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Research Article

Passive surveillance of communicable diseases among inmates of Jos central prison, Nigeria

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ABSTRACT

Background: This paper presents a comprehensive study of the disease profile among inmates of Jos prison, Nigeria.
Methods: Blood samples were examined using Giemsa-stained thin and thick smears for *Plasmodium* parasites determine and stat-pak was employed to detect antibodies against HIV types I and II, sputum samples were stained by Ziehl-Nelson method and examined for acid fast *Bacilli*. Intestinal parasites were identified and characterized from stool samples using normal saline and lugol's iodine method and subsequently formal-ether concentration and Kato-katz technique.
Results: Out of 132 inmates that presented themselves for medical treatment at the prison clinic, eighty-nine (67.4%) (95% CI=62.4-72.4) were infected with various pathogenic agents, namely Plasmodium parasites (37.1%), intestinal parasites (14.4%), human immunodeficiency virus (11.4%) and Mycobacterium tuberculosis (4.5%). The parasites occurred both as mono and mixed-double and triple infections. Malaria due to *Plasmodium falciparum* predominates with 65.3% (32/49) while non-falciparum species had 20.4% due to *P. malariae* (16.3%) and *P. vivax* (4.1%). Intestinal parasites accounted for 14.4% (95% CI=9.4-19.4) of the infections comprising five species, with *Entamoeba hystolytica* dorminating (57.9%) and *Strogyloides stercoralis* rare (4.8%). Of the co-infection, the highest combination was Plasmodium + HIV (35.3%). Fifteen inmates had HIV virus (16.5%) and 6 (6.6%) had Mycobacterium tuberculosis. The age group 1-40 years recorded 93.3% and 100% of the HIV and tuberculosis infections respectively. Eleven deaths were recorded 4 years preceding this survey from various causes including HIV and septicemia.
Conclusions: The study concludes that Nigerian prisons pose a serious threat as reservoir of diseases to the nation.

Keywords: Passive surveillance, Communicable diseases, Prison inmates, Jos, Nigeria

INTRODUCTION

Infectious diseases have remained the leading causes of death in the world largely because the major source of exposure of the people to the aetiologic agents does not rest with the individuals but with the environment.[1]

It is generally accepted that prisoners are regarded as special people at risk of being afflicted with several aetiologic agents because they have no control over their environment in which they live. Prison and jail environments are increasingly being recognized as ideal settings in which diseases of the society are concentrated, with the inmates being completely at the mercy of the state for their wellbeing and healthcare provisions.

Even though prisons are acknowledged as institutions with a high burden of communicable diseases, data on the

extent and magnitude of these infections is to a large extent unavailable and often incomplete.[2] On the few occasions that such information is available, it is mainly from studies conducted in the developed countries. However, several studies have shown that it is actually the developing countries that are affected by the challenges of both communicable diseases caused by bacteria, protozoan and viruses as well as non-communicable diseases like hypertension, diabetes, obesity, cancer, substance abuse and mental disorders[3,4] and that these diseases are more associated with prison population compared to the general population. Despite the above revelations, only few of the communicable diseases have attracted attention of medical researchers within prison facilities, especially those working on hepatitis C (HCV), tuberculosis (TB) and human immunodeficiency virus (HIV) both in terms of prevention and control.

At the individual level, many prisoners are believed to enter the prison with negative history of health-related problems and often complete their terms without any medication, eventually leaving the facility at the end of their incarceration in a worse state of health and conveyed these health problems back into their communities where they came from.[1]

Most of the studies conducted on disease situations in Nigerian prisons have focused mainly on intestinal parasites.[5] Literature on other disease conditions is scanty, except for the study on pulmonary tuberculosis among inmates of Aba Federal Prisons in Nigeria[6] and few others that studied haemoparasites and urinary parasites.[5,7,8] Recent studies conducted in Jos prison facility were centered mainly on helminthes and malaria.[7,9]

It has been reported that Nigeria has 227 prisons spread across the country with about 54,000 inmates of various categories.[10] These lockups and their large inmate population do not enjoy comparable healthcare services with the outside prison population because of the absence of linkages between national health and prison health services. The need for constant monitoring and evaluation of the health status of prison inmates in correctional facilities in Nigeria during their periods of incarceration becomes even more paramount to remind policy makers of the potential risks that such facilities pose as reservoir of diseases to the nation.

This paper presents a comprehensive study of the disease profile among inmates of Jos prison covering intestinal protozoans and helminthes, haemoparasites, Human Immunodeficiency Virus (HIV) and Mycobacterium tuberculosis.

METHODS

Study area

The study was conducted in Plateau State, Nigeria, whose detail has already been presented.[7,9]

The Jos central prison was established in 1930 with a capacity for 1,149 inmates that was later extended to Lamingo to meet up with the manpower need for the construction of the Lamingo dam. The small Lamingo facility is now referred to as the Lamingo Prison Farm Centre. The prison facility houses inmates of different categories such as convicts (CV), awaiting trial persons (ATP), armed robbery suspects ARS), rioters (RT), condemned persons (CP) and those serving life terms (L). Unlike other facilities where congestion is an issue, the Jos prison houses only 654 inmates at the time of the present study, representing 56.9% of its carrying capacity.

Study population

The de facto eligible population comprised all the inmates that presented themselves for medical treatment at the prison clinic. Therefore, only one hundred and thirty two (132) inmates were registered for the study.

Ethical clearance

Permission was obtained from the Jos prison authority, informed consent sought from the inmates and ethical clearance obtained from the Ethical Committee of Kaduna State University. Prisoners had the option to accept, refuse to participate or opt out of the study at any time. Those inmates that did not give their consent to participate in the study were excluded without any threat. All the participants were assured of the confidentiality of the test results.

Sample collection

Demographic information such as age, sex and unit of each inmate were obtained orally when the inmates visited the clinic. Reasonable amount of stool specimens (0.5-1.5 g) were collected by each inmate into sterile wide mouthed screw capped labeled containers. Four (4) milliliters (ml) of blood were collected aseptically by venipuncture of the cubital vein using sterile disposable syringes and placed into sterile containers containing Ethylenediaminetetracaetic Acid (EDTA) as anticoagulant.

Preparation and laboratory analyses of stool and blood samples

Parasites were identified and characterized from stool samples using normal saline and lugol's iodine method and subsequently formal-ether concentration and Kato-katz technique. Cysts, ova and trophozoite were

identified based on their morphological characteristics, motility and presence of cytoplasmic inclusion bodies such as erythrocytes in trophozoites and chromatoid bodies in cysts.[11] For *Strongyloides stercoralis*, samples were processed using the Baermann method. From the blood collected, Plasmodium parasites were diagnosed and examined using Giemsa stained thin and thick blood smears.[11] Antibodies against Human Immunodeficiency Virus (HIV) types I and II were screened using Determine and Stat-pak.[12]

Smear microscopy for sputum samples

Three sputum samples were collected from each inmate to increase the possibility of detecting the organisms: spot sputum on first visit, early morning sample the next day and another spot sample on third visit. Smears were prepared directly from non-concentrated specimen, heat-fixed and stained with Ziehl-Nelson staining method and examined for Acid Fast Bacilli (AFB).

Data analysis

Data was analysed using descriptive statistics. Infection rate was compared on the basis of sex, age, and conviction status using $\chi 2$ test (chi-square). Significance test was set at 5% alpha and 95 confidence interval. The analysis was performed with the aid of Minitab Statistical Programme version 16.0.

RESULTS

Study subjects

Owing to the fact that this was a passive survey, only the inmates that voluntarily presented themselves to the prison clinic were included. The one hundred and thirty two (132) inmates sampled constitute 20.0% of the prison inmates enough to serve as representative sample of the prison community. Out of this, 93.2% were males and only 6.8% females. Table 1 presents the distribution of the inmates in relation to age, indicating that about 60% of the inmates are young below 30 years. Figure 1 shows the conviction status of the inmates according to gender and Table 2 shows the disease distribution according to gender. Generally, males had higher infections (94.4%) than the females (5.6%) who were afflicted with only malaria parasites.

Table 1: Age distribution of the Jos prison inmates used in the study.

Age group (yrs)	No examined	Percentage	CI*
≤21	16	12.1	± 5
21 – 30	63	47.7	± 7
31 – 40	28	21.2	± 6
41 – 50	13	9.5	± 4
51 – 60	8	6.1	± 3
61 – 70	2	1.5	± 2
71+	2	1.5	± 2

CI* = Confidence interval calculations[43]

Prevalence rates of the diseases

Eighty-nine inmates (67.4%) (95% CI=62.4-72.4) were infected with various pathogenic agents, namely Plasmodium parasites (37.1%), intestinal parasites (14.4%) (Protozoans 57.1%, helminthes 28.6% and flukes 14.3%), human immunodeficiency virus (11.4%) and *Mycobacterium tuberculosis* (4.5%) (Tables 2 & 3).

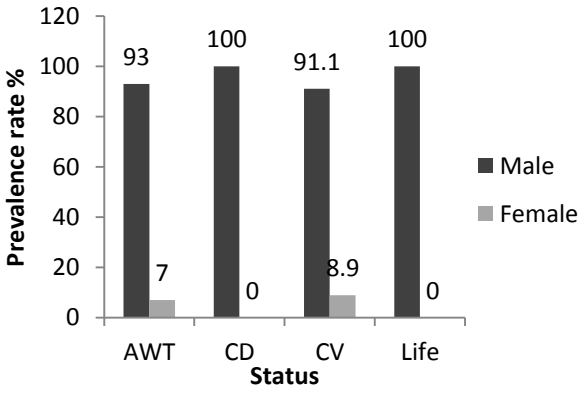

Figure 1: Conviction status of the inmates according to gender.

Table 2: Disease distribution among the inmates of Jos prison according to gender.

Disease	No. Examined	Gender					
		No +ve (%)	CI*	Male	% Prevalence	Female	% Prevalence
HIV/Aids		15 (11.4)	± 5	15	100.0	0	0
Int. parasites		19 (14.4)	± 6	19	100.0	0	0
Malaria	132	49 (37.1)	± 7	44	89.8	5	10.2
Tuberculosis		6 (4.5)	± 3	6	100.0	0	0

CI* = Confidence interval calculations[43]

Table 3: Disease condition of inmates of Jos prison according to conviction status.

Conviction status	No/unit	No +ve (%)	CI*	Medical conditions			
				Malaria	HIV/AIDS	Tb	IP
AWT	57	45 (78.9)	± 6	23	10	3	9
CV	56	30 (53.6)	± 7	19	1	1	9
CD	7	7 (100.0)	± 0	3	2	2	0
L	12	7 (58.3)	± 7	4	2	0	1

AWT– Awaiting trial, CV – Convicted, CD - Condemned, L - Life, TB – Tuberculosis, IP – Intestinal parasites, CI* = Confidence interval calculations[43]

Mixed infections and co-infections

The diseases occurred both as mono and mixed double and triple infections. The mixed infections were in the following combinations: Plasmodium + M. tuberculosis (2.7%), Plasmodium+ HIV (35.3%), Plasmodium + intestinal parasites (23.5%), HIV + intestinal parasites (23.5%) and Plasmodium + HIV + intestinal parasites (5.9%) (Table 4).

Malaria infections

The overall prevalence of malaria was 37.1% (95% CI=30.1-44.1). Of this, *Plasmodium falciparum* predominates with 65.3% (32/49) while non-falciparum species had 20.4% with unidentified species accounting for 14.3% (Table 5). The non-falciparum species encountered are *P. malariae* (16.3%) and *P. vivax* with 4.1%. Cases of infection due to *P. ovale* were not observed. There were no cases of mixed Plasmodium species infections in the individuals. More males were infected with malaria (89.8%) than in females (10.2%) (Table 3) but the difference was not statistically significant (χ^2=1.4062; df=1; P-value=0.235692; p>0.05). The seven Plasmodium species that could not be identified to species level were excluded from further the analysis.

Table 4: Differential overall prevalence of mono and mixed malaria-intestinal-HIV-Tuberculosis infections

Infection status	Disease combination	Parasite species	No	(%)	CI*
Mono infection		P.f.	21	38.9	± 7
		P.m.	6	11.1	± 4
		P.v.	2	3.7	± 2
		HK	3	5.6	± 3
		A.l.	3	5.6	± 3
		S.m.	2	3.7	± 2
		Stercoralis	1	1.9	± 2
		M.b.	6	11.1	± 4
		E.h.	6	11.1	± 4
		HIV	4	7.4	± 4
		Total	**54**	**76.1**	
Mixed double + Triple infections	Malaria + Tuberculosis	P.f + M.b.	1	2(11.8)	± 4
		P.m. + M.b.	1		
	Malaria + HIV	P.m. + HIV	1	6(35.3)	± 7
		P.f. + HIV	5		
	Malaria + HIV + Intestinal parasites	P.f. + HIV + E.h.	1	1(5.9)	± 3
	Malaria + Intestinal parasites	P.f. + E.h.	4	4(23.5)	± 6
	HIV + Intestinal parasites	HIV + E.h.	2	4(23.5)	± 6
		HIV + HK	1		
		HIV + A.l.	1		
		Total	**17**	**23.9**	

M.b.=*Mycobacterium*, E.h.=*Entamoeba histolytica*, A.l.= *Ascaris lumbricoides*, S.m.=*Schistosoma mansoni*, HK=Hookworm, HIV=Human Immunodefiency Virus, P.f.=*Plasmodium falciparum*, P.m.=*Plasmodium malariae*, P.v.=*Plasmodium vivax* CI* = Confidence interval calculations[43]

Table 5: Distribution of plasmodium parasites according to conviction status.

Status	Number of malaria parasites (%)						
	No/unit	No. +ve (%)	CI*	*P. f.*	*P. m.*	*P. v.*	Unidentified
AWT	57	19 (33.3)	± 7	13	1	1	4
CV	56	22 (39.3)	± 7	15	5	0	2
CD	07	05 (71.4)	± 6	3	1	0	1
L	12	03 (25.0)	± 6	1	1	1	

AWT – Awaiting trial, CV – Convicted, CD - Condemned, L – Life term, P.f. – *Plasmodium falciparum*, P.m. – *Plasmodium malariae*, P.v. – *Plasmodium vivax*, CI* = Confidence interval calculations[43]

Table 6: Distribution of species of intestinal parasites among the inmates of Jos prison.

Parasite	No. examined	No +ve	%	Gender				
				CI*	Males	% Prevalence	Females	% Prevalence
E. histolytica		11	57.9	± 7	11	57.9	0	0
Hookworm		2	10.5	± 4	2	10.5	0	0
A. Lumbricoides	132	3	15.8	± 5	3	15.8	0	0
S. mansoni		2	10.5	± 4	2	10.5	0	0
S. stercoralis		1	5.3	± 3	1	5.3	0	0

CI* = Confidence interval calculation[43]

Table 7: Prevalence of intestinal parasites with respect to age groups in the Jos prison.

Age group (yrs)	No Inmates	No +ve (%)	CI*	Intestinal parasites (%)				
				E. h.	HK	S. m.	A.l.	S.s.
≤21	16	2 (12.5)	± 5	1	0	1	0	0
21 – 30	63	8 (12.7)	± 5	4	2	0	2	0
31 – 40	28	7 (25.0)	± 6	5	0	1	0	1
41 – 50	13	0 (0.0)	± 0	0	0	0	0	0
51 – 60	8	1 (12.5)	± 5	1	0	0	0	0
61 – 70	2	0 (0.0)	± 0	0	0	0	0	0
71+	2	1 (50.0)	± 7	0	0	0	1	0

E.h.=*Entamoeba histolytica*, HK= Hookworm, S.m.= *Shistosoma mansoni*, A.l.= *Ascaris lumbricoides*, S.s=. *Strongyloides tercoralis*, CI*= Confidence interval calculations[43]

Table 8: Prevalence of intestinal parasitism with respect to conviction status in the Jos prison

Status	No/unit	No +ve (%)	CI*	Number of intestinal parasites				
				E. h.	HK	*S.m.*	*A.l.*	*S.s.*
AWT	57	10(17.5)	± 5	6	2	0	2	0
CV	56	9(16.1)	± 5	5	0	2	1	1
CD	7	0(0)	± 0	0	0	0	0	0
L	12	0(0)	± 0	0	0	0	0	0

AWT – Awaiting trial, CV – Convicted, CD - Condemned, L – Life term, E.h.= *Entamoebahistolytica*, HK= *Hookworm*, S.m.= *Shistosoma mansoni*, A.l.= *Ascaris lumbricoides*, S.s=*Strongyloides stercoralis*, CI* = Confidence interval calculated according to Thrustfield[43]

Intestinal parasites-malaria-HIV co-infection

Prevalence of intestinal parasites was 14.4% (95% CI=9.4 – 19.4) comprising five species. The infections occurred both as single (14.4%) and co-infection with other parasites (52.9%). Of the mono infection, *Entamoeba hystolytica* dorminates (57.9%) and *Strogyloides stercoralis* were rare with only (4.8%) (Table 6). Of the co-infection, the highest was Plasmodium+ HIV (35.3%) followed by Plasmodium+ E. histolytica (23.5%). All the intestinal parasites were observed in the male population. The distribution of the parasites according to age and conviction status is presented in Tables 7 and 8. Fifteen inmates had HIV virus (16.5%) and only 6 (6.6%) had *Mycobacterium tuberculosis*. The inmates aged between 1-40 years constitute 81% of the studied population where 93.3% and 100% of the HIV and tuberculosis infections were recorded (Table 9).

Table 9: Disease condition in relation to age of inmates.

Age group (yrs)	No. Examined	No +ve (%)	CI*	Number with medical conditions (%)			
				Malaria	HIV/AIDS	Tuberculosis	Intestinal parasites
≤21	16	10 (62.5)	± 7	6	2	0	2
21 – 30	63	43 (68.3)	± 7	25	10	2	6
31 – 40	28	27 (96.4)	± 2	12	2	4	9
41 – 50	13	7 (53.8)	± 7	4	1	0	0
51 – 60	8	3 (37.5)	± 7	2	0	0	1
61 – 70	2	0 (0.0)	± 0	0	0	0	0
71+	2	1 (50.0)	± 7	0	0	0	1

CI* = Confidence interval calculations[43]

DISCUSSION

A result from this work is consistent with studies in Nigeria and elsewhere that recorded higher prevalence rates of disease conditions among prison inmates than the general community.[13]

Distribution of inmates in the studied facility show that those awaiting trials constituted 43.2% of the population, closely followed by convicted prisoners (42.4%). This situation reflects the national trend where awaiting trial persons account for 68.6% of the total Nigerian prison population.[14]

Among the medical conditions encountered, malaria was more predominant. It is considered a risk for 97% of Nigeria's population with an estimated 100 million malaria cases and more than 300,000 deaths per year.[15]

In Nigeria, the use of rapid diagnostic tests (RDTs) for malaria diagnosis dedicated for *P. falciparum* is the common approach employed by most health facilities. Result from this study has demonstrated the presence of other species of Plasmodium infecting man besides *P. falciparum* which hitherto the RDT will have missed. It thus shows that the widespread utilization of the RDT for malaria diagnosis is obscuring the real malaria situation in the country by missing out non-falciparum malaria infections. Earlier reports on malaria prevalence in Jos prison were entirely based on RDT.[7,9] In Zambia, similar trend was observed and the consequences of such under-diagnosis of non-falciparum malaria on the general disease burden was discussed.[16]

Previous reports on malaria infection among inmates of Jos prison did not indicate gender susceptibility[7,9] but our results showed that females demonstrated a higher susceptibility more than males (Table 2), agreeing with the reports from different parts of Nigeria including Iwo community in south west Nigeria[17], Ilorin[18], Awka[19] and Abeokuta[20]. However, contradictory observations were made by some workers who reported higher infection in males than the females in Aba[21], Abakaliki[22] and in Nsukka area[23]. Still few others did not observe any difference between sexes in their studies.[24] Even though it was opined that there appears to be no scientific evidence linking prevalence to gender,[18] results from the present work shows that females are more affected by malaria, though the difference was not significant ($p>0.05$).

The dominance of *P. falciparum* over *P. malariae* and *P. vivax* observed in this study agrees with the reports that ranked it as the most prevalent species in Nigeria.[17,25] Of the non-falciparum species encountered, *P. malariae* had the highest prevalence, agreeing with the observations made in Garki, Kano State[26] and in southwest region of Nigeria.[27,28] *P. vivax* was rare and the least species encountered in this study, just as observed in Port Harcourt.[29] The general notion that *P. vivax* is not found among indigenous Nigerians therefore requires a re-visit. Species of *P. ovale* reported by some workers[26,28] was not detected in our study.

The co-infection of Plasmodium + other parasites recorded in this study were in the following 4 combinations: Plasmodium + M. tuberculosis (2.7%), Plasmodium + HIV (35.3%), Plasmodium + intestinal parasites (23.5%), and Plasmodium + HIV + intestinal parasites (5.9%) (Table 4). Of the different combinations, Plasmodium+HIV was the commonest, followed by Plasmodium+intestinal parasites. Mixed Plasmodium species infection was not observed but the occurrence of high co-infection of Plasmodium + HIV agrees with observation of P. falciparum as the commonest cause of malaria among HIV patients in Port Harcourt and Benin city, Nigeria respectively.[25,30]

Recorded prevalence of 23.5% co-infection of Plasmodium + intestinal parasites is high. The overlap in the geographical distribution of Plasmodium and intestinal parasites makes their co-existence and co-infection possible especially in tropical regions.[31] The increasing interest on the co-infection relationship of Plasmodium + intestinal parasites arose partly because of the hypothesis that Th2 polarized immune response elicited by intestinal helminthes could alter the natural immune response of the host to Plasmodium parasites.[32,33] A study by Spiegel et al[34] indicate that parasitic infections have a negative effect on host response to malaria,

including increased susceptibility to Plasmodium infection and increased severity of disease, while Briand et al[35] argued that it generate a protective effect, such as decreased risk of cerebral malaria and lower incidence of malaria. Yet still, Bejo et al[36] think that co-infection of Plasmodium+intestinal parasites does not have any effect on the susceptibility to malaria or in the pathologic effect of Plasmodium infections. Findings in Thailand[33] revealed a higher rate of severe malaria attack among individuals co-infected with helminthes as compared with those free from helminthes while contradictory result was obtained from study in Uganda that failed to show such association even in heavily infected individuals.[37] How concurrent infections affect the epidemiology and the pathogenesis of each other remains controversial.

The prison population studied shows an overall prevalence of infection with intestinal parasites of 23.1%, higher than the 9% earlier reported for the same facility9, but the two studies recorded the same species of parasites, namely *Entamoeba histolytica*, hookworm, *Schistosoma mansoni, Ascaris lumbricoides* and *Stercoralis spp*. The observed occurrences of high infection rates of intestinal parasites that are mostly helminthes suggest a poor sanitary condition in the prison associated with improper sewage disposal, resulting to faecal pollution of the soil and water supply. Previous reports have described Nigeria as hyperendemic for soil-transmitted helminthes.[38,39]

The low prevalence of *S. stercoralis* among the prison inmates is surprising and suggests that strongyloidiasis is not a major problem in the prison, even though prisoners have been recognized as people at high risk of acquiring the disease.[40] The difficulty in diagnosing uncomplicated cases of strongyloidasis due to low worm load[40] may be partly responsible for the observed low prevalence.

The presence of 6 inmates that tested positive for Acid Fast Bacilli (AFB) from sputum smear microscopy demonstrate active pulmonary tuberculosis, giving a minimum point prevalence of 910 cases per 100,000 prison inmates. This figure is about x5 times higher than the reported national prevalence rate of 171 per 100,000 for Nigeria.[41] Much higher prevalence rates x14 times higher than the general Nigerian population was seen in Aba prison, Abia State, Nigeria.[6] The average point prevalence rate for African region is x4 times higher than our result. Ekundayo et al[6] observed that the consequences of high prevalence of tuberculosis in the prisons was observed to extend beyond the prison walls because it could spread through visitors, prison staff and discharged inmates into the larger society.

The sero-prevalence of 16.9% recorded for HIV antibodies in this study was much higher than the 7% recorded in the same prison.[12] Even though no explanation could be given for this increase, it is believed that our smaller sample size of 132 inmates (against 234 used by Abba and colleagues) could be a contributing factor. This not-withstanding, the 16.9% prevalence recorded in the present work is far above the national prevalence of 4.1% reported by UNAID[42] in 2015. The national prevalence figure of 4.1% reported for 2015 indicate an increase in prevalence from 3.4% in 2012, an alarming 17% overall increase that places Nigeria as the second largest HIV burden country in the world.

Data from the prison clinic reported eleven deaths in the four years preceding this study: two deaths in 2011, one death in 2012, five deaths in 2013 and three in 2014. Analyses of the deaths showed that four were attributed to septicemia, a serious bloodstream infection which could result from bacteria, fungal or viral agents and two from HIV. In conclusion, the overall findings from this study have implications on policy and practice.

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