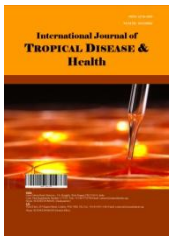

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Prevalence of Intestinal Parasites and Their Transmission Risk Factors among Inmates of Naivasha and Kisii Prisons in Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Parasites live off a host to survive where they grow, reproduce and invade organ systems therefore causing parasitic infections. Among the ten most common parasitic infections according to world health organization are hookworm, ascariasis, amoebiasis and trichuriasis. Parasitic infections in endemic countries shorten lives and impose a lifelong burden on the potential for advancement. Limited studies have been carried out to establish the prevalence of intestinal parasites among neglected and institutionalized groups of the population such as prison inmates which justified the need to establish the prevalence of intestinal parasitic infections (IPIs) among inmates of Kisii and Naivasha prisons in Kenya. A cross-sectional study was used. Four hundred inmates after sampling, provided stool samples for analysis. Formal-ether concentration techniques was used for identification of helminths eggs and cysts of protozoa while direct wet mount using saline and iodine was used for microscopic examination of loose stool for identification of trophozoites of protozoa. Data on the predisposing factors were collected using structured questionnaire and focus group discussion. Chi Square test was used to determine the association between age groups and sex

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while odds ratio was used to determine the association of personal hygiene and infection by intestinal parasites. The prevalence rate of intestinal parasites was 84(20.84%) with Kisii prison having a prevalence of 37(20.04%) while Naivasha prison having 47(21.56%). Intestinal protozoa infections were higher 50(12.4%) than helminthes 28(10.4%). Intestinal protozoa identified were *Entamoeba histolytica* 30(7.4%) and *Giardia lamblia 20(*4.9%) while the intestinal helminthes identified were *Ascaris lumbricoides* 22(5.5%), *Strongyloides stercolaris* 2(0.5%) and hookworms 4(1.0%). Chi square test showed that significantly more females were infected than males (χ^2 = 12.53, P=0.016, df = 2) as well as inmates of 18-27 years in both prisons (χ^2 = 9.36, P=0.007, df = 28). Correlation coefficient indicated that the infections increased with lack of footwear (OR 2.68, CI 0.94-3.41), failures to hand wash before meals (OR 2.88, CI 0.93-3.36) and after toilet use (OR 2.19, CI 1.02-4.44). Provision of health education and personal hygiene and sanitation, more pit latrines with enough water points for hand washing as well as sufficient footwear is recommended to reduce the IPIs in the prisons. This can be facilitated by the officers-in-charge in collaboration with the Ministry of health.

Keywords: Inmates; intestinal parasitic infections; prevalence; sanitation; prison.

1. INTRODUCTION

There are two types of intestinal parasites infesting humans; helminthes and protozoa. The main species of soil transmitted helminthes are *Ascaris lumbricoides, Trichuris trichura* and hookworms (*Ancylostoma duodenale* and *Necator americanus*) [1]. Significant level of morbidity and mortality across the globe especially in developing countries is caused by intestinal parasitic infections and more so in persons with additional disorders [2,3]. Transmission of *Ascaris lumbricoides* and *Trichuris trichura* occurs through ingestion of eggs passed out in stool by an infected person which becomes infective in soil where sanitation is poor [4]. Hookworm larvae cause infection by penetrating the skin. Approximately 1.7 billion people are infected with soil transmitted helminthes worldwide [5]. There is also a striking relationship between the prevalence of hookworm and low socio-economic status [6]. Pathogenic intestinal protozoa frequently isolated from diarrheal patients include *Giardia lamblia* and *Entamoeba histolytica* [4]. Some of the epidemiological factors that promote the transmission of intestinal parasites include poor personal hygiene, poor sanitation and waterborne epidemics due to water treatment failure, climatic condition and socio-cultural practices [7].

Prisoners get infected with diseases that are either due to their home environment prior to imprisonment or the prison environment. Prisoners are vulnerable to diseases due to poor health care delivery, overcrowding, high risk behavior such as homosexuality and reduced immunity compared to the general population [8,9]. Prisoners in Kenya just like those in other parts of the world such as California are faced with problems such as severe drug and substance abuse, HIV/AIDS, STDs, TB, skin and helminthes infections among others [9]. Furthermore, prison facilities are few and insufficient due to high growth rate of Kenya population and as such, the problem of congestion and overcrowding, degrading beddings and clothing, poor sanitation are experienced [10]. Most of these factors predispose the inmates to parasitic infections and because most of these infections are asymptomatic they are neglected to a point of chronic features appearing [10]. Those imprisoned represent a medically underserved population and are always at a higher risk of medical disorders [11]. Many studies have been carried out in children and mental institutions but very little work has been carried out in these neglected prison institutions. Results from this study will help to develop policies to improve the health aspects of inmates among the other ongoing reform programmes. Kisii and Naivasha Prisons were used for this study as the prisons have both male and female sections making the study all inclusive.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in two prisons in Kenya which have both male and female sections. 1) Naivasha prison is situated 2km north of the central business district of Naivasha town which is within Nakuru County in Kenya. It

has an attitude of 2084m above sea level. On average, it receives an annual rainfall of 677 mm and average temperature of 17°C [12].

2) Kisii prison is situated in Kisii County located in the western Kenya highlands at an altitude of 1660 M above sea level with an annual rainfall of 1500 mm, distributed throughout the year. It has annual temperatures range from 10 to 30°C and 88% relative humidity [13].

2.2 Study Design

A cross-sectional study of inmates from Kisii and Naivasha prisons was carried out to establish the prevalence of IPIs among the inmates. Four hundred inmates were sampled, stratified into three based on their jail terms; Short Jail Term (SJT), Medium Jail Term (MJT) and Long Jail Term (LJT). Inmates that attended the dispensary for treatment were picked by simple random sampling. Participation was voluntary after signing an informed consent.

Each of the sampled inmates recruited at the prison health facility was given dry, clean, leak proof container for 3gms stool collection and requested to bring early morning stool samples the following day. Diarrheic samples were examined immediately at Kisii and Naivasha prison dispensaries by wet mount technique [14,1]. The remaining stool samples of approximately 2 gm were mixed thoroughly with 10% formalin to preserve the trophozoites and emulsify formed stool. Shipment and laboratory examination within Kisii level 5 hospital and Naivasha maximum prison's health facilities was done. Formalin-Ethyl Acetate Sedimentation concentration technique was used [15].

The questionnaires were filled by inmates the morning of returning the stool specimen which provided data on demographic and socio-environmental factors that potentially predispose the inmates to parasitic infections. Chi Square test and ANOVA were used to determine the association between age and sex while adjusted odds ratio was used to determine the association between personal hygiene and infection by intestinal parasites. The differences were considered significant when the *p*-value was ≤ 0.05.

3. RESULTS

3.1 Prevalence of IPIs by Demographic Characteristics of Inmates

Four hundred inmates filled the questionnaires and provided stool specimen for the study of which 185(46.25%) were from Kisii prison while 215(53.75%) were from Naivasha prison.

The infection rates of intestinal parasitic infections with respect to sex was significantly higher among females than males (χ^2 = 12.53, P=0.016, df = 2). According to Table 1, age was statistically significant factor to the infection rate (χ^2 = 9.36, P=0.007, df = 28) where infection rate of intestinal parasites was higher among inmates of ages 18-27 years (41.67%) but hookworm infections were much higher among inmates of above 58 years 11.11%.

The male inmates sampled were more 311(77.75%) than females 89(22.25%) as the population of male inmates was higher than females in these prisons. Protozoa infections were proportionately higher among female inmates (13.48%) than the male counterparts (12.1%) and so were helminthic infections (7.86%) and (6.68%) as shown in Table 2. The infection rates of intestinal parasitic infections with respect to sex was significantly higher among females than males (χ^2 = 12.53, P=0.016, df = 2).

3.2 Risk Factors Associated with Protozoa and Helminthes Infections among Inmates

Table 3 shows some of the personal hygiene practices could influence transmission of intestinal parasites among the inmates as recorded from questionnaires and focus group discussions. Almost 52% of the inmates had no shoes out of which 22% had at least one intestinal parasitic infection. The odds of being infected with an intestinal parasite for a person not wearing shoes were 2. 68 (i.e 3 to 1 for a person wearing shoes). Lack of hand washing before meals had an odds ratio of 2.88 showing that 3 to 1 inmates not washing hands were at risk of infection with IPIs. Hand washing after visiting the toilet had an odds ratio of 2.19 which indicate that twice the numbers of inmates who do not practice hand washing after toilet use were predisposed to infections compared to those who washed hands.

Table 1. Age of inmates and type of parasite infection in the two prisons

Age	Age of respondents					
Intestinal parasites	**18 – 27 N=84 (%)**	**28 – 37 N= 161 (%)**	**38 – 47 N=103 (%)**	**48 – 57 N= 34 (%)**	**≥ 58 N= 18 (%)**	**ANOVA P-value**
E. histolytica	**17(20.24)[a]**	5(3.11)	5(4.85)	2(5.88)	1(5.56)	0.014
G.lamblia	6(7.14)	6(3.73)	5(4.85)	3(8.82)	0(0.00)	0.057
Total protozoa	**23(27.38)**	**11(6.83)**	**10(9.71)**	**5(14.7)**	**1(5.56)**	**0.061**
A. lumbricoides	12(14.28)	6(3.73)	3(2.91)	0(0.00)	1(5.56)	0.068
S. stercolaries	0(0.00)	1(0.62)	1(0.97)	0(0.00)	0(0.00)	0.159
Hookworms	0(0.00)	1(0.62)	1(0.97)	0(0.00)	2(11.11)	0.101
Total helminthes	**12(14.28)**	**8(4.97)**	**5(4.85)**	**0(0.00)**	**3(16.67)**	**0.395**
Total infection	**35(41.67)[b]**	**19(11.8)**	**15(14.6)**	**5(14.7)**	**4(22.22)**	**0.028**

Superscript a and b show results where infection rate was significantly higher among inmates aged 18-27 years as compared to other age groups ($\chi^2 = 9.36$, P=0.007, df = 28).

Table 2. Type of parasite infection relative to sex of the study subjects

Sex	Female	Male	ANOVA
Intestinal parasites	**n=89 (%)**	**n= 314 (%)**	**P- value**
E. histolytica	9(10.11)	21(6.68)	0.067
G. lamblia	3(3.37)	17(5.41)	0.088
Total protozoa	**12(13.48)[a]**	**38(12.1)**	**0.025**
A. lumbricoides	5(5.62)	17(5.41)	0.113
S. stercoralis	1(1.12)	1(0.318)	0.143
Hookworms	1(1.12)	3(0.95)	0.207
Total helminthes	**7(7.86)[b]**	**21(6.68)**	**0.014**
Total infection	**19 (21.34)[c]**	**59 (18.79)**	**0.041**

Superscript a, b and c shows results where protozoa and helminth infections were significantly higher among female inmates than their male counterparts ($\chi^2 = 12.53$, P=0.016, df = 6).

Table 3. Risk factors of transmission of intestinal parasites infections

Environmental factor n= 403	Number of inmates (%)	Infected inmates (%)	Odds ratio (95% cl)
Wearing shoes	194 (48.5)	38 (19.6)	OR 2.68
Not wearing shoes	**206 (51.5)[a]**	46 (22.3)	Cl (0.94-3.41)
Washing hands before meals	288 (72.0)	58 (20.1)	OR 2.88
Not washing hands before meals	112 (28.0)	**26 (23.21)[b]**	Cl (0.93-3.36)
Using soap while hand washing before meals	33 (8.2)	6 (18.2)	OR 1.47
Not using soap while hand washing before meals	255 (63.3)	52 (20.4)	Cl (0.22-2.19)
Washing hands after visiting the toilet	152 (37.7)	27 (17.8)	OR 2.19,
Not washing hands after visiting the toilet	**247 (61.8)[c]**	57 (23.1)	Cl (1.02-4.44)
Using soap while washing hands after visiting the toilet	33 (8.25)	4 (21.1)	OR 1.24, Cl (0.12-2.19)
Not using soap while washing hands after visiting the toilet	116 (29.0)	23 (19.8)	

Superscript a, b and c shows lack of shoe wear and failure to wash hands as some of the factors that significantly increased the risk of transmission of intestinal parasites infections.

4. DISCUSSION

The results in this study indicate that, intestinal parasitic infections were prevalent among inmates of Kenya prisons where 20% and 21.57% of the inmates in Kisii and Naivasha prisons respectively were infected with one or more species of intestinal parasites. This prevalence was lower than that reported by Rop [16] where 24.7% of inmates in Kisii prison in

Kenya were parasitized by IPIs. *E. histolytica* cysts are infectious when passed in stool or shortly afterward unlike helminth eggs which has to undergo development to infective forms in the soil or where the egg has to hatch into larvae and therefore protozoa can indefinitely propagate the infections unless treated. This could be the reason why *E. histolytica* was the most prevalent among the inmates [17].

Intestinal parasitic infections were significantly higher in females 21.34% than in males 18.97%. This could be attributed to the fact that, females were engaged more in garden activities. From focus group discussions, it was noted that, females had the habit of eating unwashed fruits and vegetables/salads which could be contaminated with intestinal parasites. From these garden activities, helminthes eggs present in soils contaminated by stool can adhere to hands and finger nails, ingested and thus causing infections [18]. This study is contrary to Acuna-soto [19] who reported that asymptomatic *E. histolytica* infection was distributed equally among both sexes.

In the current study, as age increased (from ≥18 years) the burden of intestinal parasite infection reduced. Inmates aged 18-27 years (27.38%) had higher prevalence of intestinal protozoa compared to those of ages> 58years (5.56%). These age groups of the inmates are the most active when it comes to duties assigned to them such as carpentry, farming and others. They are also mobile inmates taken to duties outside the prison walls thus high exposure to the parasites, increasing their risk of infection [20]. This is because the older inmates are confined and thus their movements are restricted. Hookworm infections were notably higher among inmates of age ≥58years (11.11%). Hookworm infection was higher in elderly people possibly due to a drop in immunity among elderly people [21,22].

High prevalence of various infections observed in this study may be attributed to the direct effect of the prison environment. This study shows that, most of the inmates that walked barefoot (51.9%) were 3 times more likely to get infected with intestinal parasites unlike those wearing shoes (OR=2.68, Cl 0.94-3.41). Wearing footwear protects the feet against penetration of hookworms and *Strogyloides stercolaris* larvae through the skin especially when working on farms and playing sports such as football barefoot [23]. It was reported that three times more inmates are likely to get infected with IPIs due to poor hygiene practices such as failure to wash hands before meals (OR 2.88, Cl 0.93-3.36). Failure to wash hands and eating raw, unwashed fruits and vegetables increases chances of infection by IPIs especially among immigrants and institutionalized people [24]. Furthermore overcrowding and high risk behaviors such as homosexuality predispose inmates to infections by IPIs [25,3]. Naivasha and Kisii prisons whose cells are recommended to house approximately 25 male inmates were housing 40-45 inmates. Kisii prison is one of the congested prisons in Kenya with poor living conditions for the prisoners. The dilapidated state of the prison toilets, buildings, infrastructure and environment may have contributed greatly to the declined health of the inmate as reported previously [17].

5. CONCLUSIONS

Intestinal parasitic infections are common in Naivasha and Kisii prisons with a prevalence of 20.8%. The most common protozoa were *Entamoeba histolytica* (7.5%) while the most frequently occurring helminthes was *Ascaris lumbricoides* (5.5%). The least occurring helminthes was *S. stercolaris* with a prevalence of 0.5% in both prisons. Poor personal hygiene practices including failure to wash hands before meals and after toilet use as well as not wearing shoes were some of the factors found to predispose inmates to intestinal parasitic infections in the study sites.

6. RECOMMENDATIONS

Due to the high prevalence of IPIs recorded, constant medical checkups should be provided to all inmates as well as treatment with anti-helminthes in case of infection. Public awareness on the transmission factors of intestinal parasites especially relating to environmental sanitation and personal hygiene in prison should be done to help reduce transmission of parasites. The conditions of the facilities in prisons such as toilets and sewage disposal should be improved as well as provision of constant and clean water supply.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical clearance was sought from the ethical review committee of Kenyatta University while the research permit was acquired from the National Commission for Research Technology and Innovation (NACOSTI) alongside the Ministry of Health in Naivasha and Kisii and the concerned officers-in-charge of the prison facilities.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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