

Occupational Exposures to Blood and Body Fluids among Healthcare Workers in Ethiopia: A Systematic Review and Meta-Analysis

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Abstract

Background: Occupational exposure to blood and body fluids is a major risk factor for the transmission of blood-borne infections to healthcare workers. There are several primary studies in Ethiopia yet they might not be at the national level to quantify the extent of occupational blood and body fluid exposures among the healthcare workers. This systematic review and meta-analysis aimed to estimate the pooled prevalence of occupational blood and body fluid exposure of health-care workers in Ethiopia.

Methods: PubMed, Science Direct, Hinari, Google Scholar, and the Cochrane library were systematically searched; withal, the references of appended articles were also checked for further possible sources. The Cochrane Q test statistics and I^2 tests were used to assess the heterogeneity of the included studies. A random-effects meta-analysis model was used to estimate the lifetime and 12-month prevalence of occupational exposure to blood and body fluids among health-care workers in Ethiopia.

Results: Of the 641 articles identified through the database search, 37 studies were included in the final analysis. The estimated pooled lifetime and 12-month prevalence on occupational exposure to blood and body fluids among healthcare workers were found to be at 54.15% (95% confidence interval (CI): 47.54–60.75) and 44.24% (95%CI: 36.98-51.51), respectively. The study identified a variation in healthcare workers whom were exposed to blood and body fluids across Ethiopian regions.

Conclusion: The finding of the present study revealed that there was a high level of annual and lifetime exposures to blood and body fluids among the healthcare workers of Ethiopia.

Keywords: Blood and body fluid, Ethiopia, Healthcare workers, Occupational exposure, Splash

Introduction

Occupational exposure to blood and body fluids (BBFs) is a major risk factor for the transmission of blood-borne infections to healthcare workers (HCWs). These exposures can heighten the risk of infection to Human Immunodeficiency Virus (HIV), Hepatitis B, and Hepatitis C. In many cases, exposures occur through a needle stick or contact in the eyes, nose, mouth, or when a broken skin comes in contact with the patient's blood or body fluid [1,2].

According to the World Health Organization (WHO), it is estimated that about 3 million HCWs are exposed to bloodborne pathogens each year – occupational exposure causes approximately 170,000 to HIV infections, 2 million to HBV infections, and 0.9 million to HCV infections [3]. A recent review also stipulated that the prevalence of infections, such as HCV is significantly higher in HCWs than in the general population [1]. And more than 90% of HIV, HBV, and HCV exposures transpire in the developing countries [4].

Antecedent literatures publicized that blood or blood products accounted for 66% of exposures and the remaining involved vomits, urines, amniotic fluids, and cerebrospinal fluids; saliva; sputum; and other BBFs; 28% of these cases were fluids which contained visible bloods, and in some exposure incidents, multiple body areas were splashed or sprayed with these body fluids. The face is the most common exposure site reported: healthcare workers' eyes (conjunctiva) were exposed to BBF (53%) of all reported cases. The mucosa of the mouth and nose were exposed in 11% and 5% of cases, respectively [5,6,7].

In sub-Saharan Africa, HCWs are at consequential risk of infection from blood-borne pathogens because of the excessive prevalence of such blood-borne infections in the general population [5,8]. A systematic review conducted in 21 African countries found a high prevalence of occupational exposures to blood and body fluids among HCWs – about two-thirds were exposed during their entire career, and almost half of them were exposed each year [9]. Additionally, evidence from every region of Africa indicates considerable variations in the prevalence of blood and body fluid exposures. The 12-month prevalence of all the types of occupational exposure to blood and body fluids ranged from 17.0% to 67.6% in Kenyan and Burundian studies. The estimated pooled 12-month prevalence was 48.0%. Regional pooled estimates covered from 33.9% to 60.7% in Southern Africa and Northern Africa [9].

In Ethiopia, occupational exposure to BBFs is a pressing concern and continues to have a significant problem in its healthcare system [10-14]. Antecedent studies also reported that

standard precaution practices among HCWs were suboptimal, and the lack of compliance with these measures is still a great lookout [11, 13, 15, 16]. Though attention is paid to the safety of HCWs through the National Infection Prevention and Patient Safety (IPPS) initiatives, the number of exposures to BBFs reported did not manifest a sign of decline as evidenced by some studies [11,14,15,18].

Several primary studies in Ethiopia conveyed a high prevalence of occupational exposures to BBFs. However, the results were inconsistent [11,16-23]. For some instances, in Central Ethiopia, the prevalence of a 12-month BBF exposures among HCWs was 19.9% [11] and 41.3% [20]; in North Ethiopia 60.2% [16] and 31.7% [21]; and in East Ethiopia 43.8% [17] and 20.2% [14]. Currently in Ethiopia, no report exists to quantify the pooled prevalence of BBF exposures among its HCWs, even the existing review determined the prevalence of needle stick injury and did not estimate BBF exposures [24]. Moreover, the epidemiology of blood-borne infections in Ethiopia is on the rise and dynamically changing over the past decades, along with poor compliance toward standard precautions among HCWs. Given these developments, it is timely and crucial to investigate the burden of occupational BBF exposures among HCWs. Therefore, the objective of the present systematic review and meta-analysis directs to estimate the pooled prevalence of BBFs among HCWs in Ethiopia.

Methods

This systematic review and meta-analysis were conducted subsequent to "the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" guidelines [25]. Studies were favoured according to the criteria outlined below (**Appendices A**).

Eligibility Criteria

Study Designs and

In this review, we appended cross-sectional studies and baseline assessment of longitudinal studies. Studies that reported the lifetime and/or 12-month prevalence of occupational exposure through blood and/or body fluid exposures to mucous membranes and broken skins were eligible to be included in the present review. Systematic reviews, letters to editors, short communications, qualitative studies, case series, case-control studies, and case reports were excluded. Also, articles that were not fully accessible, unsuccessful two-email contacts with the primary/corresponding authors were excluded, too. In addition to the aforementioned, studies restricted to HCWs' needle stick and/or sharp injuries were excluded when data were not provided separately for blood and body fluid exposures. Lastly, the aggregate reports for blood and/or body fluid exposures and needle stick and/or sharps injuries were debarred from the study.

Participants

Studies who met the following criteria were considered for inclusion:

Population: Healthcare works (HCWs) with direct contact to patients or blood/body fluids. We also encompassed studies which were conducted on a specific segment of the healthcare workforce (such as physicians, nurses, midwives, laboratory technicians, and cleaners).

Exposure: study examines occupational BBFs exposures

Study Period

No restriction on publication date.

Language

Articles which were only reported in the English language.

Article Searching Strategy

MEDLINE/PubMed, Hinari, Science Direct, and the Cochrane Library databases from inception until January 31, 2020, that reported the prevalence of occupational exposures to blood and/or body fluids among HCWs in Ethiopia were sought. Literature search strategies were developed using medical subject headings (MeSH) and text words related to occupational blood and/or body fluid exposures. The following search terms were used and combined using Boolean operators: "prevalence", "magnitude", "occupation", "exposure", "accident", "occupational exposure", "accidental exposure", "accidental occupational exposure", "occupational disease", "occupational hazard", "cross-infection", "blood", "body fluid", "blood spill", "blood-borne pathogens", "blood-borne infection", "health-care workers", "health workers", "medical personnel", "health personnel" and "Ethiopia". The electronic database search was also supplemented by searching for gray literature through Google scholar, Google searching, and Ethiopian University digital repositories (such as the Addis Ababa University Digital Library). To ensure literature saturation, the reference list of appended studies and/or relevant studies identified through the search were scanned as well. Finally, the literature search was limited to the English language and human subjects (**Appendices B**).

Operational Definition

Occupational Blood and Body Fluid Exposure: In this review, "occupational blood and body fluid exposure" is defined as any exposure to potentially harmful biological agents or infectious materials that occurs as a result of one's occupation, which includes the patient's blood and other body fluids. We appended studies that reported the lifetime or 12-month prevalence of occupational exposure through blood and body fluid contacts from at least one of these routes (eye, mouth, mucous membrane, and non-intact skin).

Healthcare Workers: Healthcare workers (HCWs) are referred to as paid or unpaid individuals (eg: full-time employees or medical students) working in a health-care setting whose activities involve direct contact with patients, or with blood or other body fluids from the patients. Hence, we incorporated studies which involved physicians, nurses, midwives, health officers, laboratory

technicians, anesthetists, auxiliary healthcare workers, residents, or interns undertaking clinical training or gaining experiences in the health-care settings.

Study Selection and Data Extraction

In this review, all the searched articles were imported into the EndNote version X⁴ software, and after that, the duplicate articles were removed. Two investigators (BS and YT) independently screened and identified articles by their titles, abstracts, and full-texts to determine eligibilities against predetermined inclusion and exclusion criteria. Afterwards, the screened articles were compiled together by the two investigators, and discrepancies were resolved through unanimous consensus.

The data extraction form was prepared using Microsoft Excel Spreadsheet. Two reviewers extracted data from the studies and were entered into Microsoft Excel. The data extraction form included: (i) name of primary author; (ii) year of publication; (iii) region; (iv) sample size; (v) study population; (vi) type of study design; (vii) sampling technique (viii) response rate and (ix); 12 months and lifetime prevalence of blood and body fluid exposure among HCWs.

Quality Assessment

The qualities of the appended studies were assessed and the risks for biases were judged using the Joanna Briggs Institute (JBI) quality assessment tool for the prevalence studies [26]. There were nine parameters: (1) appropriate sampling frame, (2) proper sampling technique, (3) adequate sample size, (4) study subject and setting description, (5) sufficient data analysis, (6) use of valid methods for the identified conditions, (7) valid measurement for all participants, (8) using appropriate statistical analysis, and (9) adequate response rate (adequate if 60% or higher). Failure to satisfy each parameter was scored as 1 if not 0. The risks for biases were classified as either low (total score: 0 to 2), moderate (total score: 3 or 4), or high (total score: 5 to 9). Two reviewers (BS and YT) assessed the quality of the studies included. Finally, articles with scores of 5 to 9, which meant having a high risk of biases were debarred (**Appendices C**).

Statistical Analysis

Primarily, appended studies were categorized whether they have measured the lifetime prevalence of blood and body fluid exposures or whether they are on a 12-month prevalence, and

later were entered into the STATA version 14. The meta pop program was utilized to estimate the pooled prevalence of lifetime and 12-month prevalence of blood and body fluid exposure among HCWs. Accordingly, the prevalence of blood and body fluid exposure (p) were estimated using data from the appended studies which reported the proportion of HCWs whom were exposed to body fluids at any time during their career, and twelve-month prevalence was appraised using data from the studies which reported the proportion of participants exposed to body fluids in the preceding 12 months. Corresponding standard errors (SE) were calculated using $se = \sqrt{p(1 - p)/n}$. The researchers estimated the pooled prevalence of blood and body fluid exposures using random-effects meta-analysis based on the DerSimonian and Laird approach. The existence of heterogeneity among the studies was checked using the I^2 test statistics. Heterogeneity will be classified into the following three categories: low heterogeneity (I^2 index < 25%), average heterogeneity (I^2 index= 25–75%), and high heterogeneity (I^2 index > 75%). Also, a p-value of < 0.05 is used to declare heterogeneity. Thus, a random-effects model was used to analyze data in this study, since the estimated both 12 months and lifetime prevalence of BBFs was found to be high. Finally, Meta-regression analysis was used to evaluate the association between the prevalence of BBFs and publication year, and sample size in the selected studies.

Publication Bias

In this meta-analysis, possible publication biases were visualized thru funnel plots. Symmetrical large inverted funnels resembled the absence of publication biases. Also, the probability of publication biases were tested using two main statistical methods (Egger's and Begg's tests) which were wield to test funnel plot asymmetries. The level of significance for asymmetries were viewed as $p < 0.05$.

Sensitivity Analysis

Also, sensitivity analyses were undertaken – the stability of the pooled estimate for each study. The investigation was done by excluding a single individual study from the analysis at a time to explore the robustness of the findings.

Results

Description of the Studies

The initial electronic searches generated 641 studies using international databases and Ethiopian university research repositories. The database included PubMed (82), Science Direct (61), Hinari (279), Google Scholar (196), Cochrane Library (1), and the remaining 22 studies were identified through manual search. Of these, 151 duplicates were identified and effaced. From the tarry of 490 articles, based on the pre-defined eligibility criteria, 428 articles were excluded after reading their titles and abstracts. 62 full-text articles remained and were further assessed for their eligibilities. Finally, based on the pre-defined inclusion and exclusion criteria and quality assessment, only 37 articles were extracted for the final analyses [10-14, 16-23, 27-50] (**Fig. 1**).

Characteristics of the Appended Studies

The general characteristics of the favored articles were presented in **Table 1**. Of the 37 articles included in this review and meta-analyses, 14 were conducted in Addis Ababa; 10 in the Amhara Region; 6 in Oromia Region; 4 from the Southern Nations, Nationalities, and People (SNNP); 2 in Harari Region; and only 1 from Tigray Region. A total number of 11,168 healthcare workers participated in the study – the highest and lowest sample sizes were from the studies of Geberemariyam et al. [13] in the Oromia Region (648 HCWs), and [47] in Addis Ababa (104 HCWs). All the appended studies were cross-sectional studies. Twenty-three studies were conducted solely among hospital healthcare workers. Among the studies, twenty-three of them also presented data regarding 12-month prevalence on occupational exposures to BBFs [10-12, 14, 16, 17, 19-23, 27-29, 35, 37-39, 44-47, 49], and the lifetime prevalence on BBF exposures were reported in twenty-six studies [11-15, 18-20, 22, 28-34, 36, 39-43, 45, 46, 48, 50]. From the studies, thirteen articles have reported having both the 12-month and lifetime BBFs exposure prevalence [10-12, 14, 19, 20, 22, 28, 29, 39, 44-46]. The latest article was published in 2020 [10], and the earliest study was concluded last 2007 [45]. The prevalence of 12 months BBFs among the Ethiopian HCWs ranged from 16.5% [12] to 67.5% [23] in Addis Ababa Region. The lifetime prevalence of BBFs varied from 28.8% in the Harari Region [14] to 81.0% in the Amhara Region [33]. In this review, a low risk of bias was realized in 33 (89.2%) of the included studies (**Appendices C**).

Prevalence of Blood and Body Fluid Exposures among HCWs in Ethiopia

The current meta-analysis using the random-effects model conveyed that the estimated overall pooled prevalence of 12 months BBF exposures among HCWs in Ethiopia was 44.24% (95%CI: 36.98-51.51) with a significant level of heterogeneity ($I^2 = 97.9\%$; $p < 0.001$) (**Fig. 2**). The lifetime pooled prevalence of BBFs using the random-effects model was 54.15% (95% CI 47.54-60.75) with a significant level of heterogeneity ($I^2 = 97.6\%$; $p < 0.001$) (**Fig. 3**).

Investigation of Heterogeneity and Subgroup Analysis

The included studies in this meta-analysis exhibited a statistically significant heterogeneity between studies ($I^2 = 97.9\%$; $p < 0.001$, and $I^2 = 97.6\%$; $p < 0.001$) for the 12-month and lifetime BBF exposure prevalence estimates, respectively. Accordingly, the random-effects model was used to adjust the observed variability. In identifying the possible source of heterogeneity, subgroup analyses were utilized based on the geographical regions, type of healthcare facilities, year of publication, and sample size. However, the level of heterogeneity between studies remained high after subgroup analysis (**Table 2**).

The prevalence of 12 months BBFs was found to be higher in the Tigray Region 60.20 % (95%CI: 55.83-64.57) and the least was reported from the Harari Region 31.86% (95%CI: 8.73-54.98). This meta-analysis also found that the lifetime prevalence of BBF exposures differed between various regions, and the highest prevalence was found in the Amhara Region, 60.83% (95%CI: 47.03-74.62), followed by SNNP Region, 54.35% (95%CI: 28.38-80.31), and finally, the least in Harari Region, 20.80% (95%CI: 24.76-32.83). Withal, the 12 months and lifetime prevalence of BBF exposures were 41.04 (95%CI: 30.63-51.45) and 56.56% (95%CI: 49.44-63.68) in studies published between 2015 and 2020, respectively (**Table 2**).

Sensitivity Analysis

To identify the source of heterogeneity and to explore the robustness of the findings, a leave-one-out sensitivity analysis was employed. The result of sensitivity analyses using the random-effects model revealed that no single study influenced the overall prevalence of 12 months and lifetime BBF exposures among HCWs (**Appendices D**).

The Publication Bias

The presence of publication bias was evaluated using funnel plots and Egger's tests at a significance level of less than 0.05. The findings revealed that publication bias was not significant for the studies reported in the 12-month prevalence of BBF exposures ($p = 0.05$) (**Fig. 4**). In the same manner, it was not statistically significant ($p = 0.92$) for the lifetime BBFs exposures, as well (**Fig. 5**).

Meta-Regression Analysis

The results of the meta-regression analysis showed that the publication year and the sample size were not significant sources of heterogeneity. In this study, no significant relationship were identified between the 12 month prevalence of BBFs and publication year (p -value=0.76), and sample size (p -value= 0.44). Similarly, there was no significant association between the lifetime prevalence of BBFs and publication year (p -value=0.42) and sample size (p -value= 0.48) (**Table 3**).

Discussion

Each year, hundreds of thousands of HCWs, including waste handlers, face the risk of blood-borne diseases due to occupational BBF exposures [3, 8, 9, 51]. In Ethiopia, despite the recognition on the importance of HBV, HCV, HIV, and other diseases transmitted through BBFs by the Federal Ministry of Health (FMOH), currently, there is dearth of systematic reviews and meta-analyses that estimated the prevalence of BBFs exposure among HCWs. In this reckon, this study was the first systematic review and meta-analysis that aimed to estimate lifetime and a 12-month prevalence on occupational exposure to BBFs among Ethiopian HCWs. This review involved the results of 37 articles which investigated the prevalence of BBF exposures, and a high burden on occupational exposures to BBFs among HCWs in Ethiopia was evidently identified.

The estimated pooled 12-month and lifetime prevalence on BBF exposures among HCWs in Ethiopia were 44.2% and 54.2%, respectively. Forbye, the 12-month BBFs prevalence in the primary studies ranged from 16.5% [12] to 67.5% [23]. In parallel, the lifetime prevalence ranged from 28.8% [14] and 81.0% [33]. This 12-month pooled prevalence estimate was almost comparable from the pooled estimate from East Africa (47.3%) [9], Côte d'Ivoire, Mali and Senegal (45.7%) [52], and a study by Bi P et al from Australia, revealed that 42% of HCWs had body fluid exposures in a year on their study [53]. However, it was lower than the studies conducted in Turkey (57%) [54] and Nigeria 67.5% [55]. These differences might be subjected to the variances in the socio-demographic, cultural characteristics of study participants, and study health facility setup variations.

This study explicated a higher prevalence of lifetime BBF exposures (54.2%), however, it was subservient than the reviews from the 65 studies in 21 African countries (65.7%) [9]. The foremost reason for this variation may be due to study setting dissimilarities. This finding is also inconsistent with a study in Iran which reported the prevalence of exposures at 46.47% [56]. The variance could be due to the discrepancies in the study participants, the type of healthcare facilities, and socio-demographic factors.

In this review, the researchers identified a variation in the HCWs' exposure to BBFs across the Ethiopian regions. The lifetime (60.83% in Amhara Region) and 12 months (60.20% in Tigray Region and 48.69% in Amhara Region) occupational exposure to BBFs were consistently more frequent in Northern Ethiopia, and less in Harari Region (lifetime prevalence of 28.80% and 12-

month prevalence of 31.86%). The probable rationale for these regional variations may be due to: the number of studies included; type of healthcare facilities; and geographical and demographical differences. The other possible vindication for these disparities may be partially explained by the polarities in the levels of standard precaution practices among the HCWs in the various regions. As one study reported, 80.8% of the HCWs regularly follow standard precautions in Eastern Ethiopia, including the Harari Region [14].

A laudative prevalence of BBF exposures among HCWs working exclusively in hospitals than those in the health centers (primary healthcare units) was also found. Almost half of the HCWs working in hospitals of Ethiopia had at least one BBFs exposure in their lifetime and in the last 12 months. The finding was predictable because these HCWs had higher workloads and they performed further medical procedures, which may have exposed them to occupational BBFs compared to those in the health centers. Therewithal, the high prevalence of BBF exposures among HCWs working in the hospitals had significant implications because most of the blood-borne viruses, such as HCV, HBV, and HIV, may haply spread through BBFs exposures, therefore, enhancing HCWs' compliance towards standard precautionary measures is deemed necessary.

Limitations

This review article had a few adversities due to its limitations. One of which was the cross-sectional design nature of the included studies and all were based on self-reported data whilst estimating the prevalence of occupational BBFs exposures. Additionally, social desirability and recall biases were likely present. Since the study was conducted in Ethiopia, included healthcare facilities and the generalization of the study findings was limited to these similar contexts. Further, there was no study obtained from the some Ethiopian regions, such as Afar Regional State and Benshangul-Gumuz Regional State and this might probably affect the generalizability of the present findings at a national level.

Conclusions

This review exhibited a higher percentage of occupational exposures to BBFs among HCWs in Ethiopia. The available evidences suggest that more than two-in-five and one-half of healthcare workers in Ethiopia were exposed to BBFs annually and in their lifetime, respectively.

Therefore, efforts should be implemented to reduce the high burden of occupational blood and body fluid exposures through effective implementation of standard precaution measures along with aggressive occupational health and safety activities.

Abbreviations

AOR: Adjusted odds ratio; BBFs: Blood and body fluids; HCWs: Healthcare workers; CI: Confidence interval; IPPS: Infection Prevention and Patient Safety; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Not Applicable

Consent for publication

Not Applicable

Availability of supporting data

All relevant data are within the manuscript and its supporting information files.

Competing interests

The author declares that he has no competing interests.

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Authors' Contribution

BS: Conceptualizes, design the study and data curation, performed the analysis, wrote and approved the final manuscript. YT: Data curation and performed the analysis, and approved the final manuscript DW: Contribute to the analysis, critically reviewed the manuscript and

approved the final manuscript. BJ: critically revised the manuscript and approved the final manuscript. All authors read and approved the final manuscript before submission.

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Reference

1. Westermann C, Peters C, Lisiak B, Lamberti M, Nienhaus A. The prevalence of hepatitis C among healthcare workers: a systematic review and meta-analysis. *Occup Environ Med.* 2015;72(12):880-8
2. Deuffic-Burban S, Delarocque-Astagneau E, Abiteboul D, Bouvet E, Yazdanpanah Y. Blood-borne viruses in health care workers: prevention and management. *J Clinical Virology.* 2011;52(1):4-10.
3. World Health Organization [Internet]. Health Care Worker Safety 2016. [cited 2020 March 23]. Available from: http://www.who.int/injection_safety/toolbox/en/AM_HCW_Safety_EN.pdf
4. Belyhun Y, Maier M, Mulu A, Diro E, Liebert UG. Hepatitis viruses in Ethiopia: a systematic review and meta-analysis. *BMC Infect Dis.* 2016;16(1):761.
5. Centers for Disease Control and Prevention (National Center for HIV, STD, and TB Prevention, Divisions of HIV/AIDS Prevention): Surveillance of Health Care Workers with HIV/AIDS [Internet]. [cited 2020 March 12]. Available <http://www.cdc.gov/hiv/pubs/facts/hcwsurv.htm>
6. Ippolito G, Puro V, Petrosillo N, De Carli G, Micheloni G, Magliano E. Simultaneous infection with HIV and hepatitis C virus following occupational conjunctival blood exposure. *Jama.* 1998; 280(1):28-28.
7. Jagger J, Perry J. Avoiding blood and body fluid exposures. *Nursing* 2019. 2002;32(8):68.
8. World Health Organization. The world health report 2002: reducing risks, promoting healthy life. World Health Organization; 2002.
9. Auta A, Adewuyi EO, Tor-Anyiin A, Aziz D, Ogbole E, Ogbonna BO, Adeloye D. Health-care workers' occupational exposures to body fluids in 21 countries in Africa: systematic review and meta-analysis. *Bull. World Health Organ.* 2017;95(12):831.
10. Zenbaba D, Bogale D, Sahiledengle B, Woldeyohannes D, Tekalegn Y. Prevalence and factors associated with needle-stick injuries and splash with blood and body fluids among healthcare workers in hospitals of Bale Zone, Southeast Ethiopia. *Ethiop Med J.* 2020;58(01).

11. Gebremariyam BS. Determinants of occupational exposure to blood and body fluids, healthcare workers' risk perceptions and standard precautionary practices: A hospital-based study in Addis Ababa, Ethiopia. *Ethiop J Health Dev.* 2019;33(1).
12. Sahiledengle B, Gebersilassie A, Desta H, Tadesse G. Infection prevention practices and associated factors among healthcare workers in governmental healthcare facilities in Addis Ababa, Ethiopia. *Ethiop J Health Sci.* 2018;28(2):177-86.
13. Geberemariyam BS, Donka G, Wordofa B. Assessment of knowledge and practices of healthcare workers towards infection prevention and associated factors in healthcare facilities of West Arsi District, Southeast Ethiopia: a facility-based cross-sectional study. *Arc Public Health.* 2018; 76:69.
14. Reda AA, Fisseha S, Mengistie B, Vandeweerd JM. Standard precautions: occupational exposure and behavior of health care workers in Ethiopia. *PLoS One.* 2010;5(12).
15. Zenbaba D, Sahiledengle B, Bogale D. Practices of Healthcare Workers regarding Infection Prevention in Bale Zone Hospitals, Southeast Ethiopia. *Adv Public Health.* 2020;2020.
16. Gebresilassie A, Kumei A, Yemane D. Standard precautions practice among health care workers in public health facilities of Mekelle special zone, Northern Ethiopia. *J Community Med Health Educ.* 2014;4(3):286.
17. Alemayehu T, Worku A, Assefa N. Medical waste collectors in eastern Ethiopia are exposed to high sharp injury and blood and body fluids contamination. *Prev Inf Cntrl.* 2016;2:2.
18. Belachew YB, Lema TB, Germossa GN, Adinew YM. Blood/body fluid exposure and needle stick/sharp injury among nurses working in public hospitals; Southwest Ethiopia. *Front Public Health.* 2017;5:299.
19. Yasin J, Fisseha R, Mekonnen F, Yirdaw K. Occupational exposure to blood and body fluids and associated factors among health care workers at the University of Gondar Hospital, Northwest Ethiopia. *Environ Health Prev Med.* 2019 ;24(1):18.
20. Amerga EW, Mekonnen TG. Occupational Exposure to Blood and Body Fluids among Health Care Workers in Arada Sub-city Health Centers of Addis Ababa, Ethiopia. *Occup Med Health Aff.* 2018;6(281):2.

21. Beyera GK, Beyen TK. Epidemiology of exposure to HIV/AIDS risky conditions in healthcare settings: the case of health facilities in Gondar City, North West Ethiopia. BMC Public Health. 2014;14(1):1283.
22. Kaweti G, Abegaz T. Prevalence of percutaneous injuries and associated factors among health care workers in Hawassa referral and adare District hospitals, Hawassa, Ethiopia, January 2014. BMC Public Health. 2015;16(1):8.
23. Shiferaw Y, Abebe T, Mihret A. Sharps injuries and exposure to blood and bloodstained body fluids involving medical waste handlers. Waste Manag Res. 2012;30(12):1299-305.
24. Yazie TD, Chufa KA, Tebeje MG. Prevalence of needlestick injury among healthcare workers in Ethiopia: a systematic review and meta-analysis. Environ Health Prev Med. 2019;24(1):52.
25. Moher D, Liberati A, Tetzlaff J, Altman DG. Group TP, Oxman A, Cook D, Guyatt G, Swinger G, Volmink J, Ioannidis J, Young C, Horton R, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009;6:e1000097.
26. The Joanna Briggs Institute. Critical appraisal tools for use in JBI systematic reviews checklist for prevalence studies: The University of Adelaide. [cited 2020 February 10]. Available from: https://joannabriggs.org/sites/default/files/2019-05/JBI_Critical_Appraisal_Checklist_for_Prevalence_Studies2017_0.pdf
27. Amare Z, Sheng W, Hussien A, Dawit. Assessment of knowledge, attribution and practice related to NSIS and blood exposure among health care workers in the armed forces referral and teaching hospital, Addis Ababa, Ethiopia. Int J Adv Res. 2018; 6(4), 110-119.
28. Tadesse M, Meskele M, Tadesse A. Occupational exposure to blood and body fluids among health care workers in Wolaita Zone, Southern Ethiopia. Developing Country Studies. 2016; 6(7): 70-77.
29. Yenesew MA, Fekadu GA. Occupational exposure to blood and body fluids among health care professionals in Bahir Dar town, Northwest Ethiopia. Saf Health Work. 2014;5(1):17-22.

30. Yakob E, Lamaro T, Henok A. Knowledge, attitude and practice towards infection control measures among Mizan-Aman general hospital workers, South West Ethiopia. J Community Med Health Educ. 2015;5(5):1-8.
31. Beyene H, Yirsaw BD. Occupational risk factors associated with needle-stick injury among healthcare workers in Hawassa City, Southern Ethiopia. Occup Med Health Aff. 2014;2(156):2.
32. Asmr Y, Beza L, Engida H, Bekelcho T, Tsegaye N, Aschale Y. Assessment of knowledge and practices of standard precaution against blood borne pathogens among doctors and nurses at adult emergency room in Addis Ababa, Ethiopia. Emerg Med Int. 2019;2019.
33. Gebremariam AA, Tsegaye AT, Shiferaw YF, Reta MM, Getaneh A. Seroprevalence of hepatitis B virus and associated factors among health professionals in University of Gondar Hospital, Northwest Ethiopia. Adv Prev Med. 2019;2019.
34. Desalegn Z, Gebreselassie S, Asemamaw Y. Epidemiology of needle stick-sharp injuries (NSSIs) and potential high risk exposures among health professionals in Ethiopia: neglected public health concern. Am J Health Res. 2015;3:298-304.
35. Jemaneh L. Assessment of knowledge, attitude and practice among health care workers regarding needle stick and sharp object injuries in Army force Referral and teaching hospital, Addis Ababa, Ethiopia (Doctoral dissertation, Addis Ababa University).
36. Desta B. Assessment of Knowledge, Attitude and Practice of Nurses Working in Adult and Pediatric ICU and Emergency Department Towards Standard Precautions at Tikur Anbesa Specialized Hospital from December 2016 To June 2017 (Doctoral dissertation, Addis Ababa University).
37. Aynalem Tesfay F, Dejenie Habtewold T. Assessment of prevalence and determinants of occupational exposure to HIV infection among healthcare workers in selected health institutions in Debre Berhan town, North Shoa Zone, Amhara Region, Ethiopia, 2014. AIDS Res Treat. 2014;2014.
38. Worku W. Hospital Acquired Infections and Infection Prevention Practice in Teaching Hospitals in the Amhara Regional State, Ethiopia (Doctoral dissertation, Addis Ababa University).

39. Hebo HJ, Gameda DH, Abdusemed KA. Hepatitis B and C viral infection: prevalence, knowledge, attitude, practice, and occupational exposure among healthcare workers of Jimma University Medical Center, southwest Ethiopia. *Sci World J.* 2019;2019.
40. Abeje G, Azage M. Hepatitis B vaccine knowledge and vaccination status among health care workers of Bahir Dar City Administration, Northwest Ethiopia: a cross sectional study. *BMC Infect Dis* 2015;15(1):30.
41. Tebeje B, Hailu C. Assessment of HIV post-exposure prophylaxis use among health workers of governmental health institutions in Jimma Zone, Oromiya Region, Southwest Ethiopia. *Ethiop J Health Sci.* 2010;20(1).
42. Mathewos B, Birhan W, Kinfe S, Boru M, Tiruneh G, Addis Z, Alemu A. Assessment of knowledge, attitude and practice towards post exposure prophylaxis for HIV among health care workers in Gondar, North West Ethiopia. *BMC Public Health.* 2013;13(1):508.
43. Akalu GT, Woldemariam AT, Shewaye AB, Geleta DA, Demise AH, Debele MT. Burden of hepatitis-B infections and risk factors among healthcare workers in resource limited setting, Addis Ababa, Ethiopia. *EC Microbiol.* 2016;4(4):722-31.
44. Yimechew Z, Tiruneh G, Ejigu T. Occupational exposures to blood and body fluids (BBFS) among health care workers and medical students in University of Gondar Hospital, Northwest of Ethiopia. *Glob J Med Res.* 2013 .
45. Damte M. Assessment of the Knowledge, Attitude and Practice of Health Care Workers on Universal Precaution in North Wollo Zone, Amhara Region, North Eastern Ethiopia, 2006 (Doctoral dissertation, Addis Abeba university).
46. Atlaw WD. Patterns of occupational exposure to patients' body fluids among health care workers in Tikuranbesa University Hospital, Addis Ababa, Ethiopia (Doctoral dissertation).
47. Gebreselassie FT. Investigating the compliance with universal precautions among health care providers in Tikur Anbessa Central Referral Hospital, Addis Ababa, Ethiopia (Doctoral dissertation, University of Western Cape).
48. Abreha N. Assessment of knowledge and practice towards infection prevention and associated factors among nurses working in adult and pediatric emergency in Tikur

- Anbessa specialized hospital, Addis Ababa, Ethiopia (Doctoral dissertation, Addis Ababa University).
49. Girmaye E. Belema D. Mamo K. Daba G. Assesment of Percutaneous Exposure Incidents and Associated Factors among Health Care Personnel in Gandhi Memorial Hospital, Addis Ababa. J Health Med Nurs. 2018; 52.
50. Alemu B. Awareness of Hiv Post-Exposure Prophylaxis Among Health Care Personnel in Asella Teaching Hospital, Asella Town, South-East Ethiopia (Doctoral dissertation, Addis Ababa University).
51. Chalya PL, Seni J, Mushi MF, Mirambo MM, Jaka H, Rambau PF, Kapesa A, Ngallaba SE, Massinde AN, Kalluvya SE. Needle-stick injuries and splash exposures among health-care workers at a tertiary care hospital in north-western Tanzania. Tanzan J Health Res. 2015;17(2).
52. Tarantola A, Koumare A, Rachline A, Sow PS, Diallo MB, Doumbia S, Aka C, Ehui E, Brücker G, Bouvet E, Groupe d'Etude des Risques d'Exposition des Soignants aux agents infectieux. A descriptive, retrospective study of 567 accidental blood exposures in healthcare workers in three West African countries. J Hosp Infect. 2005 ;60(3):276-82.
53. Bi P, Tully PJ, Boss K, Hiller JE. Sharps injury and body fluid exposure among health care workers in an Australian tertiary hospital. Asia Pac J Public Health. 2008;20(2):139-47.
54. Irmak Z, Baybuga MS. Needlestick and sharps injuries among Turkish nursing students: A cross-sectional study. Int J Nurs Pract. 2011;17(2):151-7.
55. Nwankwo TO, Aniebue UU. Percutaneous injuries and accidental blood exposure in surgical residents: Awareness and use of prophylaxis in relation to HIV. Niger J Clin Pract. 2011;14(1).
56. Fereidouni Z, Kameli Morandini M, Dehghan A, Jamshidi N, Najafi Kalyani M. The prevalence of needlestick injuries and exposure to blood and body fluids among Iranian healthcare workers: a systematic review. Int J Med Rev. 2018;5(1):35-40.

Figure and Figure legends

Fig.1: Flow diagram, systematic review, blood and body fluid exposure among healthcare workers in Ethiopia , 2007–2020

Fig.2: Meta-analysis, 12 month prevalence of blood and body fluid exposure among health-care workers in Ethiopia, 2007–2020

Fig.3: Meta-analysis, lifetime prevalence of blood and body fluid exposure among health-care workers in Ethiopia, 2007–2020

Fig.4: Publication bias of 12 month prevalence of BBFs exposure among HCWs in Ethiopia, 2007-2020.

Fig. 5: Publication bias of lifetime prevalence of BBFs exposure among HCWs in Ethiopia, 2007-2020.

Additional Files

Appendices A: PRISMA checklist

Appendices B: Examples of search strategy

Appendices C: The risk-of-bias assessment results for included studies

Appendices D: Sensitivity analysis for included studies of BBFs

Table 1: Studies identified in the systematic review on blood and body fluid exposure among health-care workers in Ethiopia, 2007–2020

Name	Year of publication	Study design	Study population	Setting	Sampling	Region	Sample size	Response rate	12-month prevalence of BBE exposure	Life time prevalence of BBE exposure	Risk of bias
Zenbaba D et al. [10]	2020	CS	HCWs & C	Hospitals	Simple Random	Oromia	394	97.5	44.9	60.2	L
Geberemariam BS et al.[13]	2018	CS	HCWs	Hospitals & Health Centers	Simple Random	Oromia	648	95.3		39	L
Reda AA et al. [14]	2010	CS	HCWs	Hospitals & Health Centers	Census	Harari and Dire Dawa	484	84.4	20.2	28.8	L
Geberemariam BS [11]	2019	CS	HCWs	Hospitals	Simple Random	Addis Ababa	277	85.7	29.2	42.6	L
Amare Z et al.[27]	2018	CS	HCWs	Hospital	Simple Random	Addis Ababa	200	100	38		L
Gebresilassie A et al. [16]	2014	CS	HCWs	Hospitals & Health Centers	Simple Random	Tigray	483	95.6	60.2		L
Kaweti and Abegaz [22]	2014	CS	HCWs	Hospitals	Simple Random	SNNP	496	94.3	46	28	L
Amerga and Mekonnen [20]	2018	CS	HCWs	Health Centers	Simple Random	Addis Ababa	361	93.2	40.2	47.4	L
Tadesse M et al. [28]	2016	CS	HCWs	Hospitals & Health Centers	Systematic sampling	SNNP	623	82	65.7	73.8	L
Yenesew and Fekadu [29]	2014	CS	HCWs	Hospitals & Health Centers	Simple Random	Amhara	317	95	65.9	76	L
Yakob E et al. [30]	2015	CS	HCWs	Hospital	Census	SNNP	135	93.8		45.2	L
Mengesha and Yirsaw [31]	2014	CS	HCWs	Hospitals & Health Centers	Census	SNNP	162	73.3		70.4	L
Asmr Y et al. [32]	2019	CS	HCWs	Hospitals	Simple Random	Addis Ababa	123	96.1		36.6	L
Gebremariam AA et al. [33]	2019	CS	HCWs	Hospital	Census	Amhara	332	100		81	L
Desalegn Z et al. [34]	2015	CS	HCWs	Hospitals	Convenience	Addis Ababa	254	100		72.8	M
Jemaneh L [35]	2014	CS	HCWs	Hospital	Convenience	Addis	146	97.9	27.9		M

						Ababa					
Desta B [36]	2017	CS	HCWs	Hospital	Convenience	Addis Ababa	142	90.4		57	M
Tesfay and Habtewold [37]	2014	CS	HCWs	Hospitals & Health Centers	Stratified sampling technique	Amhara	234	90.2	56.7		L
Beyera and Beyen [21]	2014	CS	HCWs	Hospitals & Health Centers	Simple Random	Amhara	401	95	40.4		L
Yallew WW [38]	2017	CS	HCWs	Hospitals	Simple Random	Amhara	413	97.8	56.7		L
Hebo HJ et al.	2019	CS	HCWs	Hospital	Simple Random	Oromia	230	95.8	43	60	L
Yasin J et al. [19]	2019	CS	HCWs	Hospital	Stratified sampling technique	Amhara	282	100	39	58.5	L
Alemayehu T et al.[17]	2016	CS	C	Hospitals & Health Centers	Multistage sampling	Harari	250	98.8	43.8		L
Abeje and Azage [40]	2015	CS	HCWs	Hospitals & Health Centers	Simple Random	Amhara	370	98.9		69.2	L
Sahiledengle B et al. [12]	2018	CS	HCWs	Hospitals & Health Centers	Stratified sampling technique	Addis Ababa	605	96.2	16.5	39.8	L
Tebeje and Hailu [41]	2010	CS	HCWs	Hospitals & Health Centers	Stratified sampling technique	Oromia	254	95.8		57.1	L
Mathewos B et al. [42]	2013	CS	HCWs	Hospital	Simple Random	Amhara	195	100		33.8	L
Akalu GT et al. [43]	2016	CS	HCWs & C	Hospital	Convenience	Addis Ababa	313	100		57.2	M
Yimechew Z et al.[44]	2013	CS	HCWs & C	Hospital	Stratified sampling technique	Amhara	252	88.4	62.3	70.2	L
Belachew YB et al. [18]	2017	CS	HCWs	Hospitals	Census	Oromia	318	93.3		62.6	L
Damta M [45]	2007	CS	HCWs & C	Hospitals & Health Centers	Simple Random	Amhara	351	93.4	20.2	45.8	L
Atlaw WD [46]	2013	CS	HCWs	Hospital	Stratified sampling	Addis Ababa	290	87.3	33.5	66.5	L

					technique						
Gebreselassie FT [47]	2009	CS	HCWs	Hospital	Simple Random	Addis Ababa	104	98.1	67.3		L
Abreha N [48]	2018	CS	HCWs	Hospital	Convenience	Addis Ababa	108	94.4		56.9	M
Girmaye E et al. [49]	2018	CS	HCWs & C	Hospital	Systematic sampling	Addis Ababa	244	100	34.4		L
Shiferaw Y et al., [23]	2012	CS	C	Hospitals	Census	Addis Ababa	126	100	67.5		L
Alemu B [50]	2014	CS	HCWs & C	Hospital	Convenience	Oromia	251	100		41	L

^L:Low risk of bias ; ^M:Moderate risk of bias ; ^{HCWs}:Healthcare workers ; ^C:Cleaners/ Waste handlers ; ^{CS}:Cross-sectional study design

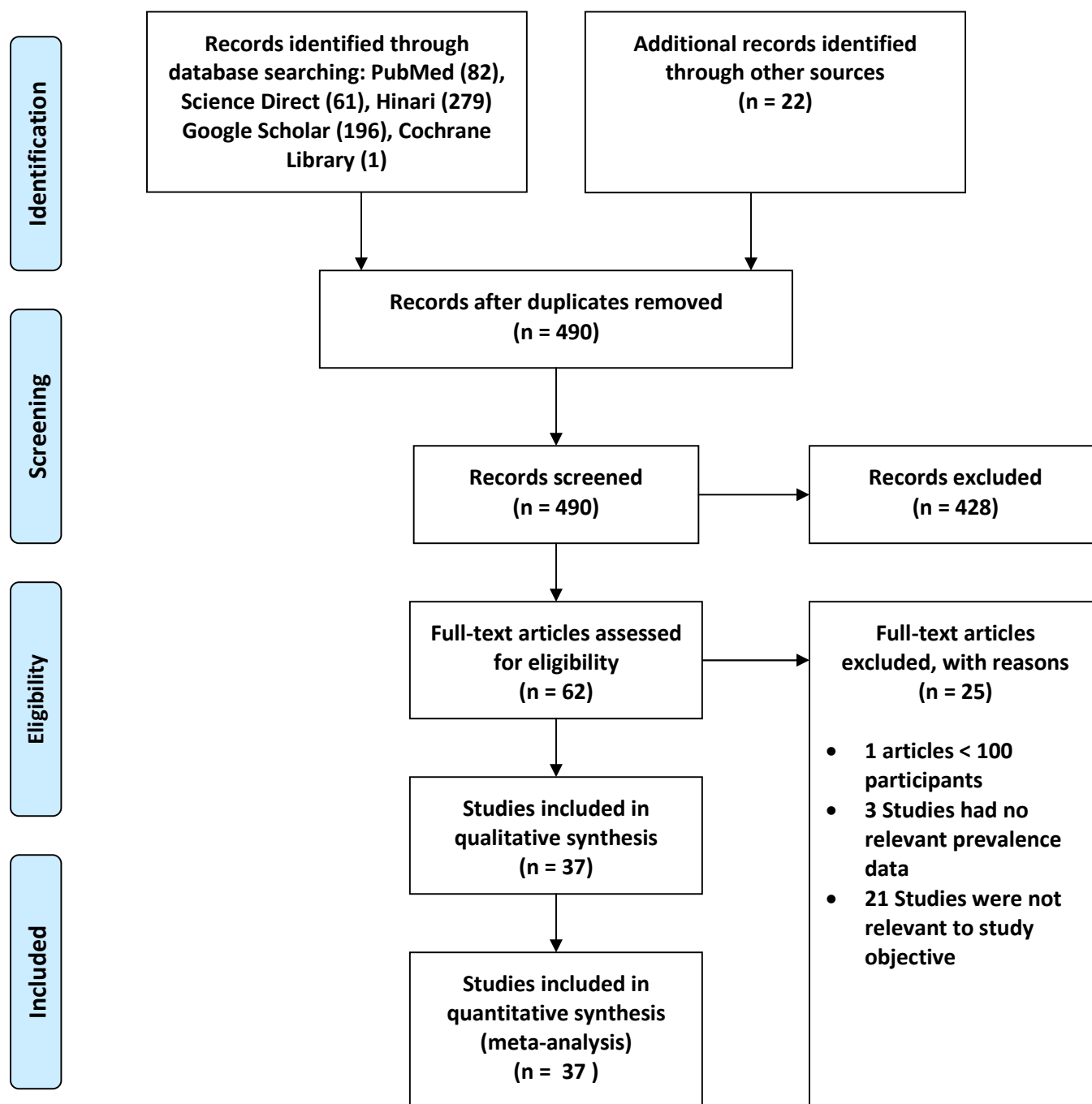
Table 2: Subgroup meta-analysis, blood and body fluid exposure among health-care workers in Ethiopia, 2007–2020

Prevalence type	Variables category	Subgroup	Number of studies included	Sample size	Prevalence (95% CI)	Heterogeneity across the studies	
						I ² (%)	P-value
Lifetime prevalence	Region	Addis Ababa	9	2,473	53.00(44.47-61.53)	94.7	<0.001
		Oromia	6	2,095	53.25(44.02-62.49)	94.6	<0.001
		Amhara	6	1,847	60.83(47.03-74.62)	97.7	<0.001
		SNNP	4	1,416	54.35(28.38-80.31)	99.1	<0.001
		Harari	1	484	28.80 (24.76-32.83)	-	-
	Type of healthcare facility	Hospital	16	4,140	53.81(45.45-62.16)	97.0	<0.001
		Hospital & health centers	9	3,814	55.50(43.15-67.84)	98.5	<0.001
		Health center	1	361	47.40(42.25-52.55)	-	-
	Publication year	2007-2014	9	2,800	49.67(36.85-62.49)	98.2	<0.001
		2015-2020	17	5,515	56.56(49.44-63.68)	96.8	<0.001
	Sample size	>=300	13	5,612	54.51(44.13-64.89)	98.6	<0.001
		<300	13	2,703	53.81(46.70-60.92)	93.4	<0.001
	Sampling technique	Probability	21	7,247	53.47(45.85-61.10)	98.0	<0.001
		Non-probability	5	1,068	57.02(45.74-68.29)	93.1	<0.001
	Risk of bias	Low	22	7,498	52.91 (45.53-60.30)	97.9	< 0.001
		Moderate	4	817	61.27(52.38-70.16)	85.2	< 0.001
A 12-month prevalence	Region	Addis Ababa	9	2,353	39.09(28.66-49.52)	96.8	<0.001
		Oromia	2	624	44.19(40.29-48.09)	0.0	0.644
		Amhara	7	2,250	48.69(35.53-61.85)	97.8	<0.001
		Tigray	1	483	60.20 (55.83-64.57)	-	-
		SNNP	2	1,119	55.89(36.58-75.19)	97.8	<0.001
		Harari	2	734	31.86(8.73-54.98)	-	-
	Type of healthcare facility	Hospital	13	3,454	45.19 (38.55-51.83)	94.5	<0.001
		Hospital & health centers	9	3,748	43.24(28.72-57.77)	99.0	<0.001
		Health center	1	361	40.20(35.14-45.26)	-	-
	Publication year	2007-2014	12	3,684	47.21(36.50-57.92)	98.0	<0.001
		2015-2020	11	3,879	41.04 (30.63-51.45)	98.0	<0.001
	Sample size	>=300	11	4,722	43.32(31.52-55.12)	98.8	<0.001
		<300	12	2,635	45.03(37.47-52.59)	94.1	<0.001
	Sampling technique	Probability	22	7,417	44.97 (37.50-52.44)	98.0	<0.001
		Non-probability	1	146	27.90 (20.63-35.17)	-	-
	Risk of bias	Low	22	7,417	44.97 (37.50-52.44)	98.0	<0.001
		Moderate	1	146	27.90 (20.63-35.17)	-	-

SNNP= South Nation Nationalities and Peoples

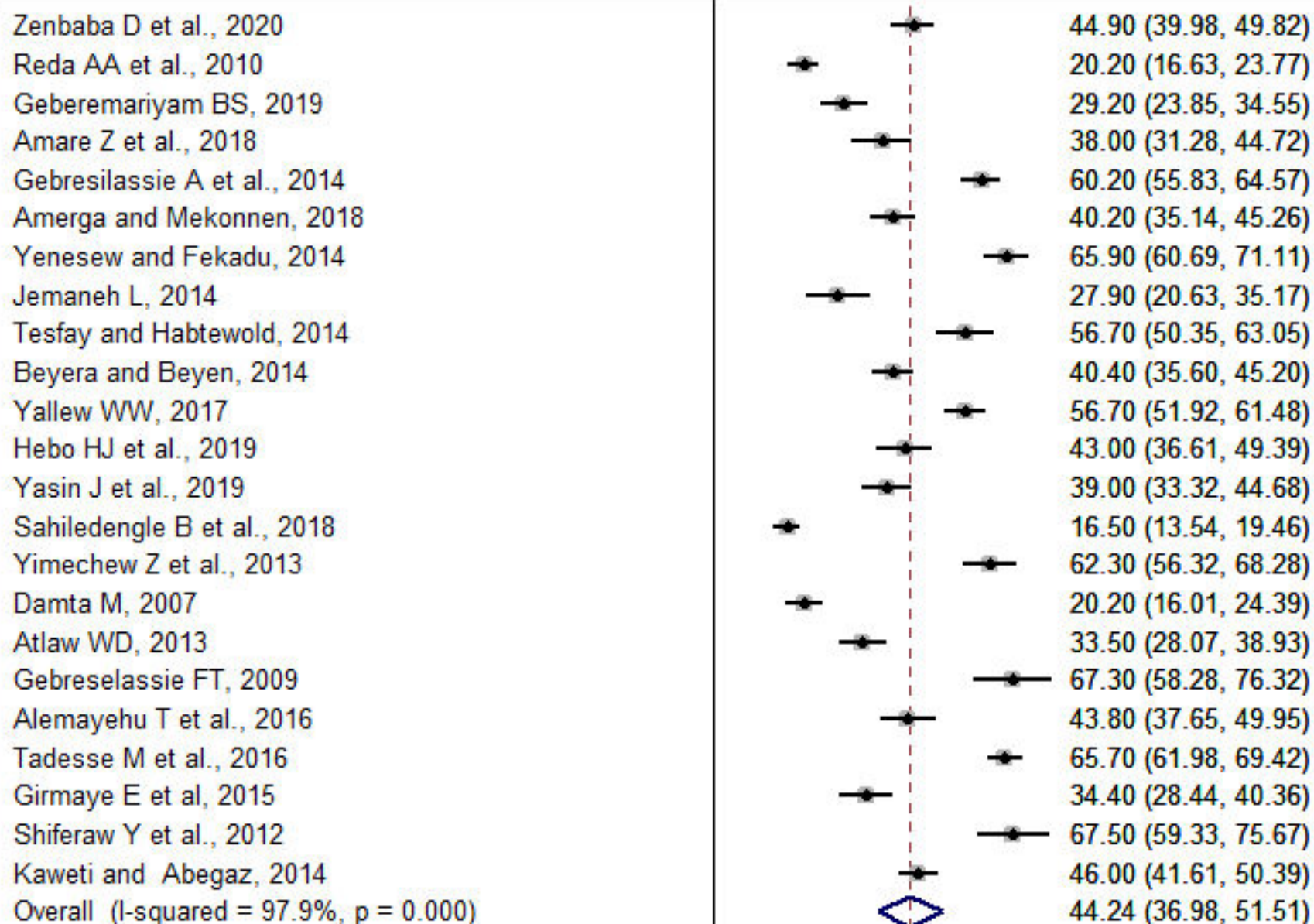
Table 3: A meta-regression analysis of factors for heterogeneity of the prevalence of blood and body fluid exposure among the healthcare workers in Ethiopia, 2007-2020.

Prevalence estimate	Heterogeneity source	Coefficients	Std. error	p-value
12 months	Publication year	-0.3185998	1.026952	0.76
	Sample size	-0.0190527	0.0242865	0.44
Lifetime	Publication year	0.7797819	0.940355	0.42
	Sample size	-0.0147593	0.020484	0.48



Study
ID

ES (95% CI)

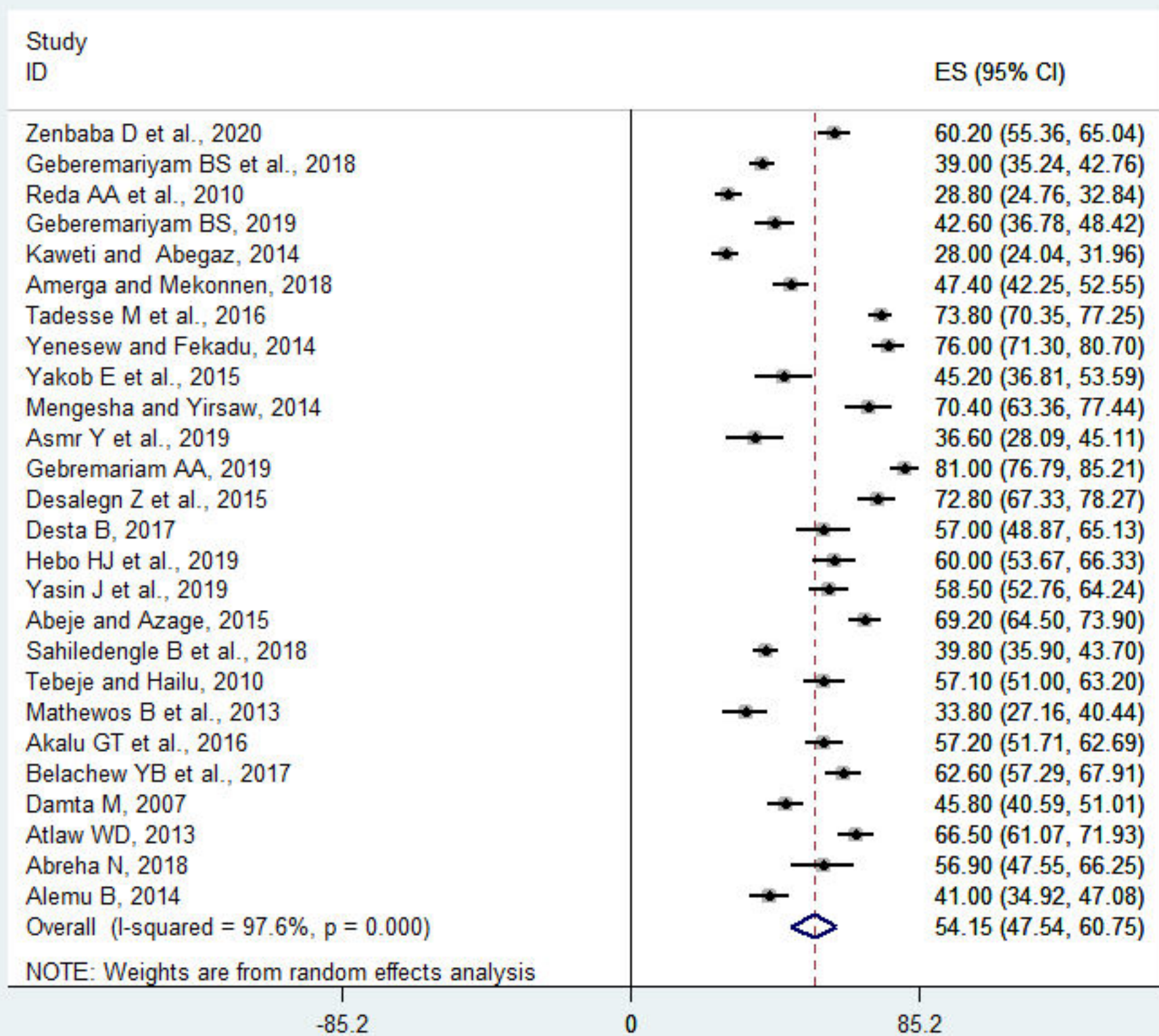


NOTE: Weights are from random effects analysis

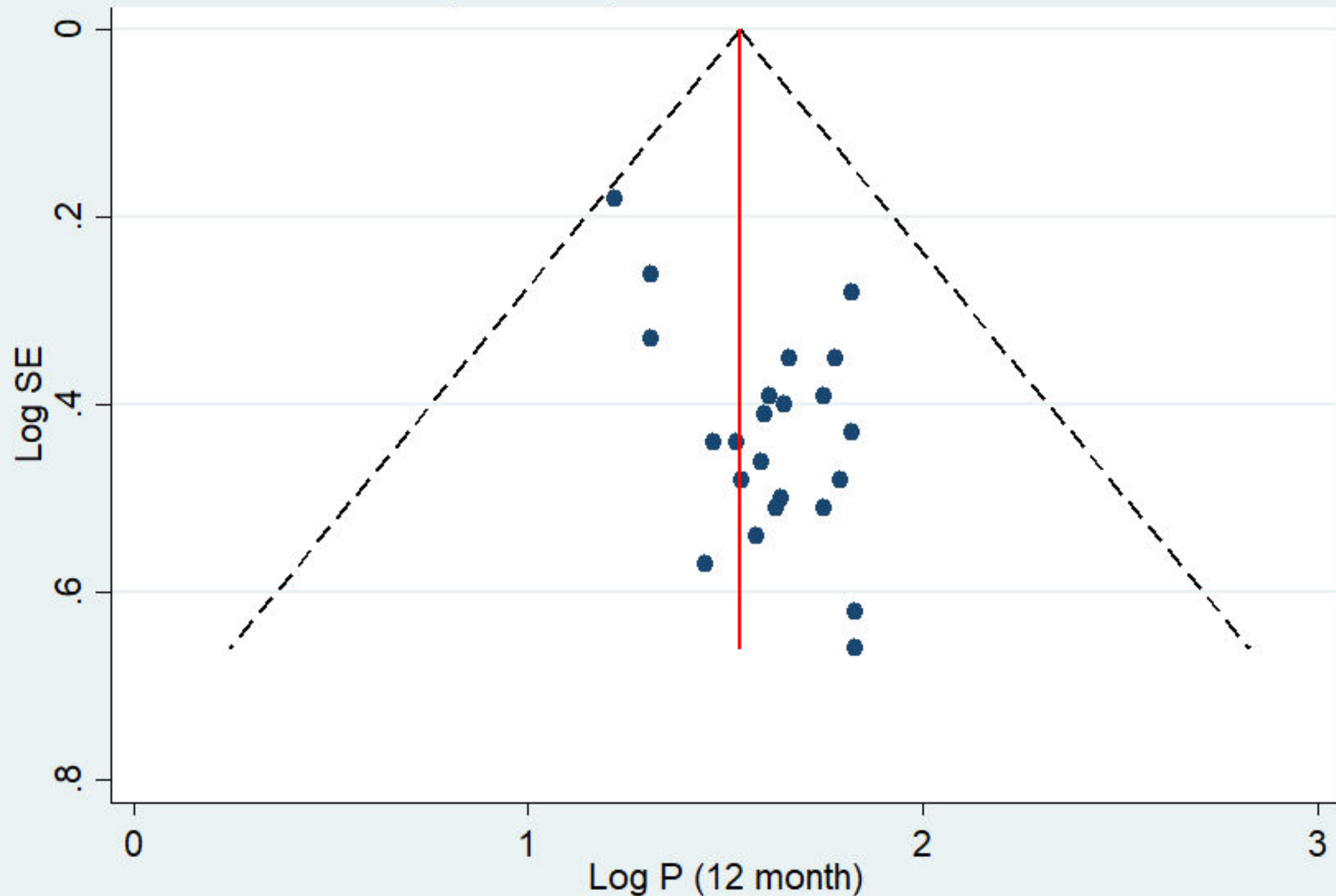
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Funnel plot with pseudo 95% confidence limits



Funnel plot with pseudo 95% confidence limits

