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Asa Auta et al.

Body fluid exposure in African health-care workers

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Health-care workers' occupational exposures to body fluids in 21 countries in Africa: systematic review and meta-analysis

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Abstract

Objective To estimate the lifetime and 12-month prevalence of occupational exposure to body fluids among health-care workers in Africa.

Methods Embase®, PubMed® and CINAHL databases were systematically searched for studies published from January 2000 to August 2017 that reported the prevalence of occupational exposure to blood or other body fluids among health-care workers in Africa. The continent-wide prevalence of exposure was estimated using random-effects meta-analysis.

Findings Of the 904 articles identified, 65 studies from 21 African countries were included. The estimated pooled lifetime and 12-month prevalence of occupational exposure to body fluids were 65.7% (95% confidence interval, CI: 59.7–71.6) and 48.0% (95% CI: 40.7–55.3), respectively. Exposure was largely due to percutaneous injury, which had an estimated 12-month prevalence of 36.0% (95% CI: 31.2–40.8). The pooled 12-month prevalence of occupational exposure among medical doctors (excluding surgeons), nurses (including midwives and nursing assistants) and laboratory staff (including laboratory technicians) was 46.6% (95% CI: 33.5–59.7), 44.6% (95% CI: 34.1–55.0) and 34.3% (95% CI: 21.8–46.7), respectively. The risk of exposure was higher among health-care workers with no training on infection prevention and those who worked more than 40 hours per week.

Conclusion The evidence available suggests that almost one half of health-care workers in Africa were occupationally exposed to body fluids annually. However, a lack of data from some countries was a major limitation. National governments and health-care institutions across Africa should prioritize efforts to minimize occupational exposure among health-care workers.

Introduction

Worldwide, health-care workers risk occupational exposure to blood-borne pathogens through contact with human body fluids. Although more than 60 blood-borne infectious pathogens have been identified, including Epstein–Barr virus, most occupation-related, blood-borne infections are due to hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV).^{1,2} However, other blood-borne pathogens still pose a risk: for example, in the 2013–2016 Ebola virus disease outbreak, over 890 health-care workers were infected, with a case fatality rate of 57%.³ Occupational exposure can occur through percutaneous injury (i.e. a needle or sharp object penetrates the skin), mucous membrane exposure (e.g. of the eyes, nose or mouth) and non-intact skin exposure. Percutaneous injury accounts for 66 to 95% of occupational exposures to blood-borne pathogens.⁴

Little is known about the global burden of percutaneous injury among health-care workers. However, a 2005 report estimated that worldwide more than 3 million occupation-related percutaneous injuries occur annually.⁴ Moreover, about 40% of HBV and HCV infections and 2.5% of HIV infections in health-care workers were due to percutaneous injuries.⁵ Hence, each year, percutaneous injury resulted in around 66 000 HBV infections, 16 000 HCV infections and 1000 HIV infections, which together caused about 1100 deaths as well as substantial disability.⁴ More than 90% of these infections occurred in developing countries, particularly in Africa, where infection is more prevalent and adherence to standard precautions can be poor.⁵

Given the severe consequences of blood-borne infections, many high-income countries have established surveillance systems to monitor exposure to body fluids in health-care settings.⁶ These systems help inform policy-makers for reducing the risk of transmission of blood-borne pathogens. In many African countries, such systems are not available and, consequently, exposure to body fluids is rarely monitored. Furthermore, occupational exposure of health-care workers in Africa is generally underreported and poorly documented – one Nigerian study found that up to 97% of exposures were not reported.⁷

The true incidence of blood and body fluid exposure in Africa is, therefore, uncertain. The 2005 report estimated that the incidence of sharps injuries in individual health-care workers in Africa was 2.10 per annum.⁴ However, the authors based the estimate on survey findings from eight African countries and did not include data on laboratory technicians or other auxiliary health-care workers. Moreover, the authors obtained the data in hospitals and may not be representative of the diverse range of health-care settings in the continent. A

Congolese study found an annual prevalence of occupational exposure to body fluids among health-care workers of 44.9%, with an average of 1.38 exposures per health-care worker per year.⁸ A Burundian study reported an annual prevalence of 67.6%, with an average of 2.7 exposures per health-care worker per year.⁹

Here we conducted a systematic review of observational studies to estimate the prevalence of occupational exposure to blood and body fluids among health-care workers in Africa, because a continent-wide estimate would help increase awareness of such exposure and prompt preventative measures.

Methods

We searched the Embase®, CINAHL and PubMed® databases on 1 September 2017 for original research articles published between January 2000 and August 2017 that reported the prevalence of occupational exposure to blood or other body fluids among health-care workers in Africa. The following search terms were combined with others using Boolean operators: “occupational exposure”, “accidental exposure”, “blood”, “body fluid”, “blood-borne pathogens”, “health-care workers”, “health workers”, “health personnel” and “Africa” (Box 1; available at: <http://www.who.int/bulletin/volumes/95/##/##-#####>). Additional articles were identified by checking reference lists and by Google and Google Scholar searches. There were no language restrictions. The research protocol was registered in the PROSPERO international prospective register of systematic reviews (CRD42017054288).

For this review, we considered occupational exposure to body fluids to occur through percutaneous injury, mucous membrane exposure, non-intact skin exposure and bites. We included studies that reported the lifetime or 12-month prevalence of occupational exposure through at least one of these routes. Health-care workers included all paid and unpaid individuals working in a health-care setting who could be exposed to infectious materials, including blood and body fluids. Hence, we included studies that involved doctors, nurses, laboratory technicians, auxiliary health-care workers or students undertaking clinical training or gaining experience in health-care settings. In addition, we included studies if they were observational studies with either a cohort or cross-sectional design. We excluded case reports, case series, case-control studies, qualitative studies, studies with fewer than 100 participants and, because of historic underreporting in Africa, studies that reviewed reported cases of blood and body fluid exposure. Two reviewers independently screened studies against inclusion and exclusion criteria (kappa for inter-rater agreement: 90.8%). Discrepancies were resolved by consensus.

The quality of each study was assessed and the risk of bias was judged using eight parameters, modelled largely on the Joanna Briggs Institute's critical appraisal framework for prevalence studies: the sampling frame, sample size, sampling strategy, detailed description of research setting and population, response rate (adequate if 60% or higher), reliability of the instrument used, recall bias (12 months or shorter) and statistical analysis methods – failure to satisfy each parameter was scored as 1.¹⁰ The risk of bias was classified as either low (total score: 0 to 2), moderate (total score: 3 or 4) or high (total score: 5 to 8).

Two reviewers extracted data from the studies and entered them into Microsoft Excel v. 16.0 (Microsoft Corporation, Redmond, United States of America). The data included: (i) author; (ii) year of publication; (iii) study country; (iv) sample size; (v) response rate; (vi) recall period; (vii) prevalence of blood and body fluid exposure; (viii) prevalence of percutaneous injury; (ix) prevalence of mucous membrane and non-intact skin exposure; (x) prevalence of blood and body fluid exposure by health staff category; and (xi) the proportions of cases due to needle-stick injury, splashes, cuts and bites. Any discrepancy was resolved by consensus.

Data analysis

We categorized studies by whether they measured lifetime or 12-month prevalence and by the type of blood and body fluid exposure considered: (i) all types, including percutaneous injury and mucous membrane exposure; or (ii) percutaneous injury only. Generally, we estimated lifetime prevalence using data from studies that reported the proportion of participants exposed to body fluids at any time during their career. Twelve-month prevalence was estimated using data from studies that reported the proportion of participants exposed to body fluids in the preceding 12 months. We derived pooled prevalence estimates of blood and body fluid exposure by random-effects meta-analysis based on the DerSimonian–Laird approach.¹¹ We assessed the robustness of our findings in sensitivity analyses that excluded studies with a high risk of bias.

Interstudy heterogeneity was assessed by Cochran's Q , which gives values for X^2 and P , and the percentage of the total variation across studies due to heterogeneity was estimated using Higgin's I^2 statistic.¹² The causes of heterogeneity were explored in subgroup and meta-regression analyses. We considered the covariates: (i) geographical region; (ii) type of health-care facility; (iii) study period; (iv) sampling procedure (i.e. random versus convenience sampling); (v) sample size; (vi) proportion of doctors; (vii) proportion of nurses; (viii) proportion of laboratory staff; and (ix) the risk of bias classification. Only those covariates found to be significant at $P < 0.10$ were included in the multivariate model. In

addition, the pooled prevalence of blood and body fluid exposure in different categories of health-care worker were derived in stratified analyses and the relative risk of occupational exposure between groups was determined by pooling data using a random-effects model. We performed all statistical analyses Stata version 13.1 (StataCorp LP., College Station, USA).

Results

We identified 904 articles through the literature search, of which 65 were eligible for inclusion: they reported on cross-sectional observational studies involving a total of 29 385 health-care workers from 21 African countries (Fig. 1).^{7–9,13–74} Of the 65 studies, 30 were conducted in eastern Africa, 18 in western Africa, eight in northern Africa, five in southern Africa and four in central Africa (Table 1). Thirty-nine studies were done solely among hospital staff, 39 investigated blood and body fluid exposure through all routes and 26 investigated exposure through percutaneous injury only. We found low risk of bias in 37 studies, moderate risk in 25 and high risk in 3; in 44 studies, the increased risk of bias was largely due to sampling bias.

Twenty-one studies presented data on the lifetime prevalence of all types of occupational exposure to blood and body fluids, including percutaneous injury and mucous membrane exposure, among health-care workers in Africa (Table 1). Lifetime prevalence varied widely from 29.1% (95% confidence interval, CI: 23.1–35.1) in Burkina Faso⁵⁰ to 89.2% (95% CI: 87.3–91.1) in Morocco (Fig. 2).²⁹ Overall, the estimated pooled lifetime prevalence was 65.7% (95% CI: 59.7–71.6). The regional prevalence estimate was highest for northern Africa: 82.9% (95% CI: 70.6–95.2). For percutaneous injury only, the lifetime prevalence ranged from 37.0% (95% CI: 34.0–40.0) in a Tanzanian study⁷¹ to 82.0% (95% CI: 78.7–85.3) in a Ugandan study (Fig. 3).¹⁹ Overall, the estimated pooled lifetime prevalence of percutaneous injury was 54.4% (95% CI: 48.4–60.3). After excluding studies with a high risk of bias, the estimated pooled lifetime prevalence of all types of exposure to blood and body fluids and of percutaneous injury only was 65.1% (95% CI: 59.0–71.3) and 53.6% (95% CI: 47.3–60.0), respectively, figures which were comparable to the overall pooled estimates.

The 12-month prevalence of all types of occupational exposure to blood and body fluids ranged from 17.0% (95% CI: 15.3–18.7) in a Kenyan study²⁰ to 67.6% (95% CI: 61.4–73.8) in a Burundian study (Fig. 4).⁹ The estimated pooled 12-month prevalence was 48.0% (95% CI: 40.7–55.3). Regional pooled estimates ranged from 33.9% (95% CI: 16.5–51.4) in southern Africa to 60.7% (95% CI: 56.9–64.5) in northern Africa. Twenty-eight studies

reported the 12-month prevalence of percutaneous injury: it ranged from 16.4% (95% CI: 10.6–22.2) to 67.9% (95% CI: 64.3–71.5; Fig. 5). The pooled estimate was 36.0% (95% CI: 31.2–40.8). Seven studies provided disaggregated data on the 12-month prevalence of mucous membrane exposure: the pooled estimate was 18.2% (95% CI: 12.6–23.7).

In Fig. 6 (available at: <http://www.who.int/bulletin/volumes/95/###/###-#####>), the slopes of the fitted lines suggest that the 12-month prevalence of both all types of exposure to blood and body fluids and of percutaneous injury decreased only gradually over the study period. The estimated pooled 12-month prevalence for studies published between 2010 and 2017 was 47.3% (95% CI: 41.5–53.1) for all types of exposure and 33.7% (95% CI: 28.2–39.2) for percutaneous injury (Table 2; available at: <http://www.who.int/bulletin/volumes/95/###/###-#####>). These estimates were comparable to the overall estimated pooled 12-month prevalence for all types of exposure and percutaneous injury, which were 48.0% (95% CI: 40.7–55.3) and 36.0% (95% CI: 31.2–40.8), respectively.

Overall, substantial heterogeneity was observed among the studies for the estimated 12-month prevalence of all types of exposure to blood and body fluids (X^2 : 1816.5; $P < 0.001$; I^2 : 98.7%) and of percutaneous injury only (X^2 : 780.9; $P < 0.001$; I^2 : 96.5%). Meta-regression analysis showed that, of all the covariates explored in the bivariate analyses, only geographical region had a P -value less than 0.10: geographical region explained 17.6% of the between-study variation in the estimated 12-month prevalence of percutaneous injury.

Subgroup analyses

As many of the studies included disaggregated data, we were able to estimate: (i) the pooled 12-month prevalence of occupational exposure to blood and body fluids by job category; and (ii) the relative risk of all types of exposure to blood and body fluids or of percutaneous injury between various demographic groups, which were distinguished, for example, by job category, gender, years of working experience or receipt of training on prevention of blood and body fluid exposure (details available from the corresponding author). The estimated pooled 12-month prevalence of exposure to blood and body fluids for medical doctors (excluding surgeons), nursing staff (including midwives and nursing assistants) and laboratory staff (including laboratory technicians) was 46.6% (95% CI: 33.5–59.7), 44.6% (95% CI: 34.1–55.0) and 34.3% (95% CI: 21.8–46.7), respectively. Moreover, when data on percutaneous injuries were included, there was no significant difference in the risk of all types of occupational exposure between these job categories: the relative risk (RR) was 1.108 (95% CI: 0.926–1.326) for doctors versus nursing staff, 1.267 (95% CI: 0.733–2.193) for doctors versus laboratory staff and 1.332 (95% CI: 0.947–1.874) for nursing staff versus

laboratory staff. Nor was there a significant difference in risk between males and females (RR: 0.886; 95% CI: 0.692–1.133).

In addition, when data on percutaneous injuries were included, there was no significant difference in the risk of all types of occupational exposure between health-care workers with 5 years or less working experience and those with more than 5 years (RR: 0.999; 95% CI: 0.831–1.202). In contrast, health-care workers who worked 40 hours or more per week were significantly more likely to be exposed than those who worked fewer hours (RR: 2.221; 95% CI: 1.001–4.926). Six studies reported on health-care workers who had received training on infection prevention and occupational exposure to blood and body fluids. The risk of occupational exposure in the preceding 12 months among health-care workers without training was significantly higher than in trained staff (RR: 1.791, 95% CI: 1.234–2.071).

Discussion

We found a high lifetime and 12-month prevalence of occupational exposure to blood and body fluids among health-care workers in Africa: about two thirds were exposed during their entire career and almost one half were exposed each year. Most exposure was due to percutaneous injury, which had an estimated 12-month prevalence of 36.0%. Direct comparison of our findings with those in other continents was difficult because of a lack of similar, continent-wide systematic reviews and meta-analyses. Nevertheless, the high prevalence of percutaneous injury among health-care workers in Africa has serious implications because most occupational exposure to blood-borne viruses, such as HBV and HIV, occurs via this route. This can have implications for the exposed health-care worker's health, the transmission of blood-borne viruses to patients and the availability of scarce human resources for health care in Africa.

We found a variation in health-care workers' exposure to blood and body fluids across Africa. Occupational exposure to blood and body fluids and percutaneous injury were consistently more frequent in northern Africa and less frequent in southern Africa. The reason for these regional differences is not clear. One possible explanation is that blood and body fluid exposure was underreported in some studies, which is likely. Alternatively, our findings may reflect regional differences in the level of knowledge of occupational exposure or in adherence to standard precautions.

Our meta-analysis found that the 12-month prevalence of blood and body fluid exposure differed little between various professions and there was no significant difference in

risk. A critical appraisal of the literature showed that these figures may have been influenced by differences in study methods and in the categorization of health-care workers but most discrepancies observed were linked to the underreporting of blood and body fluid exposure.^{75,76} In contrast, we found that the risk of blood and body fluid exposure was higher among health-care workers who had received no training on infection prevention, which is unsurprising because training improves knowledge and preventive practice. Furthermore, the risk of occupational exposure was also increased among staff who worked more than 40 hours per week. The acute shortage of health-care workers in Africa may, therefore, have contributed to the present findings.⁴ Inadequate staffing often results in a high patient-to-staff ratio, which may in turn lead to staff having to work longer hours to bridge gaps in personnel.⁷⁷ Although longer hours can bring additional rewards for health-care workers, levels of stress and fatigue can increase, which may result in overworked staff becoming less alert and more susceptible to exposure to blood and body fluids.⁷⁷ Our findings may therefore indicate the need not only to promote the safety and well-being of existing health-care workers in Africa but also to address the acute shortage of health-care workers across the continent.

Our study also highlights the need to step-up efforts to reduce occupational exposure to blood and body fluids – particularly via percutaneous injury – among health-care workers in Africa. Percutaneous injury could be prevented by practical interventions such as safety engineered devices, including needleless intravenous systems, auto-disable syringes and blunt suture needles. However, our findings suggest that it may be more cost-effective to address factors contributing to increased exposure in the continent, such as a lack of training and long work hours. Regular in-service training for health-care workers could help promote standard precautions for preventing the transmission of blood-borne infection, such as hand hygiene, the use of personal protective equipment and techniques for minimizing the manipulation of sharps, including the avoidance of needle recapping. In addition to training health-care workers, a holistic strategy is needed to address the acute shortage of health-care workers in the continent and to monitor staff workload. Furthermore, standard precautions could be supplemented by educating health-care workers to take responsibility for their own health and safety and for that of others who may be affected by their actions at work. Finally, governments should provide policies and support systems for the surveillance, reporting and management of occupational exposure to blood and body fluids among health-care workers.

This study has some limitations. First, the cross-sectional design of the studies reviewed does not allow causal relationships to be established. Second, because the studies

reviewed were based on self-reported retrospective data, they may be prone to recall and social desirability biases. Therefore, it is likely that exposure was underreported in many studies. Third, our review included single or limited reports from some countries and many reports concerned regional studies that were not nationally representative of the study countries. These factors may affect the generalizability of our findings. Furthermore, our review would have benefited from the inclusion of studies from Guinea, Liberia and Sierra Leone, where there was substantial transmission of Ebola virus infection among health-care workers during the recent outbreak. However, no studies of the prevalence of occupational exposure to blood and body fluids among health-care workers in these countries have been published. Future research in these countries should investigate occupational exposure to blood and body fluids and the circumstances in which it occurs to inform policy and practice. Nevertheless, our study provides an insight into the burden of occupational exposure to blood and body fluids among health-care workers in Africa and could prompt the development of appropriate policies, systems and processes in the continent.

Competing interests:

None declared.

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Box 1. Search strategy, systematic review, blood and body fluid exposure among health-care workers in Africa, 2000–2017

1. (Occupation* exposure OR Accident* exposure OR Occupation* disease OR Accidental blood disease* OR Accidental occupational exposure OR Occupational hazard* OR Occupational transmission OR Cross infection).af.
2. (Blood OR Body fluid* OR blood spill* OR needle injur* OR Blood borne pathogen* OR Sharps* OR Needlestick injur* OR Needle stick OR Blood-borne infection* OR percutaneous injur* OR mucus membrane exposure* OR non-intact skin exposure* OR bite* OR cut* OR Human immunodeficiency virus OR HIV OR Hepatitis B OR Hepatitis C).af.
3. (Health care worker* OR Nurse* OR Midwife* OR Physician* OR Surgeon* OR Doctor* OR Health personnel OR Health worker* OR Dentist* OR Health staff OR Medical personnel OR Health personnel OR Health officer*).af.
4. (Africa OR Nigeria OR Senegal OR Morocco OR South Africa OR Ethiopia OR Kenya OR Mauritius OR Mauritania OR Tanzania OR Congo OR Algeria OR Tunisia OR Libya OR Ghana OR Madagascar OR Gabon OR Cameroon OR Mali OR Zimbabwe OR Sudan OR Uganda OR Somalia OR Namibia OR Angola OR Mozambique OR Rwanda OR Eritrea OR Burkina Faso OR Gambia OR Zambia OR Botswana OR Guinea OR Djibouti OR Niger OR Malawi OR Togo OR Liberia OR Benin OR Sierra Leone OR Swaziland OR Côte d'Ivoire OR Chad OR Seychelles OR Cape Verde OR Burundi OR Lesotho).af.
5. 1 AND 2 AND 3 AND 4
6. Limit 5 to yr = "2000–Current"

Table 1. Studies identified in the systematic review on blood and body fluid exposure among health-care workers in Africa, 2000–2017

Study authors and year	Country and continental region	Data reported	Study participants and setting ^a	Prevalence of all types of exposure to BBF, %	Prevalence of PCI, %	Risk of bias ^b
Newsom and Kiwanuka, ¹³ 2002	Uganda, eastern Africa	12-month prevalence of PCI	180 doctors, nurses and laboratory staff in Mbarara Teaching Hospital	N/A	12-month: 55.0	Low
Le Pont et al., ⁹ 2003	Burundi, central Africa	Lifetime and 12-month prevalence of all types of exposure to BBF and disaggregated PCI data	219 doctors, nurses, nursing assistants and auxiliary staff in Kamenge University Hospital, Bujumbura	Lifetime: 79.5; 12-month: 67.6	12-month: 55.0	Low
Talaat et al., ¹⁴ 2003	Egypt, northern Africa	Lifetime prevalence of PCI	1845 doctors, dentists, nurses and laboratory and auxiliary staff in 98 health-care facilities (i.e. government hospitals, primary care facilities and private facilities) in two Governorates (Nile Delta and Upper Egypt)	N/A	Lifetime: 69.4	Moderate
Bodkin and Bruce, ¹⁵ 2003	South Africa, southern Africa	12-month prevalence of PCI	159 doctors, nurses and medical and nursing students in a teaching hospital in Gauteng	N/A	12-month: 16.4	Low
Tarantola et al., ¹⁶ 2005	Côte d'Ivoire, Mali and Senegal, western Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	1241 doctors, nurses, laboratory staff and clinical students in 43 hospital departments and transfusion clinics in Abidjan (Côte d'Ivoire), Bamako (Mali) and Dakar (Senegal)	12-month: 45.7	12-month: 38.1	Moderate
Ismail et al., ¹⁷ 2005	Egypt, northern Africa	Lifetime prevalence of PCI	1100 doctors and nurses in 7 hospitals and 18 primary health-care centres in Gharbiya Governorate	N/A	Lifetime: 66.2	Moderate
Obi et al., ¹⁸ 2005	Nigeria, western Africa	Lifetime prevalence of PCI	264 surgeons in five tertiary health institutions in south-eastern Nigeria	N/A	Lifetime: 66.7	Moderate
Nsubuga and Jaakkola, ¹⁹ 2005	Uganda, eastern Africa	Lifetime and 12-month prevalence of PCI	526 nurses and midwives in Mulago national referral hospital in Kampala, Uganda	N/A	Lifetime: 82; 12-month: 57	Low
National AIDS and STD Control Programme, ²⁰ 2006	Kenya, eastern Africa	12-month prevalence of all types of exposure to BBF	1897 doctors, clinical officers, nurses, laboratory technicians, social workers and other support staff across a nationally representative sample of 247 health-care facilities	12-month: 17.0	ND	Low
Ibekwe and Ibeziako, ⁷ 2006	Nigeria, western Africa	Lifetime prevalence of PCI	246 doctors, nurses, laboratory technicians and ward attendants in University of Nigeria Teaching Hospital, Enugu	N/A	Lifetime: 53.7	High
Braka et al., ²¹ 2006	Uganda, eastern Africa	Lifetime prevalence of PCI	311 doctors, dental staff, nurses, laboratory staff, midwives and auxiliary staff in 48 districts in Uganda	N/A	Lifetime: 77.2	Low

Kabbash et al., ²² 2007	Egypt, northern Africa	12-month prevalence of PCI	317 doctors and nurses from 32 haemodialysis units in the Nile delta	N/A	12-month: 48.6	Low
Sofola et al., ²³ 2007	Nigeria, western Africa	Lifetime prevalence of all types of exposure to BBF	153 clinical dental students in four dental training institutions in Lagos, Ibadan, Ife and Benin	Lifetime: 58.8	ND	Moderate
De Villiers et al., ²⁴ 2007	South Africa, southern Africa	Lifetime prevalence of all types of exposure to BBF	228 doctors in public and private practice in Bloemfontein	Lifetime: 54.2	ND	Low
Taegtmeier et al., ²⁵ 2008	Kenya, eastern Africa	12-month prevalence of PCI	554 doctors, nurses and counsellors in 11 health facilities: two hospitals, eight health centres and one dispensary, Thika District	N/A	12-month: 30	Low
Laraqui et al., ²⁶ 2008	Morocco, northern Africa	Lifetime and 12- month prevalence of all types of exposure to BBF	2086 doctors, nurses and laboratory and support staff in 10 hospitals in 10 cities	Lifetime: 76.6; 12-month: 58.9	ND	Low
Okeke et al., ²⁷ 2008	Nigeria, western Africa	Lifetime prevalence of PCI	346 medical students in a university	N/A	Lifetime: 48	Moderate
Manyele et al., ²⁸ 2008	United Republic of Tanzania, eastern Africa	Lifetime prevalence of all types of exposure to BBF and disaggregated data on PCI	430 nurses and attendants in 14 district, regional and referral hospitals	Lifetime: 74.6	Lifetime: 52.9	Moderate
Laraqui et al., ²⁹ 2009	Morocco, northern Africa	Lifetime and 12- month prevalence of all types of exposure to BBF	1002 doctors, nurses and support staff in four hospitals in the cities of Meknes, Taza, Tiznit and Rabat	Lifetime: 89.2; 12-month: 62.8	ND	Low
Reda et al., ³⁰ 2010	Ethiopia, eastern Africa	Lifetime and 12- month prevalence of all types of exposure to BBF and disaggregated data on PCI	484 doctors, nurses, midwives, laboratory technicians, health officers and assistants in 10 hospitals and 20 health centres, eastern Ethiopia	Lifetime: 85.0; 12-month: 51.2	Lifetime: 56.2; 12-month: 31.0	Low
Tadesse and Tadesse, ³¹ 2010	Ethiopia, eastern Africa	Lifetime and 12- month prevalence of PCI	366 nurses and laboratory technicians in 26 health facilities including a university teaching hospital and one private hospital in Awassa City, southern Ethiopia	N/A	Lifetime: 49.2; 12-month: 30.9	Low
Tebeje and Hailu, ³² 2010	Ethiopia, eastern Africa	Lifetime prevalence of all types of exposure to BBF and disaggregated data on PCI	254 doctors, nurses, midwives, laboratory technicians and health officers in government health facilities in Jimma zone and Jimma City	Lifetime: 68.5	Lifetime: 41.3	Moderate
Azodo, ³³ 2010	Nigeria, western Africa	Lifetime prevalence of PCI	300 dentists across Nigeria	N/A	Lifetime: 69.3	High
Hanafi et al., ³⁴ 2011	Egypt, northern Africa	12-month prevalence of PCI	645 doctors, nurses and auxiliary staff in University of Alexandria teaching hospitals	N/A	12-month: 67.9	Low
Nwankwo and Aniebue, ³⁵ 2011	Nigeria, western Africa	12-month prevalence of all types of exposure to BBF	184 trainee surgeons in three hospitals in Enugu, south-eastern Nigeria	12-month: 67.5	ND	Moderate

Elduma and Saeed, ³⁶ 2011	Sudan, eastern Africa	Lifetime prevalence of PCI	245 doctors, dentists, nurses and laboratory and support staff in three teaching hospitals, Khartoum	N/A	Lifetime: 51	Moderate
Kumakech et al., ³⁷ 2011	Uganda, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	224 doctors, nurses, midwives, laboratory staff and medical and nursing students in Mbarara Regional Referral Hospital, south-western Uganda	12-month: 33.9	12-month: 23.6	Low
Ngatu et al., ⁸ 2012	Democratic Republic of the Congo, central Africa	12-month prevalence of all types exposure to BBF	1043 doctors, nurses and laboratory and support staff in four urban and rural hospitals in the southern town of Lubumbashi and the western semirural city of Matadi	12-month: 44.9	ND	Moderate
Shiferaw et al., ³⁸ 2012	Ethiopia, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	126 medical waste handlers in three government hospitals in Addis Ababa	12-month: 67.5	12-month: 42.1	Moderate
Pellissier et al., ³⁹ 2012	Niger, western Africa	Lifetime prevalence of PCI	207 nurses and medical, paramedical, cleaning and administrative staff in Niamey's National Hospital	N/A	Lifetime: 40.1	Moderate
Owolabi et al., ⁴⁰ 2012	Nigeria, western Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	230 doctors, nurses and laboratory staff in University of Abuja Teaching Hospital	12-month: 30.9	12-month: 24.8	Low
Odongkara et al., ⁴¹ 2012	Uganda, eastern Africa	Lifetime prevalence of all types of exposure to BBF	235 doctors, nurses and laboratory staff in Gulu Regional Referral Hospital and St. Mary's Hospital Lacor, northern Uganda	Lifetime: 46	ND	Moderate
Noubiap et al., ⁴² 2013	Cameroon, central Africa	Lifetime prevalence of all types of exposure to BBF	111 clinical medical students of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé	Lifetime: 55.9	ND	Moderate
Zawilla and Ahmed, ⁴³ 2013	Egypt, northern Africa	12-month prevalence of PCI	1036 health-care workers in Cairo University Hospitals	N/A	12-month: 40	Low
Mathewos et al., ⁴⁴ 2013	Ethiopia, eastern Africa	Lifetime prevalence of all types of exposure to BBF	195 doctors, nurses, laboratory technicians, midwives, anaesthetists, health officers and physiotherapists in Gondar University Hospital	Lifetime: 33.8	ND	Low
Yimechew and Tadesse Ejigu, ⁴⁵ 2013	Ethiopia, eastern Africa	Lifetime and 12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	285 doctors, nurses, laboratory staff, auxiliary staff and medical students in the University of Gondar Hospital	Lifetime: 70.2; 12-month: 62.9	12-month: 41	Low
Mbaisi et al., ⁴⁶ 2013	Kenya, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	305 doctors, clinical officers, nurses, laboratory personnel, mortuary attendants, housekeeping staff and clinical students in Rift Valley Provincial General Hospital	12-month: 25	12-month: 19	Low

Osazuwa-Peters et al., ⁴⁷ 2013	Nigeria, western Africa	12-month prevalence of PCI	144 medical and dental house officers in three government hospitals in Edo State	N/A	12-month: 56.9	Low
Bagny et al., ⁴⁸ 2013	Togo, western Africa	Lifetime prevalence of all types of exposure to BBF	155 nurses in Lome Campus Teaching Hospital	Lifetime: 34.8	ND	Moderate
Mashoto et al., ⁴⁹ 2013	United Republic of Tanzania, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	401 doctors, dentists, dental assistants, clinical officers, nurses, laboratory staff, radiologists, physiotherapists and health attendants in Tumbi and Dodoma regional hospitals	12-month: 47.9	12-month: 39.1	Low
Zoungrana et al., ⁵⁰ 2014	Burkina Faso, western Africa	Lifetime prevalence of all types of exposure to BBF	275 student nurses and midwives in the medical ward of the Bobo-Dioulasso teaching hospital	Lifetime: 29.1	ND	Moderate
Beyera and Beyen, ⁵¹ 2014	Ethiopia, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	401 doctors, anaesthetists, nurses, laboratory staff, health officer and cleaners in four public health institutions (one hospital and three health centres) in Gondar city	12-month: 40.4	12-month: 22.9	Low
Yenesew and Fekadu, ⁵² 2014	Ethiopia, eastern Africa	Lifetime and 12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	317 nurses, health officers, health assistants, doctors, laboratory technicians and dentists in health-care facilities, Bahir Dar town	Lifetime: 76.0; 12-month: 65.9	Lifetime: 45.9; 12-month: 29.0	Low
Aynalem Tesfay and Dejenie Habtewold, ⁵³ 2014	Ethiopia, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	211 doctors, nurses, midwives, health officers and laboratory technicians in two hospitals and two health centres in Debre Berhan town, Amhara region	12-month: 56.7	12-month: 31.5	Low
Beyene and Tadesse, ⁵⁴ 2014	Ethiopia, eastern Africa	12-month prevalence of all types of exposure to BBF	532 health-care workers in two hospitals and six health centres run by the government in Hawassa Town, southern Ethiopia	12-month: 51.9	ND	Low
Ajibola et al., ⁵⁵ 2014	Nigeria, western Africa	Lifetime prevalence of PCI	300 doctors and nurses in Lagos University Teaching Hospital	N/A	Lifetime: 47.3	Moderate
Amira and Awobusuyi, ⁵⁶ 2014	Nigeria, western Africa	Lifetime and 12-month prevalence of PCI	102 doctors, nurses, dialysis technicians and auxiliary health staff in four (two government and two private) dialysis units in Lagos	N/A	Lifetime: 40.2; 12-month: 24.5	Moderate
Ogoina et al., ⁵⁷ 2014	Nigeria, western Africa	Lifetime prevalence of all types of exposure to BBF	230 doctors, nurses and laboratory staff in two tertiary hospitals in north-central and south-south Nigeria	Lifetime: 84	ND	Moderate
Mbah, ⁵⁸ 2014	South Africa, southern Africa	12-month prevalence of all types of exposure to BBF	515 doctors and nurses in public, primary health-care settings in subdistrict F of Johannesburg metropolitan district	12-month: 25.2	ND	Low

Bekele et al., ⁵⁹ 2015	Ethiopia, eastern Africa	Lifetime prevalence of PCI	340 doctors, anaesthetists, health officers, nurses, midwives, laboratory personnel, laundry workers and waste handlers in four hospitals in Bale zone, south-east Ethiopia 116 laboratory staff	N/A	Lifetime: 37.1	Low
Burmen and Osoga, ⁶⁰ 2015	Kenya, eastern Africa	Lifetime prevalence of all types of exposure to BBF		Lifetime: 77	ND	High
Arheiam and Ingafou, ⁶¹ 2015	Libya, northern Africa	12-month prevalence of PCI	340 dental practitioners	N/A	12-month: 35.1	Low
Kone and Malle, ⁶² 2015	Mali, western Africa	Lifetime prevalence of all types of exposure to BBF	128 doctors, nurses and students in a public hospital in Ségou, south-western Mali.	Lifetime: 64.1	ND	Moderate
Kateera et al., ⁶³ 2015	Rwanda, eastern Africa	Lifetime prevalence of PCI	378 doctors, nurses and laboratory and support staff in the University Teaching Hospital of Butare, Huye District, Southern Province, Rwanda	N/A	Lifetime: 57.1	Moderate
Chalya et al., ⁶⁴ 2015	United Republic of Tanzania, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	436 doctors, nurses, laboratory staff and auxiliary health workers in Bugando Medical Centre, Mwanza	12-month: 48.6	12-month: 31.7	Low
Mponela et al., ⁶⁵ 2015	United Republic of Tanzania, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	291 doctors, dental staff, nurses, laboratory staff, medical attendants and cleaners in one referral and two district hospitals, Mbeya region	12-month: 35.1	12-month: 22.0	Low
Kassa et al., ⁶⁶ 2016	Botswana, southern Africa	Lifetime prevalence of all types of exposure to BBF	1624 doctors, nurses and laboratory technicians in three public hospitals: a referral hospital and two district hospitals	Lifetime: 67.2	ND	Moderate
Kaweti and Abegaz, ⁶⁷ 2016	Ethiopia, eastern Africa	Lifetime and 12- month prevalence of PCI	496 doctors, nurses, laboratory technicians and cleaners in two public hospitals: Hawassa Referral and Adare District hospitals	N/A	Lifetime: 46; 12-month: 28	Low
Oluwatosin et al., ⁶⁸ 2016	Nigeria, western Africa	Lifetime prevalence of PCI	642 doctors, nurses, laboratory workers and health attendants in two specialist hospitals in Ondo State	N/A	Lifetime: 55.8	Moderate
Nmadu et al., ⁶⁹ 2016	Nigeria, western Africa	Lifetime prevalence of all types of exposure to BBF	172 nurses, midwives, community health workers and laboratory technicians in 14 primary health-care centres in Kaduna State	Lifetime: 68.9	ND	Low
Makhado and Davhana- Maselesele, ⁷⁰ 2016	South Africa, southern Africa	12-month prevalence of all types of exposure to BBF	233 nurses in a regional hospital in Limpopo Province	12-month: 43	ND	Low

Lahuerta et al., ⁷¹ 2016	United Republic of Tanzania, eastern Africa	Lifetime prevalence of all types of exposure to BBF and disaggregated data on PCI	973 doctors, nurses, dentists, students, cleaners and other support workers in three public hospitals	Lifetime: 79	Lifetime: 37	Low
Shindano et al., ⁷² 2017	Democratic Republic of the Congo, central Africa	12-month prevalence of all types of exposure to BBF	217 doctors and nurses in Bukavu, an eastern town in the Democratic Republic of the Congo	12-month: 42.8	ND	Low
Sharew et al., ⁷³ 2017	Ethiopia, eastern Africa	12-month prevalence of PCI	195 nurses, midwives, laboratory staff, doctors, health officers and anaesthetists in two hospitals in Debre Berhan town, north-eastern Ethiopia	N/A	12-month: 32.8	Low
Laisser and Ng'Home, ⁷⁴ 2017	United Republic of Tanzania, eastern Africa	12-month prevalence of all types of exposure to BBF and disaggregated data on PCI	277 doctors, nurses and laboratory and auxiliary staff in 31 private and public health facilities in Kahama District, north-western United Republic of Tanzania	12-month: 59.2	12-month: 34.7	Moderate

AIDS: acquired immunodeficiency syndrome; BBF: blood and body fluid; N/A: not applicable; ND: not determined; PCI: percutaneous injury; STD: sexually transmitted disease.

^a All studies were cross-sectional.

^b The risk of bias was assessed as described in the methods.

Table 2. Subgroup meta-analysis, blood and body fluid exposure and percutaneous injury among health-care workers in Africa, 2000–2017

Subgroup	Blood and body fluid exposure			Percutaneous injury		
	Pooled 12-month prevalence, % (95% CI)	No. studies included	Study heterogeneity, I^2 , % (P -value)	Pooled 12-month prevalence, % (95% CI)	No. studies included	Study heterogeneity, I^2 , % (P -value)
African region						
Western	47.9 (31.5–64.3)	3	96.8 (< 0.001)	36.0 (24.4–47.5)	4	94.1 (< 0.001)
Central	51.7 (37.5–65.8)	3	95.5 (< 0.001)	55.0 (48.4–61.6)	1	N/A
Eastern	47.3 (36.7–57.9)	14	98.7 (< 0.001)	33.3 (28.5–38.0)	18	94.0 (< 0.001)
Southern	33.9 (16.5–51.4)	2	95.4 (< 0.001)	16.4 (10.6–22.2)	1	N/A
Northern	60.7 (56.9–64.5)	2	77.0 (0.037)	47.9 (32.6–63.2)	4	98.3 (< 0.001)
Study period						
2000–2009	50.3 (29.2–71.4)	5	99.7 (< 0.001)	42.8 (32.7–52.8)	7	97.0 (< 0.001)
2010–2017	47.3 (41.5–53.1)	19	95.9 (< 0.001)	33.7 (28.2–39.2)	21	96.3 (< 0.001)
Type of health-care facility						
Hospital	49.7 (42.8–56.6)	14	97.0 (< 0.001)	39.2 (31.6–46.9)	17	97.6 (< 0.001)
Mixed ^a	47.8 (34.5–61.1)	9	99.1 (< 0.001)	31.5 (28.1–34.9)	9	81.7 (< 0.001)
Risk of bias						
Low	45.7 (36.7–54.6)	19	98.9 (< 0.001)	36.2 (30.5–41.8)	24	97.0 (< 0.001)
Moderate	56.4 (47.8–65.0)	5	94.5 (< 0.001)	35.2 (29.6–40.9)	4	73.3 (0.011)

BBF: blood and body fluid; CI: confidence interval; N/A: not applicable; PCI: percutaneous injury.

^a Both hospitals and primary care facilities.

Fig. 1. Flow diagram, systematic review, blood and body fluid exposure among health-care workers in Africa, 2000–2017

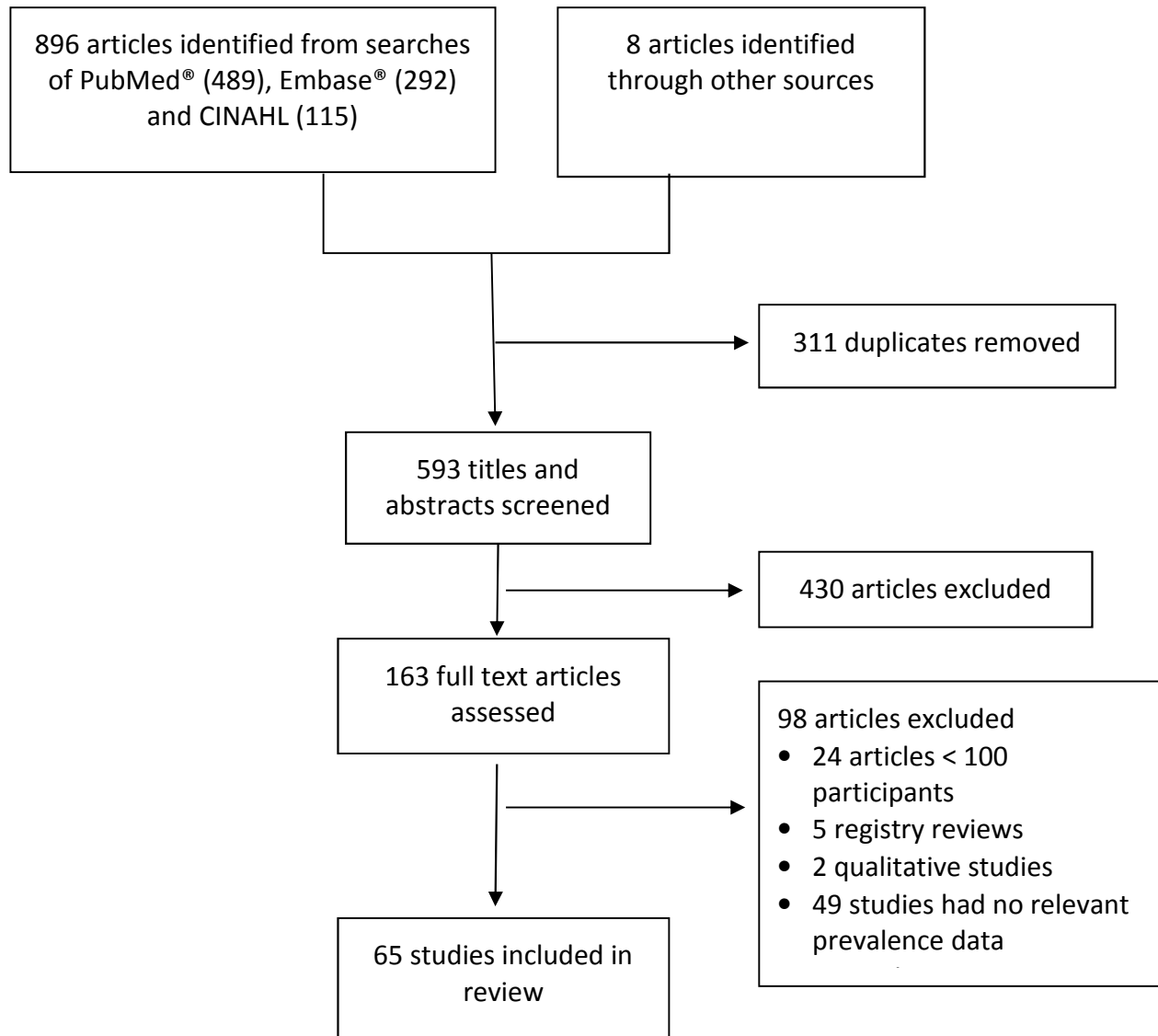
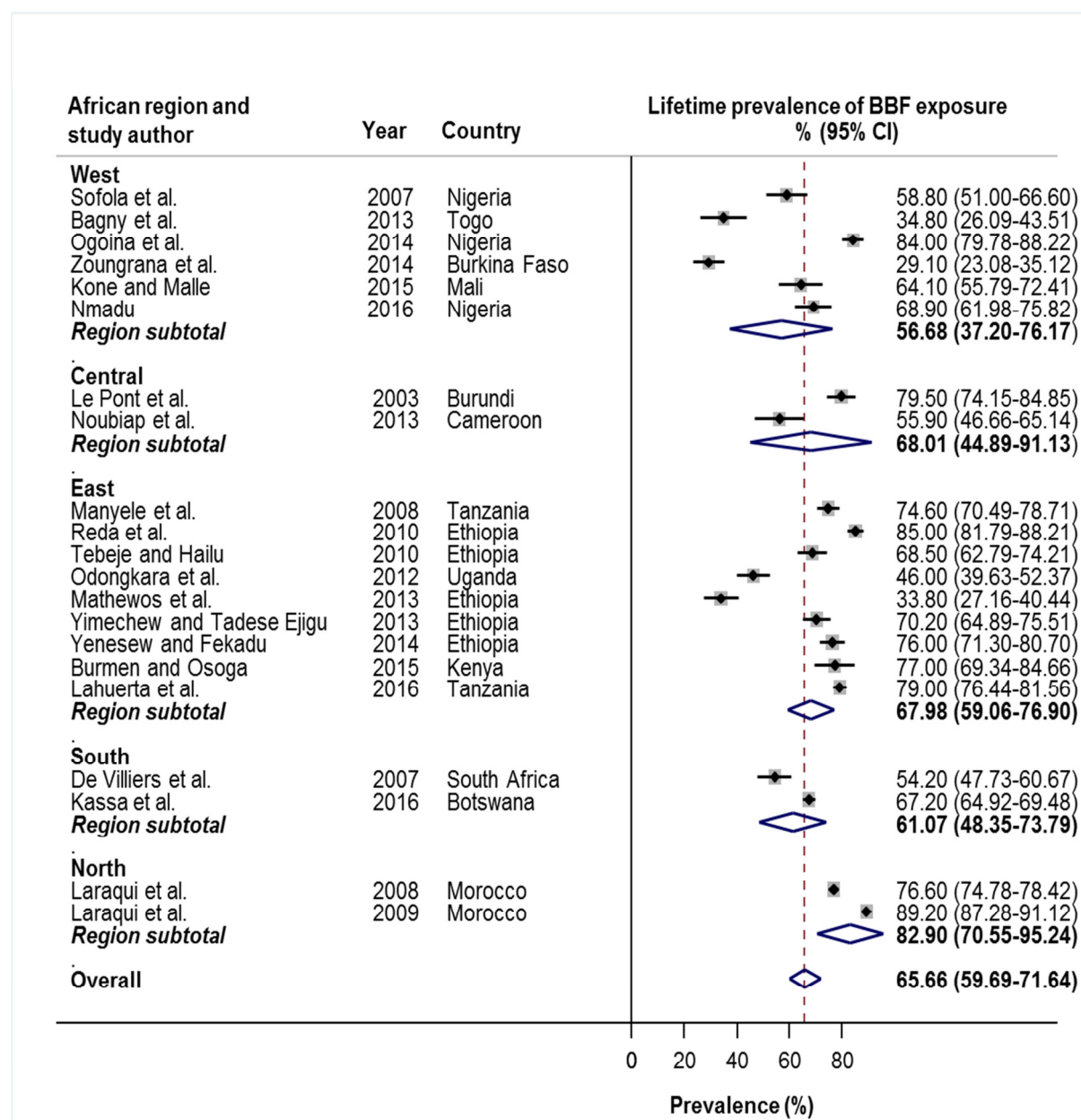


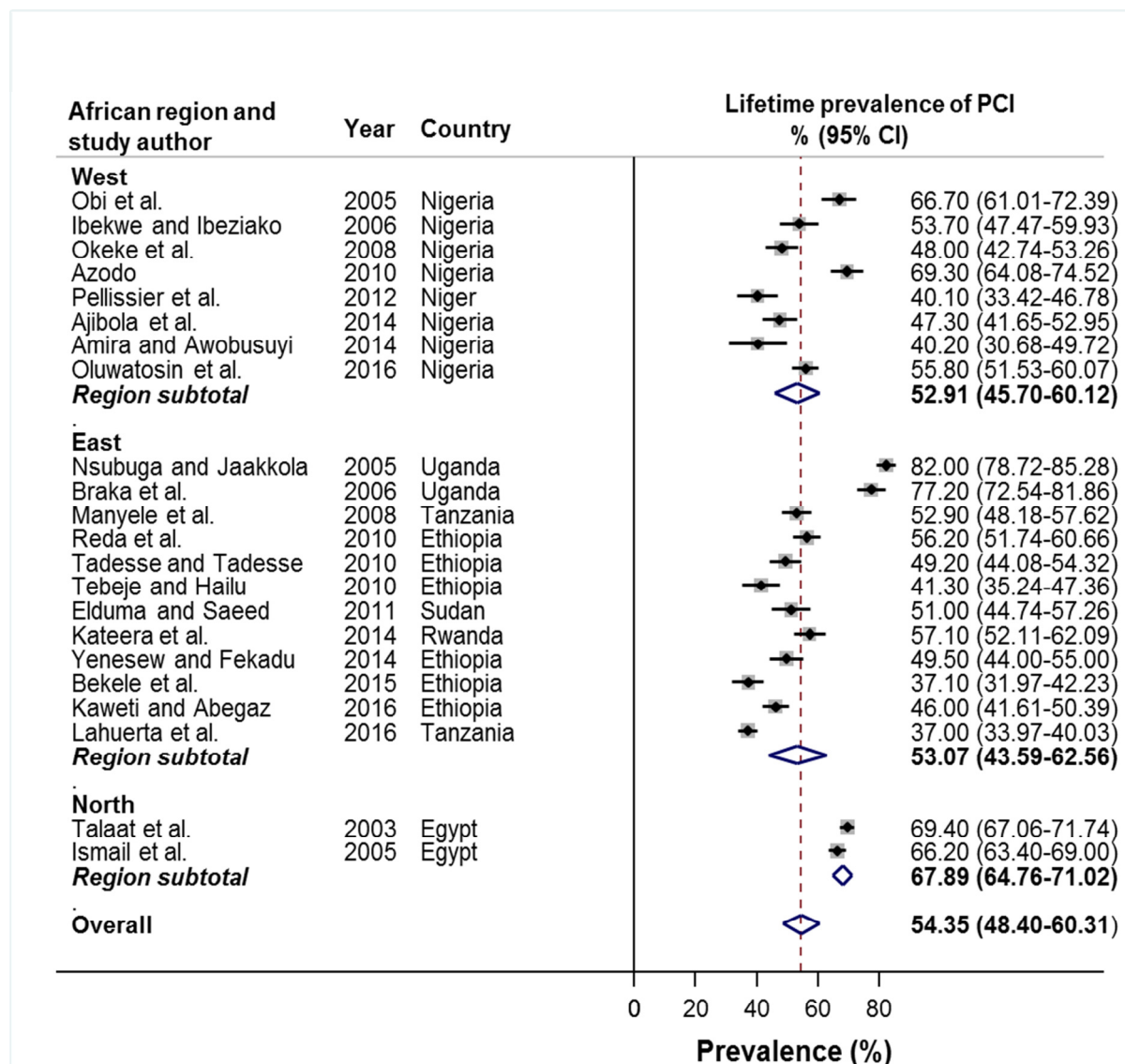
Fig. 2. Meta-analysis, lifetime prevalence of blood and body fluid exposure among health-care workers in Africa, by region, 2002–2017



BBF: blood and body fluid; CI: confidence interval.

Note: The dashed vertical line presents the overall estimated prevalence.

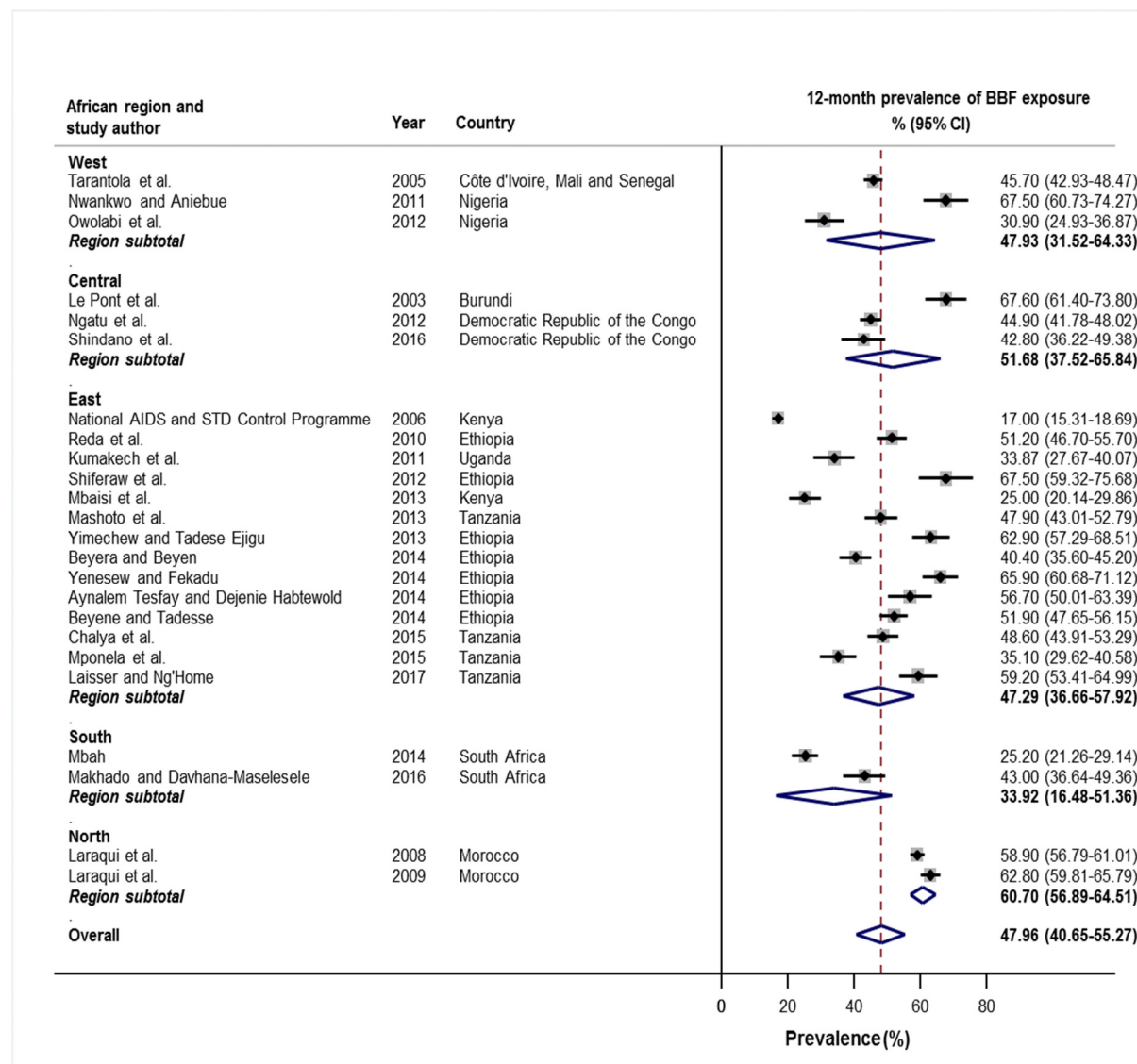
Fig. 3. Meta-analysis, lifetime prevalence of percutaneous injury among health-care workers in Africa, by region, 2000–2017



CI: confidence interval; PCI: percutaneous injury.

Note: The dashed vertical line represents the overall estimated prevalence.

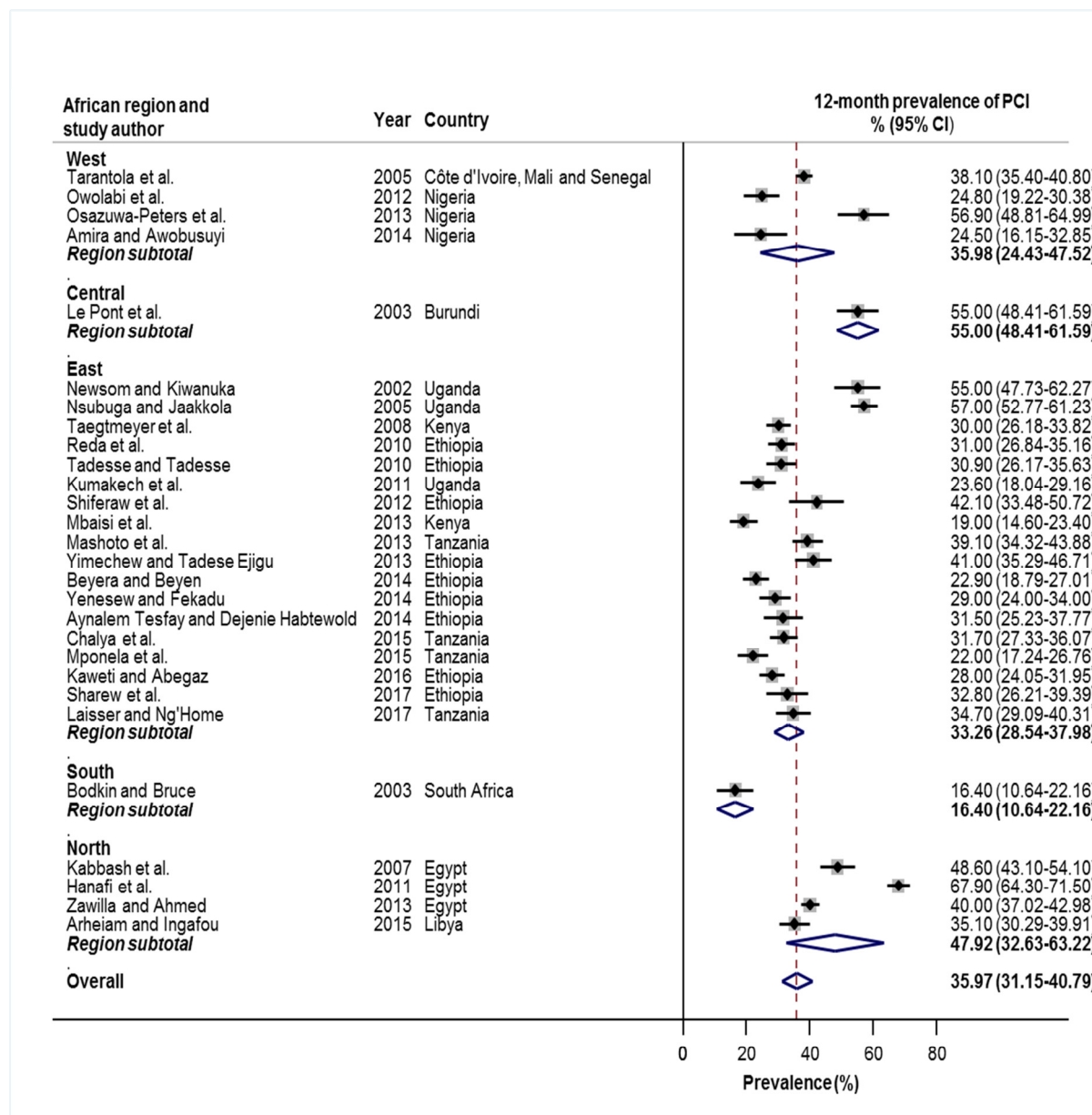
Fig. 4. Meta-analysis, 12-month prevalence of blood and body fluid exposure among health-care workers in Africa, by region, 2002–2017



AIDS: acquired immunodeficiency syndrome; BBF: blood and body fluid; CI: confidence interval; STD: sexually transmitted disease.

Note: The dashed vertical line represents the overall estimated prevalence.

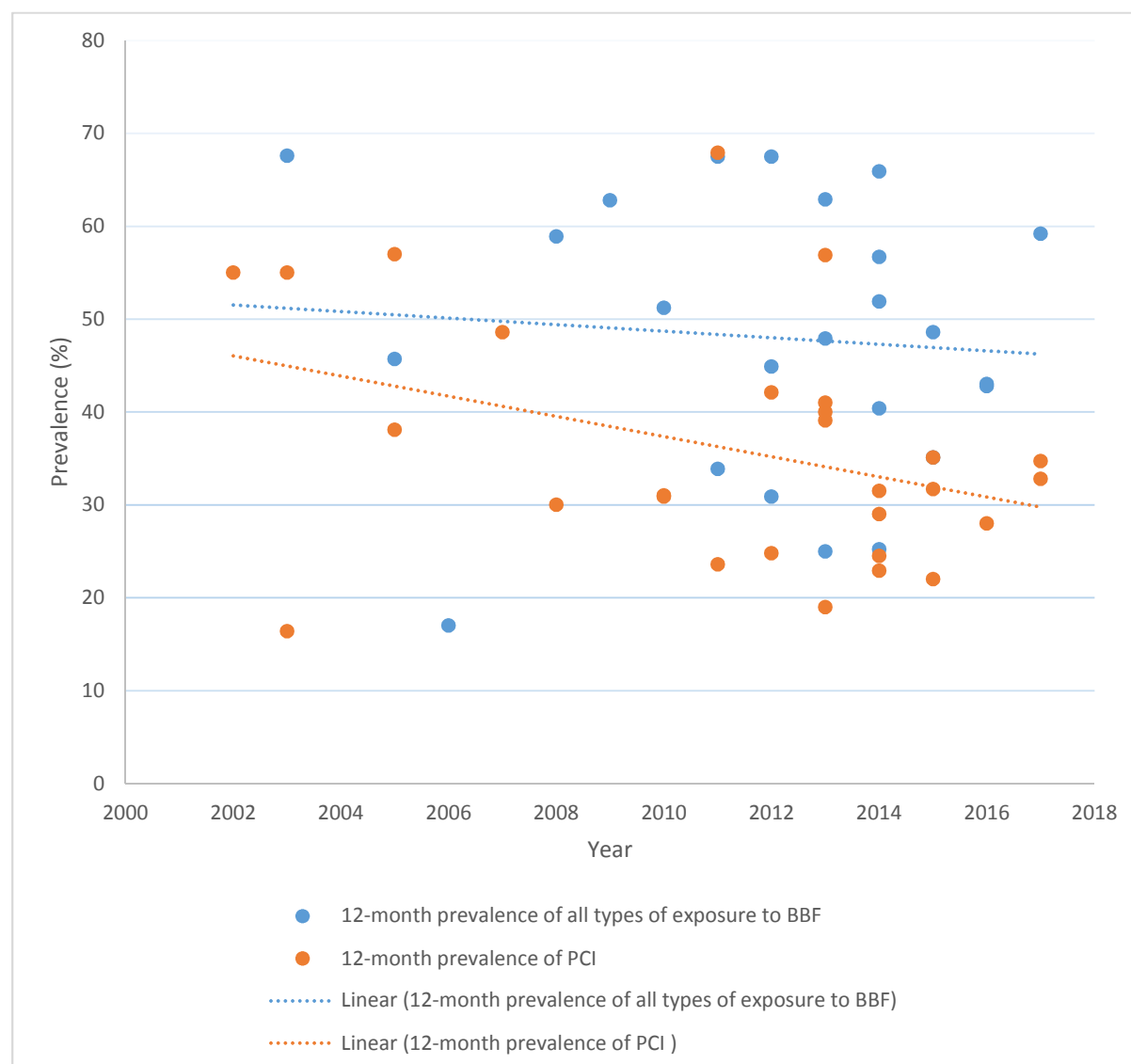
Fig. 5. Meta-analysis, 12-month prevalence of percutaneous injury among health-care workers in Africa, by region, 2000–2017



CI: confidence interval; PCI: percutaneous injury.

Note: The dashed vertical line represents the overall estimated prevalence.

Fig. 6. Trend in 12-month prevalence of blood and body fluid exposure and percutaneous injury among health-care workers in Africa, 2000–2017



BBF: blood and body fluid; PCI: percutaneous injury.

Note: The fitted lines were derived by linear regression.