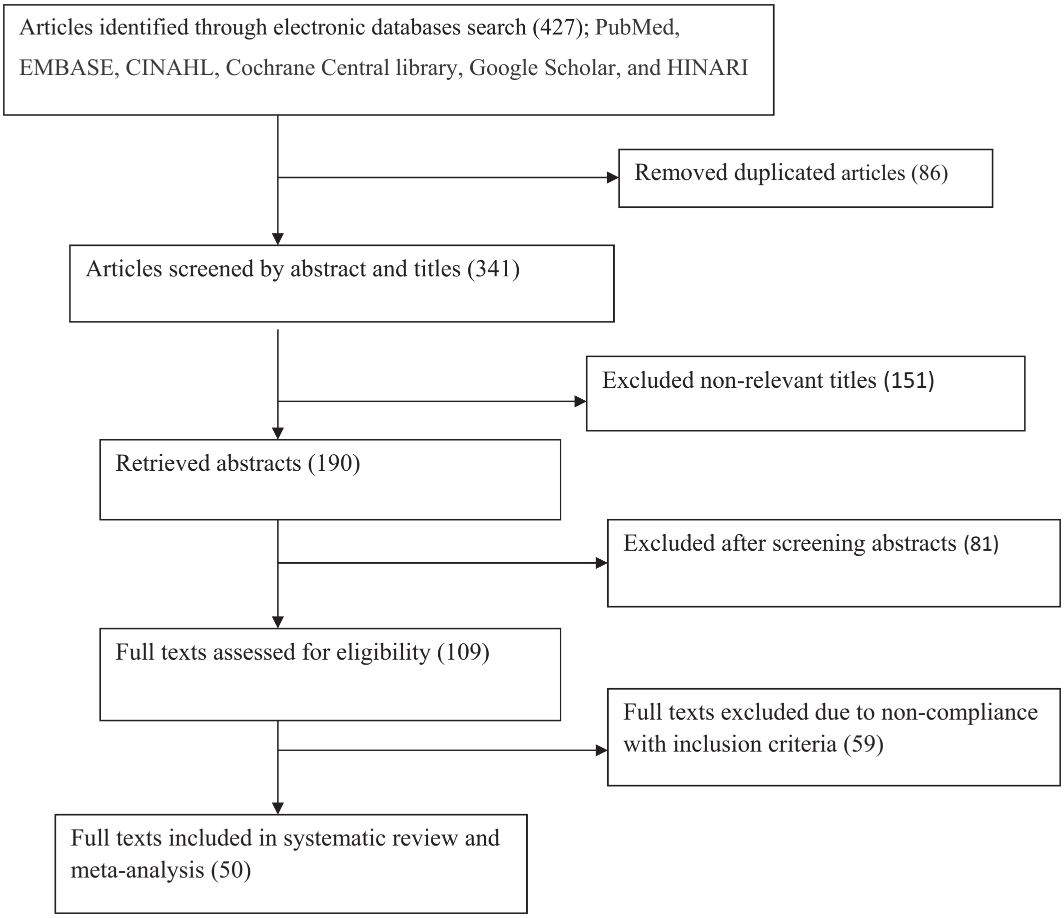

Fig. 1. Flow chart of study selection for systematic review and meta-analysis of the prevalence of Schistosomiasis among school age children in Ethiopia, 1997–2019.

Egger's test of the intercept in random effects model was used to check publication bias (Knapp and Hartung, 2003). As the results of the test suggested a possible existence of a significant publication bias ($p = 0.000$ in Egger's test), the final effect size was determined by applying Duval and Tweedie's Trim and Fill analysis in the random-effects model.

2.5. Classification of regions

The classification of the regions in Ethiopia as agrarian and emerging is based on their need for special support for health and other development services as a result of huge inequity of health and other development status in this regions due to the community in these regions are pastoralists/semi pastoralists. As we indicated in the table four of the manuscript, emerging regions = Afar, Gambela, Somalia, these regions are known as emerging regions in Ethiopia where more affirmative actions are warranted to address vertical equity.

3. Result

3.1. Characteristics of the original studies

This systematic review and Meta-analysis has been reported according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA). The publication year of the included studies range from 1997 to 2019. The minimum sample size (school age children) of individual studies included in this systematic review was 224 whereas the maximum sample size for the included study was 15,455 (Tadesse et al., 2009; French et al., 2018). From the included studies, majority of them were from Amhara regional state (Abera et al., 2013; Alebie et al., 2014; French et al., 2018; Abdi et al., 2017; Afework Bitew et al., 2016; Alemu et al., 2011; Amsalu et al., 2015; Assefa et al., 1998; Ayalew et al., 2011; Essa et al., 2012; Feleke et al., 2017; Fentie et al., 2013; Gashaw et al., 2015; Gelaw et al., 2013; Jamaneh, 1998; Jemaneh, 1999; Jemaneh, 2001; Mathewos et al., 2014; Tekeste et al., 2013; Worku et al., 2014) and nearly half of the studies were from the three regions: South nation's

Table 1
Descriptive summary of the included studies in the systematic review and meta-analysis of the prevalence of Schistosomiasis (S. mansoni and S. haematobium) in Ethiopia 1997–2019.

S. No	Primary Author/s	Publication year	Study area	Study design	Response rate	Sample size	Prevalence with 95%CI
1	Abdi et al. (2017)	2017	Zegie	Cross sectional	96.68	408	29.9 (25.53–34.27)
2	Abera et al. (2013)	2013	Bahir Dar	Cross sectional	98.36	778	7.326 (5.511–9.142)
3	Afework Bitew et al. (2016)	2016	Around Lake Tana	Cross sectional	100	384	14.32 (10.82–17.83)
4	Alebie et al. (2014)	2014	Sanja	Cross sectional	100	384	76.3 (72.05–80.56)
5	Alemayehu and Tomass (2015)	2015	Woliata	Cross sectional	100	384	81.25 (77.35–85.15)
6	Alemayehu et al. (2017)	2017	Woliata	Cross sectional	97.67	503	58.65 (54.39–62.9)
7	Alemu et al. (2011)	2011	Zerma	Cross sectional	100	319	37.93 (32.61–43.26)
8	Alemu (2014)	2014	Umolante	Cross sectional	100	405	12.59 (9.361–15.82)
9	Amsalu et al. (2015)	2015	Hayk	Cross sectional	100	384	44.79 (39.82–49.77)
10	Assefa et al. (2013)	2013	Mekelle	Cross sectional	100	457	23.85 (19.94–27.76)
11	Assefa et al. (1998)	1998	Wollo	Cross sectional	100	698	24.93 (21.72–28.14)
12	Awoke et al. (2013)	2013	Amibera	Cross sectional	98.57	828	8.213 (6.356–10.07)
13	Ayalew et al. (2011)	2011	Delgi	Cross sectional	100	704	15.91 (13.21–18.61)
14	Bajiro et al. (2016)	2016	Manna District	Cross sectional	100	500	24 (20.26–27.74)
15	Bajiro et al. (2017)	2017	Jimma	Cross sectional	100	1000	8.4 (6.681–10.12)
16	Belay et al. (2018))	2018	Medebay Zana	Cross sectional	100	410	4.88 (2.793–6.963)
17	Degarege et al. (2015)	2015	Afar	Cross sectional	89.03	885	20.79 (18.27–23.31)
18	Dejenie and Asmelash (2010)	2010	Afar	Cross sectional	100	622	5.949 (4.09–7.807)
19	Dejenie et al. (2009)	2009	Waja	Cross sectional	100	224	29.91 (23.91–35.91)
20	Deribew et al. (2013)	2013	Amibara	Cross sectional	100	387	24.55 (20.26–28.84)
21	Essa et al. (2012)	2012	Gorgora	Cross sectional	100	579	20.55 (17.26–23.84)
22	Feleke et al. (2017)	2017	Haike	Cross sectional	100	279	23.3 (18.34–28.26)
23	Fentie et al. (2013)	2013	Lake Tana Basen	Cross sectional	100	520	16.73 (13.52–19.94)
24	French et al. (2018)	2018	Amhara	Cross sectional	91.15	15,455	6.904 (6.522–7.286)
25	Gashaw et al. (2015))	2015	Maksegnit	Cross sectional	100	550	49.09 (44.91–53.27)
26	Gelaw et al. (2013)	2013	Gonder	Cross sectional	93.25	304	1.316 (0.079–2.553)
27	Geleta et al., 2015	2015	Abobo	Cross sectional	97.12	304	35.86 (30.54–41.17)
28	Genanew and Teshale (2018)	2018	Medebay Zana	Cross sectional	100	410	4.878 (2.793–6.963)
29	Haile et al. (2012)	2012	Finchaa	Cross sectional	92.31	324	67.59 (62.7–72.49)
30	Jamaneh (1998)	1998	Dembia	Cross sectional	100	1282	35.8 (33.18–38.43)
31	Jejaw et al. (2015)	2015	Mizan-Aman	Cross sectional	100	460	34.35 (30.01–38.69)
32	Jemaneh (1999))	1999	Gonder	Cross sectional	100	878	17.54 (15.02–20.06)
33	Jemaneh (2001)	2001	Chilga	Cross sectional	100	687	19.36 (16.4–22.31)
34	Legesse et al. (2011)	2011	Adwa	Cross sectional	98.7	381	57.74 (52.81–62.67)
35	Legesse and Erko (2004))	2004	Lake Langano	Cross sectional	100	259	21.24 (16.25–26.22)
36	Mahmud et al. (2013)	2013	Northern	Cross sectional	100	600	13.33 (10.61–16.05)
37	Mathewos et al. (2014)	2014	Gonder	Cross sectional	93.55	261	33.72 (28.17–39.26)
38	Mekonnen et al. (2014)	2014	Fincha	Cross sectional	98.91	453	53.2 (48.63–57.77)
39	Mitiku et al. (2010)	2010	Tikur Woha	Cross sectional	97.66	375	12 (8.75–15.25)
40	Negussu et al. (2013)	2013	Afder & Goda	Cross sectional	98.09	513	15.98 (12.84–19.13)
41	Roma and Worku (1997))	1997	Wondo-Genet	Cross sectional	86.67	520	30.19 (26.52–33.87)
42	Tadege and Shimelis (2017)	2017	Hawassa	Cross sectional	97.4	374	31.02 (26.39–35.64)
43	Tadesse et al. (2009))	2009	Waja	Cross sectional	100	224	27.23 (21.4–33.06)
44	Tadesse (2005))	2005	Babile	Cross sectional	98.34	415	4.337 (2.394–6.281)
45	Tekeste et al., 2013	2013	Gorgora	Cross sectional	100	326	10.12 (6.848–13.4)
46	Teklemariam et al. (2014)	2014	Enderta	Cross sectional	100	480	23.13 (19.35–26.9)
47	Teklemariam et al. (2018))	2018	Ziway	Cross sectional	100	280	39.64 (33.91–45.37)
48	Terefe et al. (2011)	2011	Bushulo	Cross sectional	100	419	73.75 (69.53–77.96)
49	Verheyen et al. (2019)	2019	Yachi	Cross sectional	95.48	317	42.9 (37.58–48.23)
50	Worku et al. (2014)	2014	Sanja	Cross sectional	100	385	89.87 (86.86–92.88)

nationalities and people region (SNNPR) (Alemayehu and Tomass, 2015; Alemayehu et al., 2017; Alemu, 2014; Jejaw et al., 2015; Mitiku et al., 2010; Roma and Worku, 1997; Tadege and Shimelis, 2017; Terefe et al., 2011), Oromia (Bajiro et al., 2016; Bajiro et al., 2017; Haile et al., 2012; Legesse and Erko, 2004; Mekonnen et al., 2014; Tadesse, 2005; Teklemariam et al., 2018; Verheyen et al., 2019), and Tigray region (Tadesse et al., 2009; Assefa et al., 2013; Belay et al., 2018; Dejenie et al., 2009; Genanew and Teshale, 2018; Legesse et al., 2011; Mahmud et al., 2013; Teklemariam et al., 2014). In this systematic review and meta-analysis, 39,278 school age children were included to estimate the pooled prevalence of Schistosomiasis in Ethiopia. Both the lowest and highest prevalence of Schistosomiasis was observed in study conducted in Amhara region, 1.32% in Gondar (Gelaw et al., 2013) and 89.87% in Sanja area (Worku et al., 2014) (Table 1).

3.2. Meta-analysis

This meta-analysis found that the pooled prevalence of Schistosomiasis among school age children in Ethiopia was found to be 28.77% (95% CI: 23.81, 33.74). The degree of heterogeneity between studies was high ($I^2 = 99.5\%$ with Cochrane Q-statistics p-value

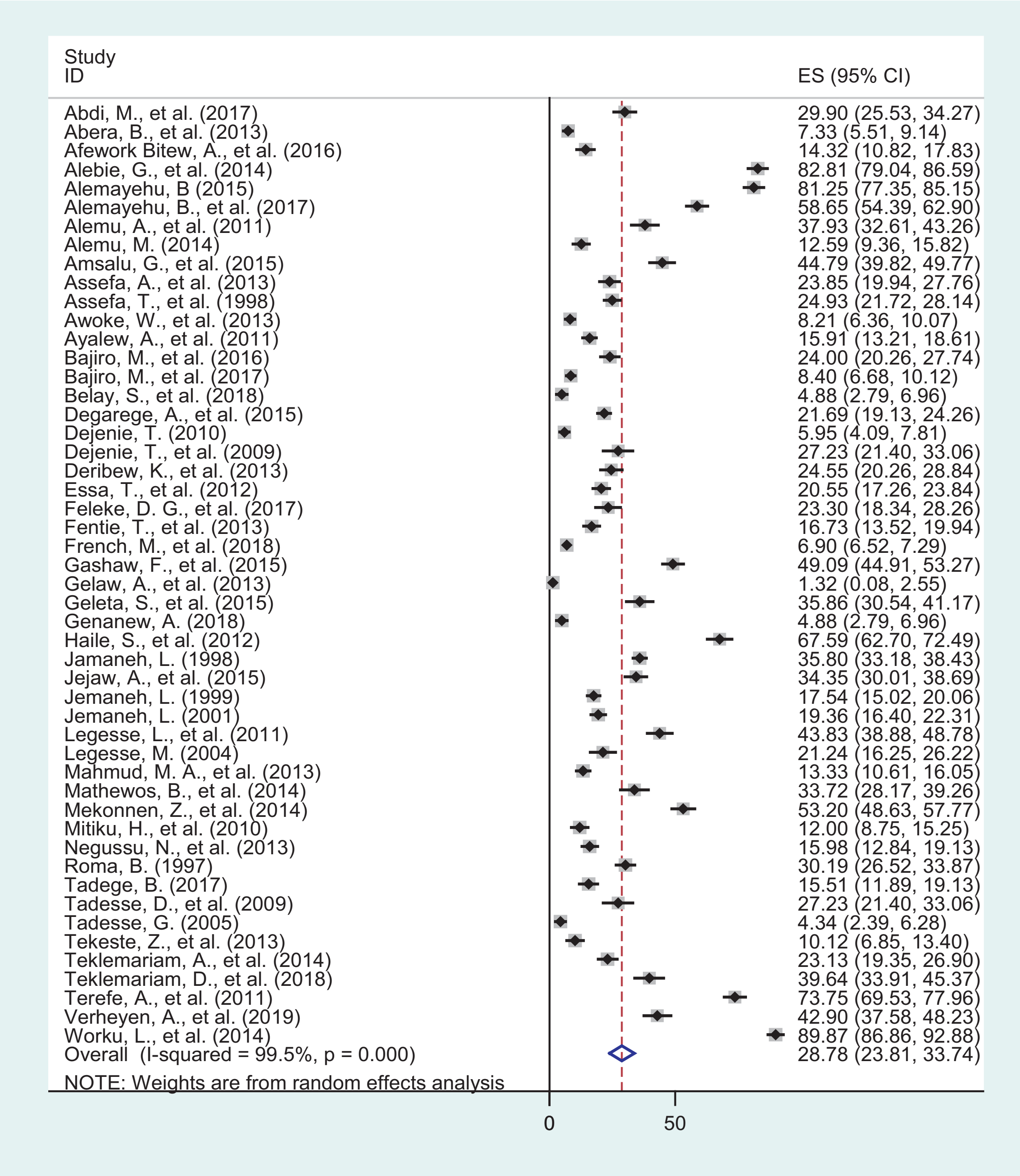

Fig. 2. Forest plot of pooled epidemiology of Schistosomiasis among school age children in Ethiopia, 1997–2019.

<0.000). This was not unexpected as each study differs in terms of study area, sample size and year of the study. Because of this, final overall prevalence was computed based on a random effects meta-analysis model. Moreover, advanced statistical meta-analysis model was conducted to identify the possible sources of random variations across primary studies such as a univariate meta-regression model by considering publication year and sample size as covariates. These variables (publication year and sample size) were not statistically significant source of heterogeneity, $P = 0.587$ and $P = 0.246$ respectively (Table 2). Additionally, Begg's correlation and Egger's regression tests was used to identify the possible publication bias. The test results, showed that there was statistically significant publication bias across the included studies (p-values = 0.000, for both tests). Finally, the pooled prevalence of Schistosomiasis among school age children was estimated by using trim and fill analysis in random effect model (Fig. 2).

Table 2
Related factors with heterogeneity of prevalence of Schistosomiasis in Ethiopia the current meta-analysis (based on univariate meta-regression), 1997–2019.

Variable	Coefficient	p-value
Publication year	0.3107278	0.587
Sample size	−0.0017061	0.246

Table 3
The subgroup prevalence of Schistosomiasis in Ethiopia, 1997–2019.

Variables	Characteristics	No. studies included	Sample size	Prevalence (95% CI)
By region	Amhara	20	25,565	29.07 (20.52–37.61)
	SNNPR	8	3440	39.77 (20.47–59.00)
	Oromia	8	3548	32.57 (18.07–47.08)
	Tigray	8	3186	20.85 (12.49–29.22)
	Afar	4	2722	14.95 (6.80–23.11)
	Others*	2	817	25.80 (6.33–45.27)
By sample size	≥600	12	24,417	15.37 (11.031–19.71)
	<600	38	14,861	33.05 (23.81–33.74)
Year	Before 2015	38	18,958	30.96 (24.01–37.91)
	After 2015	12	20,320	23.82 (17.07–30.57)

Others*: Gambela, Somali, SNNPR = South nations, nationalities and people of Ethiopia.

3.3. Sub group analysis

We performed sub group analysis using the region of the study, the sample size and year of mass drug administration started. Accordingly, the highest prevalence was observed in SNNPR (39.77% (20.47–59.00) whereas as the lowest prevalence was observed in Afar region (14.95% (6.80–23.11)). Regarding to sample size of the study, the prevalence of Schistosomiasis among school age children was higher in studies having sample size <600 study participants, 33.05% (95% CI: 23.81, 33.74) compared to those studies having sample size ≥600 study participants, 15.37% (95% CI: 11.031, 19.71). Moreover, this systematic review and meta-analysis identified that the Schistosomiasis prevalence was higher before starting mass drug administration in Ethiopia (before 2015), 30.96 (24.01–37.91) compared to after mass drug administration started in Ethiopia (after 2015) 23.82 (17.07–30.57) (Table 3).

3.4. Association between gender of school age children and Schistosomiasis prevalence in Ethiopia

Thirty six studies were examined for the association between gender of school age children and Schistosomiasis prevalence in Ethiopia (Alebie et al., 2014; Tadesse et al., 2009; Abdi et al., 2017; Alemu et al., 2011; Amsalu et al., 2015; Assefa et al., 1998; Essa et al., 2012; Feleke et al., 2017; Fentie et al., 2013; Gashaw et al., 2015; Jamaneh, 1998; Jemaneh, 1999; Jemaneh, 2001; Mathewos et al., 2014; Worku et al., 2014; Alemayehu and Tomass, 2015; Alemayehu et al., 2017; Alemu, 2014; Mitiku et al., 2010; Roma and Worku, 1997; Tadege and Shimelis, 2017; Terefe et al., 2011; Bajiro et al., 2016; Bajiro et al., 2017; Haile et al., 2012; Tadesse, 2005; Verheyen et al., 2019; Assefa et al., 2013; Belay et al., 2018; Genanew and Teshale, 2018; Legesse et al., 2011; Teklemariam et al., 2014; Awoke et al., 2013; Degarege et al., 2015; Geleta et al., 2015; Negussu et al., 2013). In this meta-analysis highest heterogeneity was observed ($I^2 = 85.7\%$ and p- value <0.000) across the studies. Hence, a random effect meta-analysis model was used to estimate the pooled effect of Schistosomiasis infection across the gender of school age children. Publication bias was checked by using Begg's test and Egger's regression analysis. The analysis revealed that there was significant publication bias with p - value of 0.000. Finally, trim and fill analysis were used to adjust the publication bias. As a result, the pooled odds ratio has been changed from (OR: 1.30, 95% CI: 1.06, 1.60) to (OR: 1.58, 95% CI: 1.33, 1.83) (Fig. 3). Therefore, male school age children were 58% more likely infected with Schistosomiasis than female school age children in Ethiopia (OR: 1.58, 95% CI: 1.33, 1.83). Analysis was done to see whether there is difference between the regions and the years before and after mass drug administration in Ethiopia, 2015. The two categories of regions in Ethiopia (agrarian and emerging regions)

Table 4
The association between gender and Schistosomiasis infection before and after 2015 and between agrarian and emerging regions in Ethiopia, 1997–2019.

Characteristics	No. studies included (36)	Sample size	OR (95% CI)
Before 2015	22	11,331	1.13 (0.84, 1.52)
After 2015	14	6708	1.63 (1.32, 2.03)
Agrarian regions	32	15,512	1.31 (1.04, 1.64)
Emerging regions	4	2530	1.26 (0.80, 1.98)

Agrarian regions = Oromia, Amhara, SNNPR, Tigray; Emerging regions = Afar, Gambela, Somalia.

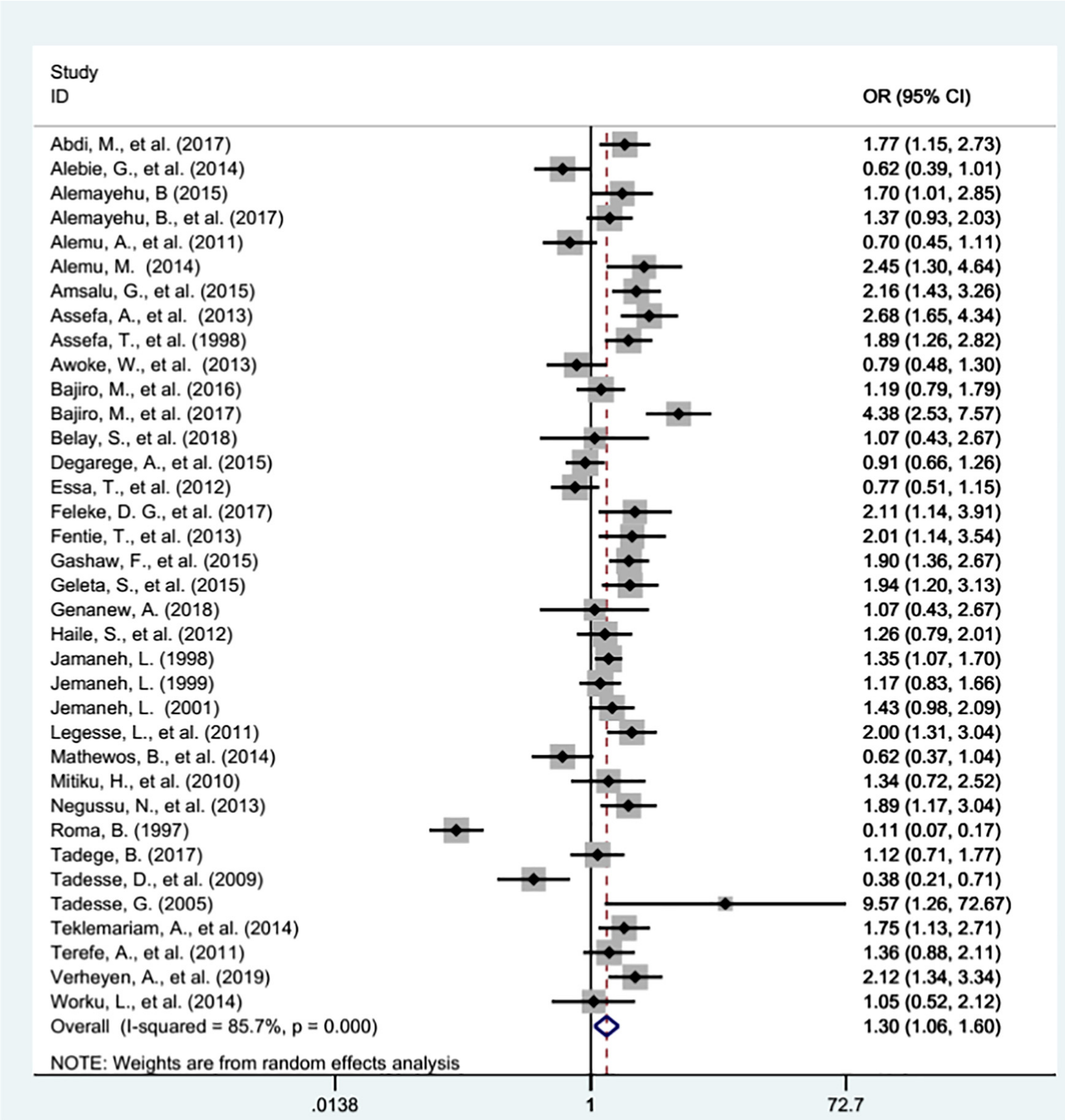

Fig. 3. The pool odd ratio of the association between prevalence of Schistosomiasis and gender of school age children in Ethiopia, 1997–2019.

and, time before and since mass drug administration were considered to see the association between gender and schistosomiasis. Accordingly, studies conducted in agrarian regions, and after 2015 showed a significant association between gender and Schistosomiasis infection, male school age children were 31% more likely infected with Schistosomiasis (OR: 1.31, 95% CI: 1.04, 1.64) and 63% more likely infected with Schistosomiasis (OR: 1.63, 95% CI: 1.32, 2.03) than female school age children in agrarian regions and since 2015 respectively in Ethiopia. (Table 4).

4. Discussion

We conducted this systematic review and meta-analysis to estimate the pooled prevalence of Schistosomiasis (S. mansoni and S. haematobium) and its association with gender of school age children in Ethiopia. The result of 50 included studies noted that the pooled prevalence of Schistosomiasis in Ethiopia was 28.77% (95% CI: 23.81, 33.74%). This find was lower than a national survey of Mozambique (47%) (Augusto et al., 2009) and Sierra Leone (69.0% & 42.2%) (Hodges et al., 2012; Bah et al., 2019). whereas, the prevalence of Schistosomiasis in Ethiopia was higher than the study conducted in Kenya (2.1%) (Mwandawiro et al., 2013), Chad (1%) (Beasley et al., 2002) and Mali (12.7%) (Landouré et al., 2012). Findings from different countries indicate that prevalence of Schistosomiasis considerably varies among countries. Differences in the prevalence of Schistosomiasis among these different countries might be associated with environmental sanitation, water supply, and the socioeconomic status of countries. Moreover, the above variations could be due to methodological differences (i.e., data analysis and sampling of study participants) and health service utilization culture of the countries.

In this study, we also performed sub-group analysis based on the study areas (i.e. regions of the country) where the studies were conducted. The findings of the subgroup analysis indicated that extreme variability was observed in the prevalence of Schistosomiasis across the regions of the country. The highest (39.77%) prevalence of Schistosomiasis was reported from the southern nation, nationality and people region, whereas the lowest (14.95%) prevalence of Schistosomiasis was reported from Afar region. The possible explanation for this variation could be due to the cultural variation across the regions of the country and geographical differences across these different regions of the country.

The current meta-analysis was also examined the association between prevalence of Schistosomiasis and gender of school age children in the context of Ethiopia. Accordingly, gender of school age children was significantly associated with prevalence of Schistosomiasis. Male school age children were 58% more likely to be infected with Schistosomiasis than female school age children in Ethiopia. This finding was consistent with a study conducted in Zimbabwe (Taylor and Makura, 1985). The obvious explanation for this could be male school age children had higher frequency of contact with contaminated water bodies than female while helping their family in outdoor activities such as herding cattle, fishing and farming. Moreover, male children usually play outdoors, and engage in outdoor activities compared to their female counterparts, which may predispose them to higher risks of Schistosomiasis infection. In this review, studies conducted in agrarian regions showed that male school age children were 31% more likely infected with Schistosomiasis than female school age children. This finding is consistent with recommendation from study conducted in 16 countries where there authors recommended context specific studies for gender inequality in neglected tropical diseases service utilization (Cohn et al., 2019). In this review, studies conducted since 2015 in which Ethiopia started national mass drug administration following WHO recommendation (https://espen.afro.who.int/system/files/content/resources/ETHIOPIA_NTD_Master_Plan_2016_220.pdf, n.d.) showed that male school age children were 63% more likely infected with Schistosomiasis than female school age children. This finding is consistent with study conducted in 16 countries where male gender had lower preventive chemotherapy coverage than Female for all diseases (Cohn et al., 2019). This might be due to strong women empowerment activities at school level and at community for health services utilization.

5. Conclusion

The prevalence of Schistosomiasis (S. mansoni and S. haematobium) in Ethiopia was higher than the 2018 report of the Ethiopian federal ministry of health. The prevalence of Schistosomiasis was predominant in male gender school age children, since 2015 and in agrarian regions of Ethiopia. Beyond current mass drug administration program, interventions against Schistosomiasis should be culture and context specific, to address the gender related risk to Schistosomiasis. Further researches should be encouraged to identify context specific factors related to gender differences in occurrence of schistosomiasis.

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Limitations

This systematic review and meta-analysis has the following limitations: only English language articles or reports and published articles were considered to conduct this review, the majority of the studies included in this review were cross-sectional in nature as a result; the outcome variable might be affected by other confounding variables. Furthermore, this meta-analysis represented only studies reported from seven regions of the country. Therefore, the regions might be under-represented due to the limited number of studies included.

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