Original Research Article

Prevalence Of Intestinal Parasitic infections Among Inmates Of The New-Bell Central Prison, Cameroon

ABSTRACT

Intestinal parasitic infections (IPIs) remain a public health issue in developing countries where overcrowded settlements and poor sanitation were of most risk factors. Due to paucity of IPIs data in known overcrowded Cameroonian prisons, this cross-sectional study conducted in 2015 in the New-Bell Central Prison (NBCP) aimed to establish biodiversity, prevalence and risk factors of intestinal protozoan and helminthe infections among inmates.

Fresh stool samples collected from the NBCP volunteered inmates were laboratory examined microscopically as fresh mounts plus iodine, Kato-Katz smears, formalin-ether concentration and modified Ziehl-Nelseen stained sediments.

Of a total 374 inmates who participated in the study, overall IPIs prevalence was 39.3%. Helminthe and protozoa prevalence was 16.6% and 24.6% respectively. Parasites species were recorded at following prevalence: *Ascaris lumbricoides* (10.4%), *Trichuris trichiura* (5.1%), *Schistosoma mansoni* (0.5%), *Entamoeba histolytica/dispar* (14.2%), *Entamoeba coli* (16.6%), *Giardia intestinalis* (7.2%), *Chilomastix mesnili* (2.4%), *Blastocystis spp* (2.1%) and *Cryptosporidium* sp (4.3%). Co-infections by two or three parasites were present among infected subjects.

Overall IPIs prevalence was not significantly influenced by gender, age, detention duration, education level, handwashing practices, sanitation and drinking water source. However, highest IPIs prevalence occurred in males aged 30 to 49 years old, less than one year detainees, latrine users and those who drank borehole water. Systematic handwashing practices and education level did not influence significantly IPIs prevalence. All helminthe infections were of light intensities.

Inmates in the New Bell central prison were parasitized by several species of protozoa and intestinal worms in varying prevalence depending on the detention period, the sex, the age and hygiene. A regular IPIs control among prison inmates was recommended to the NBCP managers to prevent related morbidity.

Key words: *intestinal parasites, protozoa, helminthes, prevalence, inmates, New-Bell central prison, Douala*

INTRODUCTION. Intestinal parasitic infections (IPIs) are among the most prevalent neglected tropical diseases (NTDs), affecting one third of the world's population and rely mainly on poor hygiene and sanitation living conditions [1]. Highest IPIs prevalence were reported mostly across sub-Saharan Africa countries where favouring factors were primarily scattered and overcrowded settlements where aggravation factors identified were safe drinking water, lack of hygienic behaviour, improper sanitary habits, poor faecal disposal systems and poor socioeconomic status [2]. Despite significant progress

made in most African countries to improve sanitation and access to potable drinking water, in 2012 only 74% and 45% of the Cameroonian population used improved drinking water sources and improved sanitation respectively, the remaining population therefore used poor sanitation conditions and doubtful drinking water source [3] therefore giving the way to poor hygiene-related infectious diseases.

In 2002, the human rights reported overcrowding in Cameroonian prisons with an approximate 450% population increase than their normal capacity [4,5]. Such high increase in prison population likely worsened living conditions to below acceptable standard and aggravated health problems by contributing to the spread of hygiene-related communicable diseases such as intestinal parasitic infections. The high numbers of persons per unit space create inadequate or poor nutritional quality, and overall low-living standards compared to the general population. Inmates may therefore have limited access to basic potable drinking (clean) water as demand increases, poor sanitation and hygiene conditions in the prison through lack or insufficient waste disposals and convenient latrines. Such unhealthy conditions may therefore favour open air defecation, poor handwashing practices before eating or after defecation in the prison area.

Hygiene-related intestinal parasitic infections data made available in prisons from some African countries indicated high overall prevalence of IPIs always over 70% at Ouagadougou [6], some Nigerian prisons namely Keffi prison, Owerri prison and Jos Central Prison [7,8,9,10] and Ethiopia [11]. In Kajang Prison, Selangor, Malaysia an overall 26.5% IPIs prevalence was reported among inmates [12]. Depending on the laboratory diagnostic techniques used, intestinal parasite found in stool samples in either studies belonged to various Protozoa and/or helminthes species and were recovered singly or in combinations. Such reports on intestinal parasitic infections in any Cameroonian prison were not available in the literature. Thus an evidence-based IPI's control strategy could not be recommended so far. However, previous hospital-based and community-based studies indicated variable prevalence of IPIs among residents of the Douala city [13,14].

This study thus aimed to assess the prevalence of intestinal parasitic infections including protozoa and helminthes infections in inmates of one the biggest prison in Cameroon, the New Bell central prison which is located in Douala metropolis. As IPIs may have significant health impact on the affected subjects, knowledge on their prevalence and major favouring factors will enable recommend specific IPIs control safeguard in the New-Bell central prison as well as other prisons in Cameroon.

MATERIAL AND METHODS

Study type, time and place. This was a cross-sectional study carried out from December 2014 to May 2015 in the New-Bell Central Prison. The New-Bell Central Prison is located in the New-Bell health area in Douala town and is of the biggest prison among the 10 central prisons in the Cameroon territory. This prison was ranked as a central prison according to a classification made by "The African Commission on Human and Peoples' Rights (ACHPR)" in 2002 [4]. This ACHPPR classification distinguished three main categories of prisons in Cameroon namely central prisons which are located in the capital city of the Regions, principal prisons which are linked to magistrate courts accommodating all categories including pre-trial prisoners, and secondary prisons which only accommodate sentenced prisoners and are spread across the country [4].

The New-Bell Central Prison was constructed in the years 50th to host a maximum of 800 prisoners [15,16]. At the time this assessment study was conducted, the New-Bell Central Prison hosted 3002 inmates according to census data received from the prison's authority. This population included 12 less than 18 years old prisoners named juveniles, 39 female inmates and 2951 adult males. The New-Bell central infrastructures were mostly dilapidated despite some repairs by NOGs.

The national observatory for human rights defines a detainee as any person punished by its society's law for misconduct [15]. In the New-Bell Central Prison, males and females inmates were separated, each sex occupying a sector also called quarter. The men's sector was divided into sub-sectors namely minors, eldest persons, previous administrators also named VIP (very important persons), disabled inmates, and an interior main hall for homeless inmates. Inmates in the main hall were the greatest number of prisoners maintained in open air conditions and subjected to any poor living conditions. Access to potable water was limited to five tap water points. Sanitation conditions were made of one toilet for each quarter therefore limiting waste disposals and likely favouring open air defecation. The interior main hall of the New-Bell Central Prison was usually flooded after heavy rains. The New-Bell Central Prison had a health centre with a pharmacy. However, heavy suffering detainees were transferred to reference hospitals in case of necessity [16].

Douala town itself is the economic capital of Cameroon and is located close to the Atlantic Ocean in the gulf of Guinea. Douala has a equatorial climate with four seasons including a greater dry season from November to March, a small rainy season which extend from March to June, a small dry season from June to August and a greater rainy season which extends from August to November. Mean annual ambient temperature is 26°c.

Ethics. Prior to starting the study, an ethical clearance, a research authorization and institutional authorization were secured from the Douala University ethical review board, the Littoral Regional Delegation of Public Health and the Manager of the New-Bell Central Prison respectively. A meeting was then held with the medical staff of the prison, prisoners guards, the leaders of each prison's quarter and the study investigators during which the research investigator presented and explained the study aim and protocol. A recruitment calendar was arranged together with the medical staff of the prison and prisoners guards. Leaders of the prison's headquarters were charged to explain the aim of the research since it was risky for investigators to face inmates for such matter. After inmates had the study information, investigators were therefore allowed to face them for data collection. During each data collection visit, the research team was accompanied by prison wardens and a member of the prison's medical staff who provided protection and assistance.

Study criteria. Only volunteered inmates of the New-Bell Central Prison irrespective to gender, age, reason of detention and detention duration who signed the study consent form were included in the study. Visitors, the prison staff, inmates who did not sign the study consent sheet and inmates who could not provide sufficient stool sample were not admitted in the study.

Data collection. Each volunteer inmate of the New Bell Central Prison who was included in the study had to response to a questionnaire and after provided an adequate stool sample. The questionnaire sought demographic information and hygiene practices. Demographic data sought were age, sex, time spent in the jail (also termed as detention duration) and educational level. Hygiene

practices referred to systematic handwashing before eating or after defecation, toilet type used for defecation, drinking water source and walking barefooted practices. A pre-labelled screw cap plastic container was then handed out to each participant and the later was asked to provide a thumb-sized fresh stool sample early in the following day morning. Stool containing containers were collected before 10 am and the fresh faecal samples were readily transferred to the parasitology laboratory of the Faculty of Medicine and Pharmaceutical Sciences within 2 to 4 hours post-collection for laboratory analysis.

Each stool sample was investigated in laboratory for possible parasites as fresh mount plus lugol's iodine, thick smear according to Kato method and sediment from centrifuged formalin-ether concentration as described by Cheesbrough [17]. Protozoan cysts were confirmed after adding iodine on fresh mount as well as formalin-ether concentrated sediment. The Kato-Katz technique was used for helminthe eggs counting as number of eggs per gram of stool (epg). *Cryptosporidium* sp oocysts were diagnosed after staining each formalin-ether concentration derived sediment by the modified Ziehl-Neelsen technique. Processed stool samples were appropriately examined under light microscope by experienced technicians and the investigators for the presence of intestinal parasites.

Data were analyzed using the software STATA CSPRO/SE, the Chi-square test for statistical analysis considering a p-value less than 0.05 as statistically significant.

RESULTS

A total 374 inmates who provided adequate stool sample were included in the study. As shown in table I, 95.5% participants were males, less than 18 years old inmates were the least represented group and inmates aged between 18 to 49 years were the most represented groups.

Intestinal parasites biodiversity recorded in stool samples. Tables I and II indicated that 9 intestinal parasites species were diagnosed during the study. These parasites belonged to protozoa and helminthe. These intestinal parasites belonged to four biological classes namely Amoeba, Flagellates, Nematodes and Trematodes. Protozoa species were diagnosed as cysts and for some species also as trophozoites whereas helminthes parasites were diagnosed only as eggs stage. Protozoa species were *Giardia intestinalis, Entamoeba histolytica/dispar, Entamoeba coli, Chilomastix mesnili*, *Blastocystis hominis and Crypstosporidium* sp. Helminthe parasites belonged to 3 species namely *Ascaris lumbricoides,Trichuris trichiura, Schistosoma mansoni*.

Overall IPIs prevalence. As indicated in the tables I and table II, 147 inmates had intestinal parasites in their stool sample owing an overall prevalence of intestinal parasitic infections was 39.3%. Prevalence of protozoa and helminthe infections was 24.6% and 16.6% respectively. Mixed infections by helminthes or protozoa as well as by protozoa and helminthes were diagnosed in some inmates stool samples. Co-infections recorded were *E.coli* + *A.lumbricoides, G.intestinalis* + *T.trichiura, E.histolytica/dispar* + *A.lumbricoides, E.histolytica/dispar* + *T.trichuira* and *E.coli* + *S.mansoni.* Prevalence of each of the co-infection was 0.5%.

One inmate (0.3%) harboured a co-infection by three parasite species namely *E.coli* + *G.intestinalis* + *A.lumbricoides*.

Prevalence of IPIs according to gender and age groups. Table I indicated that age and gender did not significantly influenced IPIs among inmates. However, prevalence of intestinal infections was significantly different between males and females inmates, males always bearing higher infection prevalence than females. This trend was identical when considering specific infections except the cases of *G.intestinalis, Cryptosporidium* sp and *T.trichiura* infections in which female inmates had higher infection prevalence than males.

According to age, inmates aged between 18 years and 49 years always had higher overall prevalence of infection by protozoa as well as helminthes infections than juvenile and older inmates. Also, considering specific infection, inmates aged less than 18 years and those aged over 50 years were frequently less parasitized.

Influence of jailed time in the New-Bell Central prison. Inmates who spent less than 1 year in the NBCP were the most represented group (56.9%). Those who had spent more than 10 years in the prison were the least represented group (3.5%). Neither overall infection prevalence, nor any specific intestinal parasite infection was significantly influenced by the jailed time in the NBCP (khi^2= 1.0; df2, p = 0.05). Inmates who had spent less than one year in the NBCP had the highest infection prevalence (41.3%) whereas those who spent more than 10 years in the prison had the lowest infection prevalence (7.6%). Overall prevalence of protozoa infections was also highest but not statistically significant in inmates who spent less than one year in the NBCP. Overall helminthe prevalence was highest among inmates who spent between 1 year and 10 year in the NBCP. Considering specific infection, inmates who spent 1year to 10 years in the NBCP, prevalence of *E.histolytica/dispar* and *G.intestinalis* infection showed highest prevalence of protozoa infections while the highest prevalence of helminthe infections was recorded in *A.lumbricoides* infected inmates.

Influence of education level on IPIs prevalence. According to school attendance, inmates were either illiterate or attended primary, secondary or higher education level. Inmates with a secondary education level were the most represented group (64.4%). There was no significant influence of educational level on IPIs prevalence (χ^2= 2.4; df3, p= 0.05). IPIs prevalence was however highest among primary level educated inmates (68.2%) whereas inmates who higher education level had the least IPIS prevalence (3.3%). When addressing specific parasite infection, inmates who attended only primary or secondary school had the higher infection prevalence than the other groups.

Influence of handwashing practices and drinking water source. According to handwashing practices before eating and after defecation, inmates who declared systematically washing hands before eating and after defecation were the most represented groups (73.5% and 74.6% respectively). As shown in table II, highest overall IPIs prevalence was recorded among inmates who systematically washed hands before eating and those who did not systematically wash hands after defecation. Prevalence in specific infections showed similar trend with highest prevalence of infection by either protozoa or helminthe recorded in inmates who reported not systematically washing hands before eating.

According to drinking water source, inmates who participated in the study drank water from tap and/or borehole or exclusively mineral water. Those who drank tap water were the most represented group

(97.6%). IPIs were recorded in either inmate group. The highest overall prevalence of IPIs was recorded among inmates who drank water from borehole (44.4%). Also, prevalence of helminthe and protozoa infections was highest in inmates water from borehole (17.5% and 26.9% respectively). All inmates who drank exclusively mineral water were infected by a protozoa or a helminthe parasite. *Entamoeba coli* showed the highest protozoa infection prevalence (29.8%) among inmates who exclusively mineral water; whereas *T.trichiura* and *A.lumbricoides* prevalences were highest but similar prevalence among inmates who drank water from borehole.

Participants who reported walking sometimes barefooted represented 13.4% of study sample. *Schistosoma mansoni* was the only percutaneous infecting helminthe found in stool samples. *Schistosoma mansoni* infection occurred in one inmate owing a 0.5%.

Helminthe infection loads. Mean *A.lumbricoides* and *T.trichiura* parasitic loads were 331 eggs per gram of faeces (epg) each. Parasitic loads among inmates infected by *A.lumbricoides* or *T.trichiura* ranged between 48 epg to 1536 epg of faeces and 48 epg to 552 epg of faeces respectively indicating overall light intensities of infection. Parasitic load for *S. mansoni* ranged between 96 and 384 epg of faeces (mean 240 epg of faeces).

DISCUSSION

This study aimed to establish the biodiversity, prevalence and identify main risk factors of intestinal protozoa and helminthe infections among inmates of the New-Bell central prison in Douala, Cameroon. Intestinal parasites recorded in this study belonged to protozoan and helminthes namely *E.histolytica/dispar, E. coli, G.intestinalis, Chilomastix mesnili, Blastocystis hominis*, *Cryptosporidium* sp, *Isospora* sp, *A.lumbricoides, T.trichuira* and *S. mansoni*. Among these parasites species identified, some are known highly harmful to human being and others less pathogenic. Also, all the parasites were of the most common species commonly found in stool samples in Cameroon and most African countries in community-based as well as hospital-based studies. Studies among inmates in Keffi and Owerri prisons reported the same protozoa parasites species exception of *Chilomastix mesnili* and *Blastocystis hominis* **[7,8]**. In a previous study focussed on laboratory analysis of stool samples from both HIV positive and HIV negative adult male inmates in Kajang Prison in Malaysia, both study groups harboured *Blastocystis sp., Strongyloides stercoralis, Entamoeba spp., Cryptosporidium spp., Giardia spp., and T.trichiura* as the major intestinal parasites using Kato-katz, formaline-ether concentration and Ziehl-Nelseen stained formalin ether-concentrated sediment with no statistical influence of HIV infection status **[12]**. Concerning helminthe infections, a greater diversity was reported in 2014 in the Jos prison in Nigeria **[9]** and the Shewa Robit prison in Ethiopia **[11]** with an additional occurrence of hookworm, *S.stercoralis* and *Taenia* sp. The greater biodiversity reported in the Nigerian and Ethiopian prisons may be due to the fact authors used also specific techniques namely Willis flotation technique, Graham tape test technique. IPIs parasites recorded in the New-Bell prison milieu show more parasites species than community-based [7] and hospital-based [6] studies recorded which did not found *Chilomastix mesnili* and *Blastocystis hominis* in the Douala town in 2013 and 2010 respectively.

Beyond the biodiversity, parasites co-infections by two or three intestinal parasites were recorded within the same inmates. Such parasites co-infections though at low prevalence indicated a risk to acquire multiple IPIs in the New-Bell central prison setting. Some of the parasites co-infections found were between known pathogenic parasites like *Entamoeba histolytica/dispar-Giardia intestinalis*, *Entamoeba histolytica/dispar–Ascaris lumbricoides* and *Giardia intestinalis–Ascaris lumbricoides.* Such combination may likely result to frequent complicated morbidity with clinical symptoms. Such intestinal polyparasitic infections were also reported in stool samples from inmates in the Nigerian prison **[7]**, the Ethiopian prison **[11]** and the Malaysian prison **[12]**.

The overall IPIs prevalence in New-Bell central prison was lower than reports from Nigerian prisons namely the Keffi prison in 2006 **[7]**, the Owerri prison **[8]**, as well as the Ouagadougou prison in Burkina-Faso **[6]** and the Shewa Robit prison in Ethiopia **[11]** where IPIs prevalence was always over 70%. Prevalence of IPIs in the New-Bell central prison was however higher than recent report from inmates in the Kajang prison, Selangor, Malaysia where in 2015 an overall 26.5% IPIs prevalence was reported among inmates **[12]**. These differences may not be due to laboratory techniques used since the studies undergone in Nigerian prisons, the Burkina-Faso prison and Ethiopia combined fresh mount and formol-ether concentration. Although other techniques were used in the study undergone in the Ouagadougou prison namely Willis and Scotch test anal, these latest techniques had specific goals. Interestingly, IPIs prevalence in the New-Bell prison setting was almost twofold high than overall prevalence previously reported from community-based **[13]** and hospital-based **[14]** studies in the Douala city. Such data indicated that inmates in the prison area were likely to acquire IPIs than subjects living outside of the prison or a lack of frequent management of infected inmates or that may be related to poor hygiene living conditions in the prison compared to standard. In fact, as indicated in material and methods section, the majority of the inmates in the New-Bell central prison are poor and homeless with limited access to potable water as well as sanitation. Such living conditions likely favoured poor handwashing practices before eating or after defecation in the prison area and also favoured open air defecation. As the interior main hall of the New-Bell central prison was usually flooded after heavy rains, parasitic infections among prisoners will be aggravated as the floods will spread parasites from any open air defecation.

Risk factors which influence on the IPIs prevalence were sometimes controversial among African prisons. Data from this study indicated highest IPIs prevalence in male inmates than females, young inmates and those who spent less than one year in the New-Bell central prison. Data according to gender corroborated trend from recent findings among inmates in Maiduguri prison in 2013 **[18]** and Jos Prison **[9]** in Nigeria who reported IPIs only among male inmates but were in accordance with data recorded in 2008 in Owerri prison in Nigeria who reported higher IPIs among female inmates than males **[8]**. Such lesser IPIs prevalence among female inmates of the New-Bell central prison may be due to better cleaner living environment found by the study investigators in their quarter compared to the open air quarters of most homeless male inmates. However, highest IPIs prevalence and parasites biodiversity recorded among less than 50 years old inmates was in general main trend in all African prisons as indicated in reports from some Nigerian prisons namely Jos, Owerri and Keffi

277 prisons and in Honduras prison **[7,8,9,19]**. Occurrence of high IPIs prevalence may be due to the fact
278 youngest inmates are mostly financially poor and live predominantly in the open air.
279 This study data also indicated higher IPIs prevalence among inmates who spent less than one year in
280 the prison compared to other groups corroborate reports from data other prisons where newly jailed
281 inmates were all parasitized in the Nigerian Keffi and Maiduguri prisons **[7,18]**. Such high parasitic
282 infections frequency may either indicate that they were infected before the custody or also be a result
283 of the almost despaired often reported among newly jailed persons who may abandon major hygiene
284 practices regulation.
285 According to education level, data showed an unexpected observation pointing illiterates to be less
286 frequently infected than literates although higher education level has often been considered as a
287 factor of good hygiene practice adhesion. We could not find an explanation to such data as data from
288 a community-based investigation in the Douala town one year before found illiterates bearing higher
289 IPIs prevalence compared to literates **[13]**. Data indicated higher IPIs prevalence among inmates who
290 did not systematically wash hands before eating or after defecation compared to those who
291 systematically washed were relevant therefore calling for improvement of hygiene practices among
292 inmates. Good handwashing practices before eating and after defecation remains the main tool
293 recommended for IPIs prevention in endemic areas **[3]**.
294 Data from this study call for the New-Bell central prison workers to improve drinking water quality from
295 tap and borehole since these two groups were predominant and had the greater number of
296 parasitized inmates. Those who declared drinking exclusively mineral water were also parasitized.
297 Although *Schistosoma mansoni* was recorded in this study, this percutaneous transmitted intestinal
298 parasitic infection seemed not to be transmitted in the prison area where only pocket waterbodies
299 were found in the New-Bell jail area only after rainfall and which dried some hours after the rainfall.
300 Transmission sites of this parasite were therefore not found in the study site. No other percutaneous
301 infection was recorded in this study therefore not corroborating data from stool samples analysis
302 collected from inmates in the Jos Prison in Nigeria where significant *Ancylostoma duodenale, S.*
303 *mansoni* and *Strongyloides stercoralis* infections were reported **[9]**.
304 IPIs transmission risk factors included in this study were not the only which could be investigated. In
305 fact, other living practices like eating raw, uncooked or unwashed food as well as person to person
306 transfer through handshake might be regarded as a probable source of intestinal parasitic infections
307 especially protozoan infections among inmates of the New-Bell Central Prison. Also, overcrowding in
308 the prison likely worsen waste disposal also favouring hygiene-related parasitic infections.
309 **Protozoa infections prevalence.** Protozoa infections biodiversity recorded in this study was
310 higher than earlier data reported in other African prisons unlike in Nigerian prisons **[7,8,9]**,
311 Ouagadougou prison **[6]** and the Ethiopian prison**[11]**. However pathogenic intestinal protozoa
312 infections were also reported in these African prisons indicating a widespread of such IPIs. Of the
313 protozoa infections identified, *E coli, C.mesnili* and *B.hominis* are known non pathogenic whereas the
314 others namely *E.histolytica, G.intestinalis* are known pathogenic. Presence of *E.histolytica*
315 trophozoites stages indicated therefore that the carrier inmates were experiencing a patent
316 amoebiasis. *Giardia* sp infections prevalence recorded was higher than data from previous studies in

two quarters of Douala town **[13]**. *Cryptosporidium* sp and *Isospora belli* oocysts recorded in the New-Bell central prison inmate's stool samples have not yet been reported in previous studies in other prisons. These intestinal Sporozoa are always considered as opportunistic in HIV patients indicating that they may likely worsen the morbidity stage in case of HIV infections in these subjects. Prevalence of intestinal protozoa infections was however lower than values reported earlier in the Owerri Nigerian prison **[8]**.

Intestinal helminthes infections prevalence. Of helminthe species recorded in this study, *Ascaris lumbricoides* infections were the most frequent as in general rule from many epidemiological studies in tropical areas **[2]**. *Trichuris trichuira* which is always considered as a less pathogenic intestinal helminthe parasite was less prevalent.

Overall intestinal helminthes infections prevalence was high than data reported in some African prisons namely Jos prison **[9,10]** and Ouagadougou prison **[6]** but was some twofold to threefold lesser than prevalence reported in other Nigerian prisons namely Keffi prison **[7]** and Owerri prison**[8]** in 2006 and 2008 respectively. These higher helminthes infections prevalence may have been due to additional specific techniques used by the authors namely the Willis flotation and Graham tape test techniques. Overall intestinal helminthes infection prevalence in the New-Bell central prison was however higher than previous data from community-based and hospital-based studies in Douala main town **[13,14]** indicating existence of high risk factors in the New-Bell setting. Helminthes infection prevalence in the New-Bell central prison though of light intensity infection need special attention from the prison medical staff for periodic management of intestinal parasitic infection. *Schistosoma mansoni* infection recorded in this study could not have any explanation linked to the prison environment since standing waterbodies found in the prison yard resulted from the rain and dry up rapidly before the next day. This Schistosoma infection cases were probably out-of-prison infections.

CONCLUSION. Data from this study sorted the vulnerability of the New-Bell central prison inmates to IPIs, the high diversity of parasitic infections among the inmates, and poor living conditions which likely aggravated the intestinal parasites infection process. These data which can be generalized to almost all prisons in Cameroon call for the New-Bell central prison manager and the prisons authorities in the whole country to improve living conditions of inmates such limitation of overcrowding, increase clean water supply and sanitation access which will in turn limit poor hygiene related infections such as IPIs. Also, a control scheme for intestinal parasitic infections through regular administration of antiprotozoa and antihelminthic drugs may be implemented in completion of water and sanitation access.

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Table I. Prevalence of intestinal parasites carriage according to gender, age groups, detention duration and education level

Infection type	Total	GENDER			AGE GROUPS (years)					DETENTION DURATION (years)				EDUCATION LEVEL				
		M	F		< 18	18-30	31- 49	≥ 50		< 1	1–10	>10	P	Illiterate	Primary	College	Higher	P
Sample size	374	357	17	P	9	150	185	30	P	213	148	13		18	85	241	30	
Overall prevalence	39.3	39.7	29.4	0.46	11.1	42.7	43.8	3.3	0.72	41.3	39.2	7.6	0.7	5.5	68.2	36.1	3.3	0,0
Protozoa	24.6	24.9	17.6	0.61	11.1	26.0	28.1	0	0.64	27.7	22.3	0	0.6	5.5	14.1	32.4	3.3	0.4
Helminthes	16.6	17.1	11.8	0.61	11.1	14.0	21.1	3.3	0.47	15.5	18.9	7.3	0.6	0	22.3	17.4	3.3	0.3
G.intestinalis	7.2	6.7	17.6	0.40	0	7.3	8.6	0	0.47	9.4	4.7	0	0,2	0	3.5	9.9	0	0.3
E. coli	16.6	17.1	5.9	0.96	0	23.3	14.6	0	0.57	4.3	1.1	0.2	0,1	0	8.2	22.8	0	0.0
E. histolytica	14.2	14.8	0	0.22	11.1	18.7	13.0	0	0.92	13.6	16.2	0	0.2	0	9.4	18.7	0.8	0.6
C. mesnili	2.4	2.5	0	0.82	0	2.7	2.7	0	0.79	2.8	2.0	0	0.4	0	0	3.7	0	0.3
B. hominis	2.1	2.2	0	0.82	0	4.0	1.1	0	0.66	2.8	1.3	0	0.6	0	1.1	2.9	0	0.0
Cryptosporidium	4.3	4.2	5.9	0.36	0	4.7	4.9	0	0.8	5.2	3.4	0	0.3	5.5	5.9	3.7	0	0.4
A.lumbricoides	10.4	16.5	0	0.15	0	9.3	12.9	3.3	0.16	9.8	11.5	7.6	0.8	0	14.1	11.2	0	0.7
T.trichiura	5.1	4.8	11.8	0.32	0	7.3	4.3	0	0.82	5.2	6.1	0	0.6	0	7.0	6.2	3.3	0.4
S. mansoni	0.5	0.6	0	0.75	0	0.3	0.2	0	0.96	0.5	0.7	0	0.9	0	1.1	0	0	0.8

M: male; F: female; *A.lumbricoides: Ascaris lumbricoides ; T. trichiura: Trichuris trichiura ; S. mansoni: Schistosoma mansoni. E.histolytica: Entamoeba histolytica. E. coli: Entamoeba coli. G.intestinalis: Giardia intestinalis. C. mesnili: Chilomastix mesnili. B. hominis: Blastocystis hominis.*

Table II. Prevalence of intestinal parasitic infection according to handwashing practices, sanitation type used, drinking water source

		Handwashing practices						Sanitation type			Drinking water type*			
		Before eating			After defecation			Modern	Latrine		Tap	Borehole	Mineral water	
	Overall	Yes	No		Yes	No								
Sample size	374	275	99	P	279	95	P	48	326	P	365	63	47	P
Overall prevalence	39.3	40.4	36.4	0.06	36.5	47.4	0.08	25.0	44.5	0.07	33.7	44.4	40.4	0.5
Protozoa	24.6	20.7	35.3	0.07	19.7	38.9	0.06	18.7	25.5	0.08	18.3	26.9	29.8	0.4
Helminthe	16.6	14.9	21.2	0.06	12.9	27.4	0.06	16.7	16.7	0.07	12.9	17.5	19.1	0.3
Giardia intestinalis	7.2	4.4	15.1	0.79	6.4	9.5	0.25	8.3	7.0	0.78	5.2	9.5	6.4	0.6
E. coli	16.6	8.4	39.4	0.42	10.4	34.7	0.02	22.9	15.6	0.12	10.1	19.0	29.8	0.4
E. histolytica	14.2	9.8	41.1	0.14	12.2	20.0	0.77	8.3	15.0	0.87	9.9	17.5	14.9	0.7
Chilomastix mesnili	2.4	1.8	4.0	0.54	2.1	3.1	0.55	2.1	2.4	0.7	1.9	3.2	0	0.8
Blastocystis hominis	2.1	1.1	5.1	0.09	1.8	3.1	0.55	2.1	2.1	0.7	1.4	1.6	4.2	0.8
Cryptosporidium sp	4.3	2.5	9.1	0.4	0.3	10.5	0.04	4.2	4.3	0.8	1.9	11.1	4.2	0.7
A.lumbricoides	10.4	9.1	14.1	0.15	10.7	9.5	0.72	6.2	11.0	0.6	10.1	9.5	4.2	0.2
Trichuris trichiura	5.1	4.0	8.1	0.10	5.7	3.1	0.32	4.2	5.2	0.7	3.6	9.5	2.1	0.4
S.mansoni	0.5	NA	NA	NA	NA	NA	NA	NA	NA	0.5	NA	NA	NA	NA

*Some inmates drank water from different sources. NA: not applicable