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Review

Prevalence of urinary schistosomiasis in Nigeria, 1994–2015: Systematic review and meta-analysis

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Nigeria;
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Survey

Abstract

Introduction: The Global significance of schistosomiasis started waning over the years owing to its eradication in most developed societies, until the reawaking of global attention and it now occupies a prominent place amongst the neglected tropical diseases (NTD). The aim of our study was to accurately estimate the prevalence of schistosomiasis in Nigeria, and its six geo-political zones.

Subjects and methods: We utilized electronic databases to search and select studies on prevalence across the geographical zones between 1994 and 2015. STATA 10 Random effects meta-analysis of observational studies was used to generate our estimates.

Result: Sixty-seven studies met the inclusion criteria. The unified pooled population studied was 47,440 (n = 14,888 persons). The pooled prevalence]) of Schistosoma haematobium infestation was, for all regions = 34.7% (31.0–38.5) (95% confidence interval [CI]).

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Conclusion: Schistosomal infestations remain hyperendemic in Nigeria. Nigeria must, therefore, expedite the execution of resolution WHA66.12 adopted by the World Health Assembly on NTD.

Introduction

Despite the gains in the health care delivery of the past decades, schistosomiasis has prevailed as a health challenge in the tropic and the subtropics [1]. According to the World Health Organisation (WHO), schistosomiasis is second to malaria alone amid the vector-borne diseases in terms of public health and remuneration importance in the tropics [2]. In 2013, more than 62 million persons representing greater than 39% of those requiring preventive chemotherapy in the top ten African countries with the highest prevalence of the disease are Nigerians; of these less than 6% had the preventive chemotherapy [3]. This increased to greater than 64 million in 2014 [4]. Another study suggested Nigeria had the highest schistosomiasis burden in the world [5,6]. Akinwale et al. using PCR technique reported startling 98.4% prevalence in a local community in the southwestern Nigeria among the age group 6–63 years [7]. Urinary schistosomiasis is a risk factor for the second most common urologic malignancy (bladder cancer) and myriads of disorders that result in morbidity and mortality [8–10]. Schistosomiasis infestations additionally result in poor physical and psychosocial development among the school-aged children and adolescents [11]. Furthermore, a study had shown that control of schistosomiasis may be more cost-effective compared to current measures in curtailing the HIV spread among Africans [12]. The prevalence and these public health aftermaths of schistosomiasis with other neglected tropical disease necessitated the ratification of resolution 66.12 in 2013 by World Health Assembly [13]; the intent was curtailing the problem common in 78 countries and affecting more than 200 million people [14]. Nonetheless, in Nigeria many governmental, and non-governmental bodies have devoted resources aimed at prevention and controlling schistosomiasis. These endeavors incorporated community reawakening on the inherent imperils of untreated childhood haematuria; numerous community screening with the computation of the populace prevalence, and the provision of free mass drug treatment in communities with high endemicity [15–18]. However, it is onerous to objectively affirm if the efforts are effective since the current prevalence is unknown for the country and its sub-regions. Hence, the aim of our studies was to accurately estimate the current prevalence of urinary schistosomiasis in the country and the six geopolitical subregions.

Subjects and methods

We did a systematic review and Meta-analysis of observational studies in epidemiology (MOOSE) guideline [19]. We searched for the articles on the prevalence of schistosomiasis in the relevant international databases, including PubMed, ISI, Google Scholar, Scopus and African journal online (AJOL), from 1994 to 2015. This search was completed on 24th March 2016. In search of gray articles, we reviewed non-indexed Nigerian journals and also contacted experts in the field for other articles we might miss. The keywords for the research were: "prevalence","incidence", "schistosomiasis", "Bilharziasis", "Nigeria" and the sub-region with the states were crossed in the search.

We attempted to minimize the risk of bias, by assigning six reviewers to independently search reviews and merge selected studies that we used in the final summary of included articles. The reference lists of the articles obtained were then reviewed to find other eligible studies. The inclusion criteria included: study done in Nigeria, study design been cross-sectional, parasitological identification of schistosome ova in the urine; and a sample size of at least 100 persons; studies were included if they were published in English between 1994–2015. No age limitation was proffered. The only exclusion criterion was articles written in languages other than English. Age group categorization was done as follows; children were designated as those of 12 years of age and below; adolescent 13–17 years; and adult 18 years or higher. The study quality was evaluated by 12-points scoring system established upon the Down and Black checklist [88].

In the second phase, all the articles identified were independently reviewed by three investigators; favorable studies were summarized and incorporated for the meta-analysis.

The primary outcome measured was the prevalence of schistosomiasis, the standard error of prevalence was determined by the binomial probability distribution. Between-study heterogeneity was evaluated using the Cochran test and I^2 test. The level of significance for the Cochran test was set as 0.05. I^2 values near 25% indicate low heterogeneity, values near 50% show moderate heterogeneity, and those above 75% show high heterogeneity. Random effect model with DerSimonian–Laird method was utilized for estimation of pooled measures by calculating the pooled estimate and confidence intervals, based on the weighted least square (weighting is given by the reciprocal sum of between and within study variances) [20].

Publication bias was appraised by a funnel plot and Begg's as well as Egger's regression tests. All analysis was performed using STATA software (version 10).

Results

Our search yielded an initial 359 reviews. After screening and assessment for eligibility of the studies; ultimately, sixty-seven cross-sectional studies were selected and used for the final analysis as shown in table of summaries of the included studies (Table 1) [21–88] and flow diagram of the studies included in the review (Fig. 1).

Overall prevalence

The prevalence of urinary schistosomiasis infestation in Nigeria varied from 2% to 82.5% amidst analyzed studies. The pooled prevalence measure for Nigeria was 34.7% (95% confidence interval

Table 1 Summary of the studies on the prevalence of urinary schistosomiasis in Nigeria 1994–2015.

Authors	Year	Location	Source of infestation	Setting	Population	Sample size	No of schisto	Quality score
1. Ekpo et al. [21]	2010	South west	Running	Rural	Children and adolescent	167	97	A
2. Morenike and Idowu [22]	2011	South west	Running	Urban	All	276	89	A
3. Akinwale et al. [23]	2010	South west	Running	Rural	All	536	293	B
4. Sowole and Adegbite [24]	2012	South west	Still and running	Rural	All	268	221	A
5. Adewoye and Fanfure [25]	2012	South west	Still	Urban	Children	1402	572	A
6. Otuneme et al. [26]	2014	South west	Still	Rural	All	150	49	B
7. Babatunde et al. [27]	2013	South west	Running	Rural	Children and adolescent	274	132	B
8. Oluwasogo and Fagbemi [28]	2013	South west	Still and running	Urban	All	102	80	B
9. Olagunde et al. [29]	2012	South west	Running	Rural	Children and adolescent	172	130	A
10. Oladejo and Ofoezie [30]	2006	South west	Still	Rural	Children and adolescent	320	149	A
11. Akinwale et al. [31]	2011	South west	Still and running	Urban	Children and adolescent	200	33	A
12. Okoli and Odaibo [32]	2002	South west	Still and running	Urban	All	1331	232	B
13. Sam-Wobo [33]	2013	South west	Running	Urban	All	552	33	B
14. Dawaki et al. [34]	2015	North west	Still	Rural	Children and adolescent	960	418	A
15. Sarkinfada et al. [35]	2009	North west	Still and running	Urban	Children	890	370	B
16. Bello et al. [36]	2011	North west	Still and running	Urban	Children	300	110	A
17. Kabiru et al. [37]	2011	North west	Still and running	Urban	Children	300	115	B
18. Ukatu et al. [38]	2015	North west	Still	Urban	All	206	87	C
19. Rikota and Danladi [39]	2008	North west	Still and running	Urban	Children and adolescent	198	90	A
20. Ladan et al. [40]	2009	North west	Still and running	Rural	All	500	235	B
21. Bala et al. [41]	2010	North west	Still and running	Rural	All	400	296	A
22. Kanwai et al. [42]	2009	North west	Still and running	Urban	All	657	165	A
23. Damen et al. [43]	2005	North west	Still and running	Urban	Children	306	20	A
24. Omenesa et al. [44]	2009	North west	Still	Urban	Children	200	39	B
25. Duwa et al. [45]	2009	North west	Still	Rural	Children and adolescent	493	218	B
26. Bigwan et al. [46]	2012	North east	Still and running	Urban	Adolescent and adult	300	30	B
27. Biu et al. [47]	2009	North east	Still and running	Rural	Children and adolescent	494	120	B
28. Balla and Jabbo [48]	2013	North east	Still	Rural	Children and adolescent	112	38	C
29. Ameh et al. [49]	2014	North east	Running	Rural	All	618	31	C
30. Dagona et al. [50]	2013	North east	Still	Rural	Children and adolescent	200	110	B
31. Balla [51]	2013	North east	Still and running	Rural	Adolescent	302	147	B
32. Houmsou et al. [52]	2012	North central	Still and running	Urban	All	1124	467	C
33. Okpala [53]	2004	North central	Still and running	Urban	All	3187	8	A

34. Amuta and Houmsou [54]	2014	North central	Still and running	Rural and urban	Adolescent and adult	300	165	B
35. Nanvyat et al. [55]	2011	North central	Still and running	Urban	All	535	221	B
36. Abdullahi and Saidu [56]	2011	North central	Still and running	Urban	Children and adolescent	200	80	C
37. Reuben et al. [57]	2013	North central	Still and running	Urban	All	160	26	B
38. Okpala et al. [58]	2003	North central	Still and running	Urban	All	200	46	B
39. Okafor et al. [59]	2014	North central	Still and running	Urban	All	625	186	B
40. Dawet et al. [60]	2012	North central	Still and running	Rural	All	242	5	B
41. Ejima and Odaibo [61]	2010	North central	Still and running	Rural	All	1104	206	C
42. Okwori et al. [62]	2014	North central	Running	Rural	Children	192	85	B
43. Okpala et al. [63]	2004	North central	Still and running	Urban	Children and adolescent	300	1	B
44. Chidozie et al. [64]	2008	North central	Still	Urban	Children and adolescent	217	28	B
45. Ifeanyi et al. [65]	2010	North central	Still and running	Rural and urban	All	1150	360	A
46. Mbata et al. [66]	2009	North central	Running	Rural and urban	All	657	300	A
47. Amazigo et al. [67]	1997	South east	Running	Rural	Children	333	85	B
48. Okoli and Iwuala [68]	2004	South east	Still and running	Rural and urban	All	3504	880	A
49. Okoli et al. [69]	2006	South east	Still and running	Rural and urban	All	487	55	A
50. Okwelogu et al. [70]	2012	South east	Running	Rural	All	600	144	B
51. Anosike et al. [71]	2003	South east	Still and running	Rural	All	3296	776	A
52. Anosike et al. [72]	2006	South east	Still and running	Rural	All	2104	466	C
53. Ossai et al. [73]	2014	South east	Still and running	Rural	Children and adolescent	842	287	A
54. Uwaezuoke et al. [74]	2008	South east	Still and running	Rural	All	838	350	A
55. Okeke et al. [75]	2013	South east	Still	Urban	Children and adolescent	323	15	B
56. Ugochukwu et al. [76]	2013	South east	Still and running	Rural	All	2064	323	B
57. Nmorsi et al. [77]	2005	South south	Still and running	Rural	All	300	195	A
58. Nmorsi et al. [78]	2001	South south	Still and running	Rural	All	1136	371	B
59. Etim et al. [79]	2012	South south	Still and running	Rural	All	412	174	B
60. Okon et al. [80]	2007	South south	Still	Rural	Children and adolescent	200	70	B
61. Tobin et al. [81]	2013	South south	Still and running	Rural	Children and adolescent	403	43	A
62. Agi and Okafor [82]	2005	South south	Still	Rural	All	360	250	B
63. Agi [83]	1995	South south	Still	Rural	All	890	514	B
64. Agi and Awi-Waadu [84]	2008	South south	Still and running	Rural	All	3948	2048	B
65. Adie et al. [85]	2013	South south	Still and running	Rural and urban	All	1121	778	B
66. Adie [86]	2015	South south	Still	Rural	All	600	1	C
67. Imarenezor [87]	2013	South south	Still and running	Rural	All	300	130	B

a.

Table 2 Estimated urinary schistosomiasis by age group, sources of infestation, the community set up, region, subregions and the year of publication.

Category	Subgroup	Studies reviewed	Prevalence% (95%CI)	I^2	P
Study population (age group)	Children	8	20.4–42.8	98.4	<0.0001
	Adolescents	1	43.0–53.3	.	.
	Adolescents and adults	2	−11.7–76.5	99.4	0.149
	Children and adolescents	18	24.3–45.4	99.4	<0.0001
	All groups	38	30.3–40.0	99.8	<0.0001
Source of infestations	Running	11	24.8–51.2	99.3	<0.0001
	Still	15	21.8–50.0	99.7	<0.0001
	Both	41	27.6–39.5	99.8	<0.0001
Community	Rural	36	31.9–47.6	99.8	<0.0001
	Urban	25	21.3–31.5	99.5	<0.0001
	Both	6	22.9–56.2	99.6	<0.0001
Regions overall	North	33	25.1–35.2	99.6	<0.0001
	South	34	30.0–46.0	99.8	<0.0001
	Whole country	67	31.0–38.5	99.7	<0.0001
Sub regions	North central	15	20.5–32.6	99.6	<0.0001
	North east	6	14.3–44.2	98.9	<0.0001
	North west	12	27.9–49.5	98.8	<0.0001
	South east	10	17.4–28.0	98.4	<0.0001
	South west	13	31.6–58.6	99.4	<0.0001
	South south	11	22.5–64.3	99.9	<0.0001
Year of publication	1994	1	54.5–61.0	.	<0.0001
	1995	–	–	–	–
	1996	–	–	–	–
	1997	1	20.8–30.2	.	<0.0001
	1998	–	–	–	–
	1999	–	–	–	–
	2000	–	–	–	–
	2001	1	29.9–35.4	.	.
	2002	1	15.4–19.5	.	.
	2003	2	22.1–24.9	0.0	0.859
	2004	3	0–17.0	99.8	<0.0001
	2005	3	1.4–92.5	99.7	<0.0001
	2006	3	12.6–40.2	98.5	<0.0001
	2007	1	28.9–41.6	.	.
	2008	4	21.7–54.3	98.9	<0.0001
	2009	7	27.1–43.7	96.8	<0.0001
	2010	5	27.3–67.2	99.4	<0.0001
	2011	6	26.4–41.9	92.0	<0.0001
	2012	8	21.4–58.1	99.6	<0.0001
	2013	12	22.1–49.3	99.5	<0.0001
	2014	6	16.7–50.0	99.2	<0.0001
	2015	3	6.0–63.1	99.8	0.105

[CI]: 31.0, 38.5%) [Table 2]. Considering Nigeria with a projected population of 172,626,526 people [89],we estimate a burden of 59,901,405 persons (95% CI 53,514,223; 66,461,213).

Subgroup analysis

Stratified analysis revealed a broad disparity in the prevalence of urinary schistosomiasis infestation vulnerability among the analyzed sub groups. [Table 2]. By the year of publications, prevalence was highest among 1994 publication at 57.8% (95% CI, 54.5, and 61.0%) and the least in 2004 publications at 8.5% (95% CI, 0, 17.0%). Urinary schistosomiasis infestation prevalence was highest in the study with adolescents 47.7% (95% CI, 43, 54.3%), compared to other age groups. Prevalence was greater for southern Nigeria at 38% (95% CI, 30.0, 46.0%) (Fig. 2) compared with 30% (95% CI 25.1, 35.2%) for the Northern Nigeria region (Fig. 3). Urinary schistosomiasis infestation prevalence was highest amid the southwest sub-region 45.3% (95% CI, 31.6, 58.9). The infestation prevalence also varied by the setting. Among rural populations, the urinary schistosomiasis infestation prevalence was higher with 39.8% (95% CI, 31.8, 47.6%). Prevalence was higher in communities whose water source is predominantly running 38.0% (95% CI, 24.8, 51.2%). Meta-regression analysis shows that prevalence estimates rise with the study year are not statistically significant ($p = 0.583$) (Fig. 4). There was evidence of publication bias with Egger's and Begg's test having a $P < 0.001$. This was portrayed graphically by an asymmetry in the funnel plot (Fig. 5).

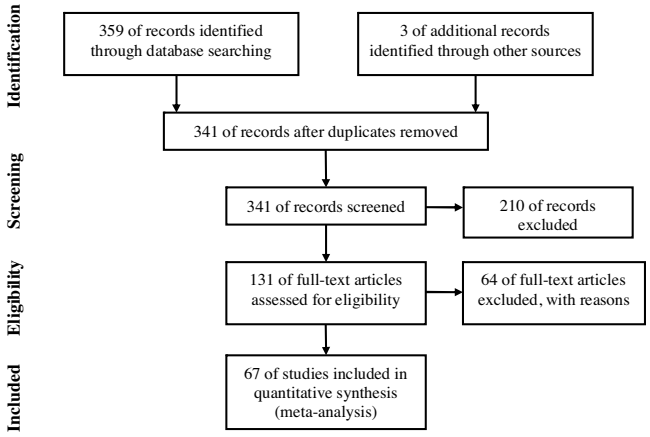

Figure 1 Flow diagram of the studies reviewed.

Discussion

This is the first systematic review and meta-analyses on the prevalence of urinary schistosomiasis in Nigeria. The 2015 Nigerian population was projected at 172 million [89] with the land mass of more than 900,000 km^2 hence exceptional planning, greater time and enormous resources are required in the use primary data to obtain the national prevalence of urinary schistosomiasis. In lieu of this we, therefore, scientifically assessed the prevalence by statistically pooling together studies that met the inclusion criteria from the entire regions. Approximately, one-third of the pooled populations studied have urinary schistosomiasis. This affirmed the WHO 2013 earlier estimate of more than 60 million Nigerians required preventive chemotherapy for schistosomiasis [3,4]. The southwestern Nigeria with the highest prevalence had all the three effect sizes greater than 75% emanated being from that region [24,28,29]. Our finding is consistent with other findings which showed the infestation is more common in the rural setting. WHO inferred that such finding mirrors low socio-economic and educational attainment in such communities [90]. The prevalence peaked at adolescent age

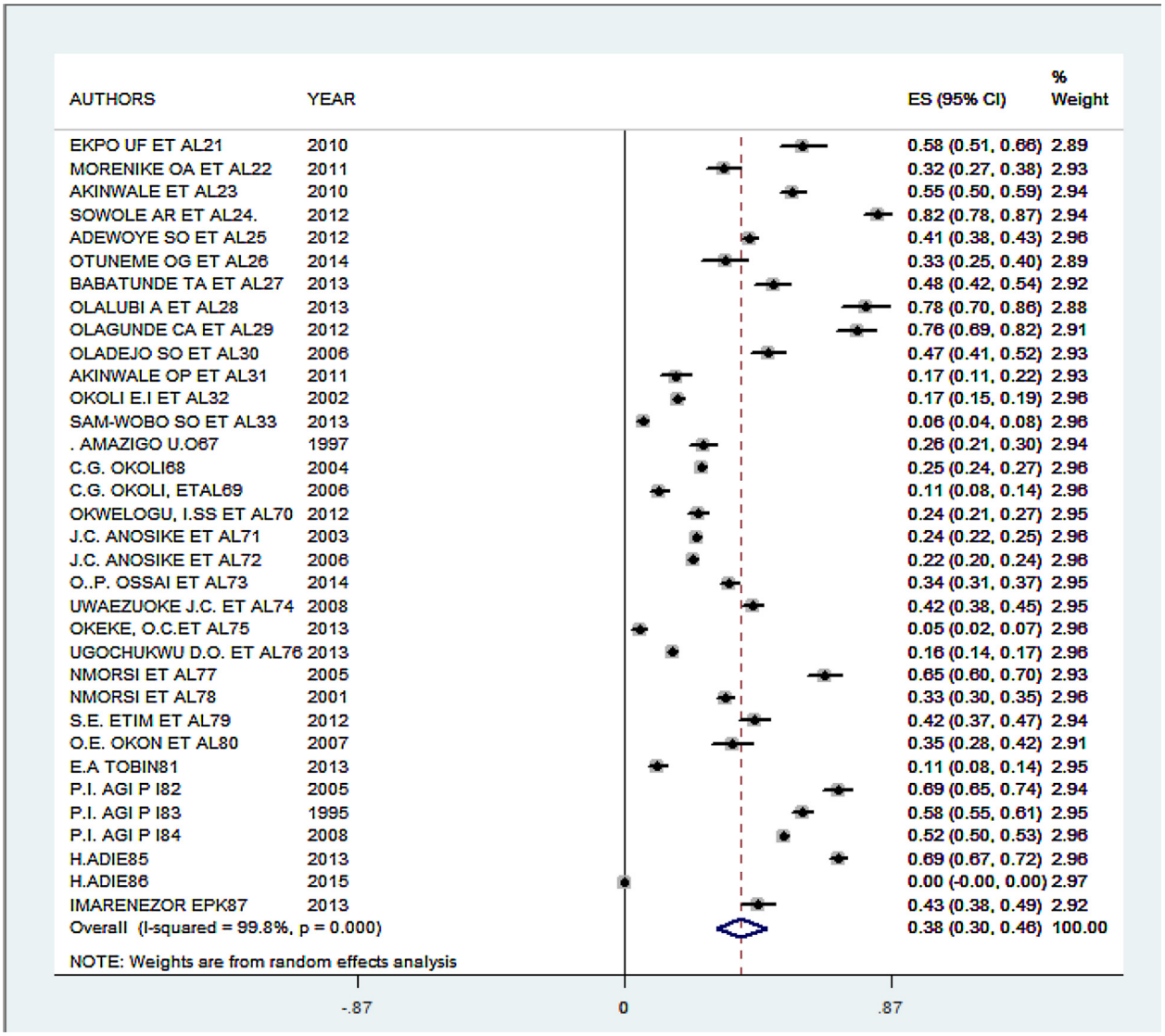

Figure 2 Forest plot studies included from the southern region of Nigeria.

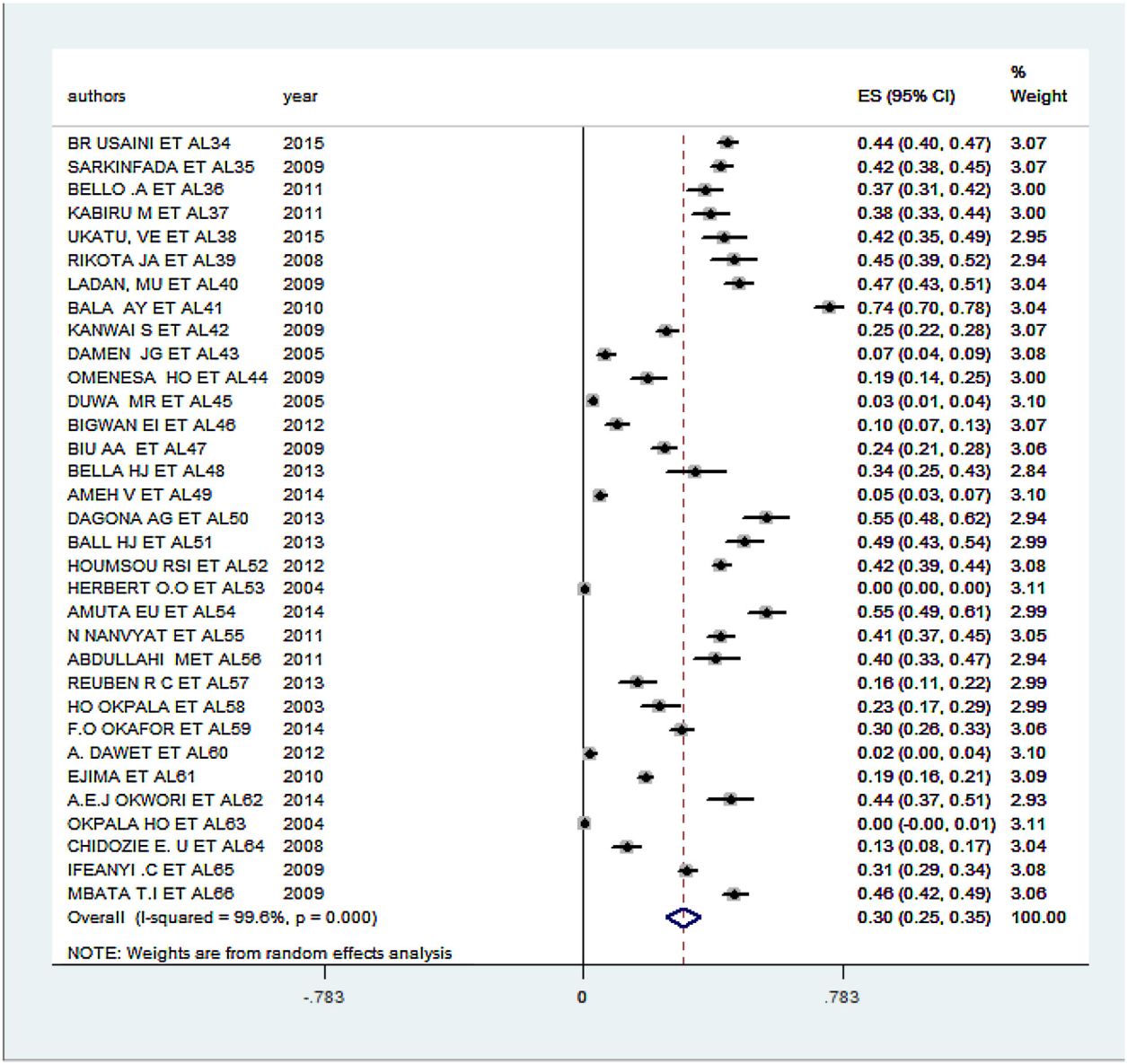

Figure 3 Forest plot studies included from the northern region of Nigeria.

period, although this estimate was weighted by only one studies, in certain settings haematuria which is the most common presentation is assumed to be the "male menses" consequently it is a normal expectation at adolescence/puberty. In Nigeria, Adolescents are partakers in swimming sports and recreations, farming in swampy farms and water based enterprises. Our finding showed communities with running water source have a higher prevalence, although backed by a pool of less than 17% of the total studies; this was supported by Senghor et al. [91] They demonstrated in their review that infestations were more in individuals that use part of the river that was not reached by the water current and relatively stagnant compared to those that use pond that is a still water source of infestation. The presence of running water source serves as means of transportation in addition to being used for water based sport, household and trade needs and as such the greater water contact time in the given community correlates with infestations. Further buttressing this, shores of the running water often harbor pockets of stagnant water that could also serve as a source of *S. haematobium*. The yearly comparison from 1994 to 2015 (Table 2) encompassed the estimated prevalence before and after WHO resolution adopted in 2013.The prevalence peaked at 54.5 to 60% in 1994 was before this resolution (although this was supported by a single review) the prevalence then declined eccentrically over time, this with the subregional trend suggested a significant impact of several control interventions by governmental and non-governmental bodies particularly in the south south and southeastern Nigeria (Fig. 6).

In 2012, the World Health Assembly ratified resolution WHA65.21; [92] embraced global eradication of schistosomiasis, charged all countries endemic with schistosomiasis to examine and produce suitable projects with precocious goals, to strengthen rules on the interventions and to effect the procurement of vital medications. Our study suggested Nigeria as a signatory to this resolution needs to do more three years after the resolution. Supplementary studies

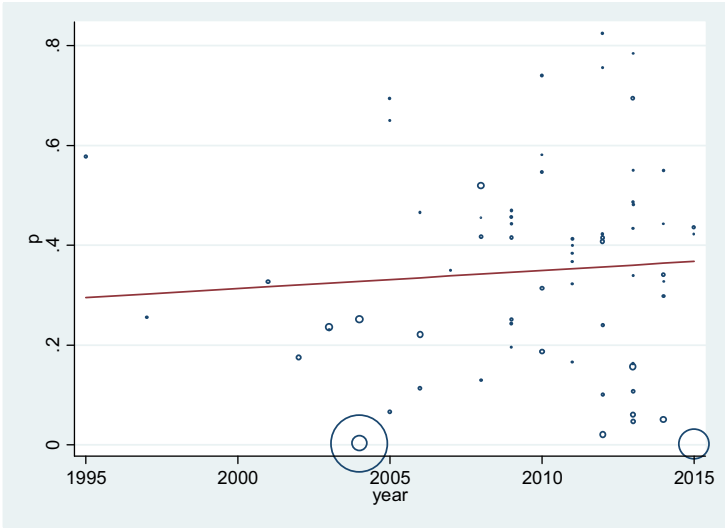

Figure 4 Meta-regression plot showing the trend in urinary schistosomiasis prevalence with theyear of the study.

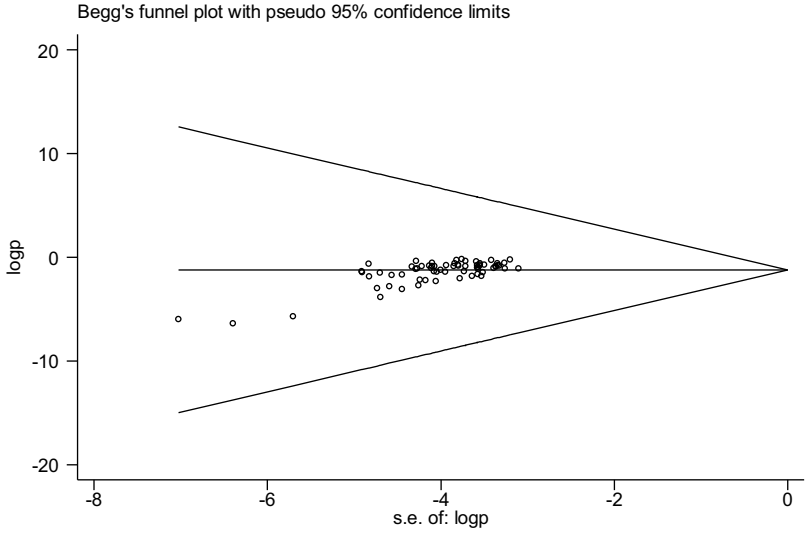

Figure 5 Funnel plot of the studies on the prevalence of urinary schistosomiasis in Nigeria 1994–2015.

are needed to unveil the most effective means for the control and prevention of this hyperendemic problem.

Our study estimates adduced challenges as a result of innate biases in the original studies and variations in research designs [93]; the file-drawer effects could not be ruled out among the reported studies as all the studies are from 'water centered' communities. Besides there is the established clustering effect among cases of urinary schistosomiasis in such communities studied that could add to overall high prevalence. The review includes studies within a 20 year period of different generation of researchers using different generations of diagnostic kits and reagents. The use of urine sample for defining the prevalence is dependent on the presence of the ova, substandard drugs suppress the production and release of this ova, the time of collection of the samples are overlooked in most studies and this all will affect yield and the prevalence. On the other hand, our study presents a medium to emphasize urinary schistosomiasis endemicity in Nigeria and the need for more urgent preventive actions. The accuracy of our derived estimates is supported by the minimal publication bias (Egger's and Begg's $p < 0.0001$) as displayed in the Funnel plot (Fig. 5). In Meta-regression analysis, the year of publication does not significantly affect the prevalence ($p = 0.583$) (Fig. 4), although different locations are assessed at the different time. Also, sample sizes affected the prevalence inversely $p = 0.229$ (Fig. 7) as often expected which is an important source of heterogeneity and might have contributed to the publication bias observed.

Conclusion

Our appraisal conveyed the reality that Schistosomal haematobium infestation is still hyperendemic in Nigeria and hence, the need for control focused on communities Health awareness campaign, appropriate medications, snail elimination, enhanced hygiene, and subduing poverty. Maneuverings to moderate negating effects in construction and handling of water schemes should be basic components in the devising, usage, and maintenance blueprints. Both

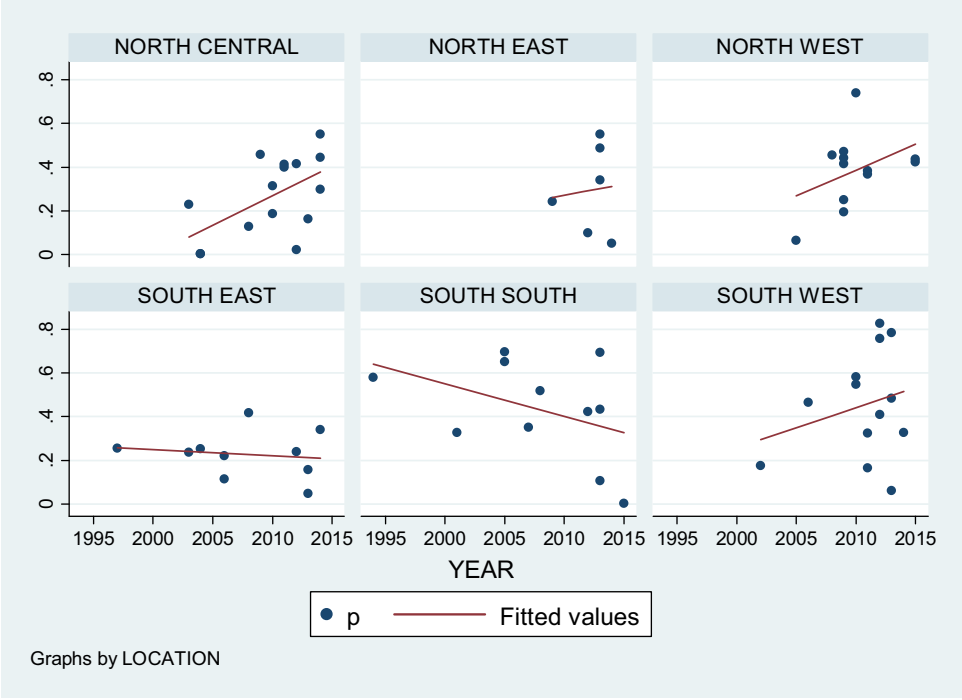

Figure 6 Scatter plot indicating the relative prevalence trend by subregion.

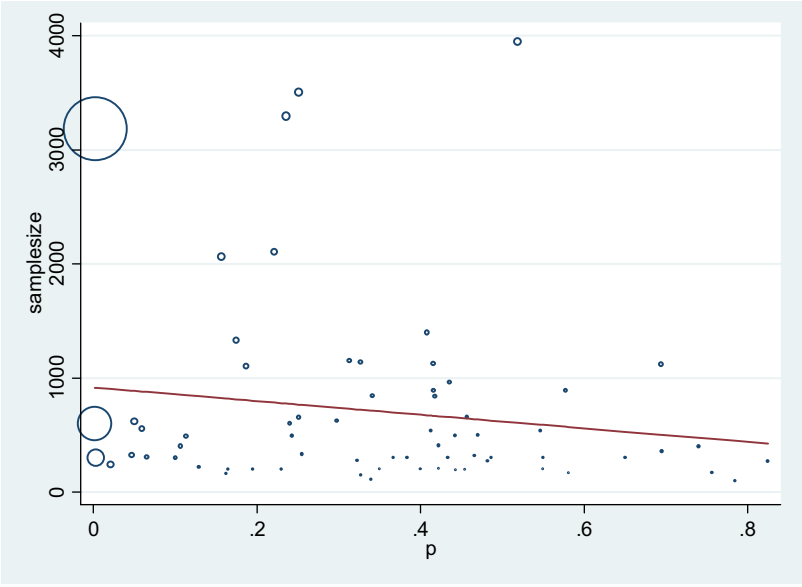

Figure 7 Sample sizes of the various publications against the prevalence.

government and nongovernment bodies' support are decisive for the broader research required on these strategies. Health worker being considerable team player must strive towards repression of *S. haematobium* in Nigeria. Our study is indeed germane for the relevant bodies and organization policies en route "Transforming our world: the 2030 Agenda for Sustainable Development", ending the schistosomiasis epidemics in Nigeria.

Conflict of interest

None.

Source of funding

None.

Author agreements/declarations

All authors have seen and approved the final version of the manuscript being submitted. They warrant that the article is the authors' original work, has not received prior publication and is not under consideration for publication elsewhere.

Permission notes

All material in the manuscript such as figures, tables etc are original content.

Author contributions

1. Abubakar Abdulkadir role was search reviews, designed the study concepts and coordinated contributions from co-authors. Acquisition of data and data analysis.
2. Muhammed Ahmed role was revising the study critically for the important intellectual content, contributed to the design and concept.
3. Babagana Mustapha Abubakar role was search reviews in the states and geopolitical zones.
4. Ibrahim Eneye Suleiman role was search reviews in the states and geopolitical zones.
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10. Ahmad Maifada Yakasai role was substantial contributions in interpretations and the analysis of the software findings.
11. Baba Maiyaki Musa role was substantial contributions in interpretations and the analysis of the software findings.

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