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Intestinal parasitic infections and predisposing factors among prison inmates in Southern Ghana: A cross-sectional study

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Abstract

Background and Aims: The environment within prisons, such as overcrowding, lack of access to portable water, poor sanitation, and hygiene predisposes inmates to infections, including intestinal parasitic infections (IPIs). This study therefore determined the prevalence and associated factors of IPIs among prison inmates in Southern Ghana.

Methods: A cross-sectional study using the stratified sampling technique was employed. The study recruited 461 prison inmates across three notable prisons, with 50 inmates from Ho Central, 357 inmates from Nsawam Medium Security, and 54 inmates from Sekondi Central Prisons all in Southern Ghana. A structured closed-ended questionnaire was administered to collect data on sociodemographics, lifestyle/behavioral characteristics, and signs and symptoms of IPIs. In addition, stool samples were collected and analyzed for the presence of various stages of intestinal parasites (trophozoites, cysts, ova, and larva) using formol-ether concentration, and the modified Ziehl–Neelsen techniques.

Results: The prevalence of IPIs among inmates of the three selected prisons was 38.2% (95% confidence interval [CI]: 33.72%–42.79%). The prevalence of IPIs among inmates of the three prisons, the Ho Central, Nsawam Medium Security, and Sekondi Central were 46% (95% CI: 31.82%–60.68%), 37.5% (95% CI: 32.49%–42.79%), and 35.2% (95% CI: 22.68%–49.38%), respectively. After adjusting for confounders, the following factors; handwashing after defecation (adjusted odds ratio [AOR]: 0.05 [0.00–0.67]; $p = 0.024$), trimmed fingernails (AOR: 0.32 [0.13–0.76]; $p = 0.011$), itchy skin (AOR [95% CI]: 5.99 [3.43–10.43]; $p < 0.001$), anal itching (AOR [95% CI]: 0.35 [0.19–0.62]; $p < 0.001$), nausea (AOR [95% CI]: 5.57 [3.22–9.65]; $p < 0.001$), and worm expulsion (AOR [95% CI]: 3.80 [1.42–10.18]; $p = 0.008$) were found to be associated with intestinal parasitic infections.

Conclusion: The study revealed that the prevalence of intestinal parasitic infections among prisons in Southern Ghana is high and is therefore an important public health concern. The Public Health Department of Ghana Health Service should therefore embark on health promotion and deworming exercise in all prisons in Ghana.

KEYWORDS
Ghana, inmates, intestinal parasites

1 | INTRODUCTION

Intestinal parasitic infections (IPIs) are primarily caused by protozoans and helminths,[1] which are ubiquitous, and the mode of transmission is ostensibly by the oral-fecal route through consumption of contaminated food and water and contact with infected person. IPIs are associated with low socioeconomic and unhygienic environmental factors, thus are prevalent in areas where there is overcrowding, limited access to clean water, and poor personal hygiene.[2]

Prison environment presents a complex and thriving environment for the transmission of intestinal parasitic infections, with overcrowding, poor sanitation, unhygienic practices, and limited access to portable water and quality healthcare creating the perfect environment for spread of infections. Furthermore, a good number of prison inmates are often from poor economic backgrounds with long history of poor nutrition, substance abuse and poor hygienic practices which may impact on their immune system and make them susceptible to the infections.

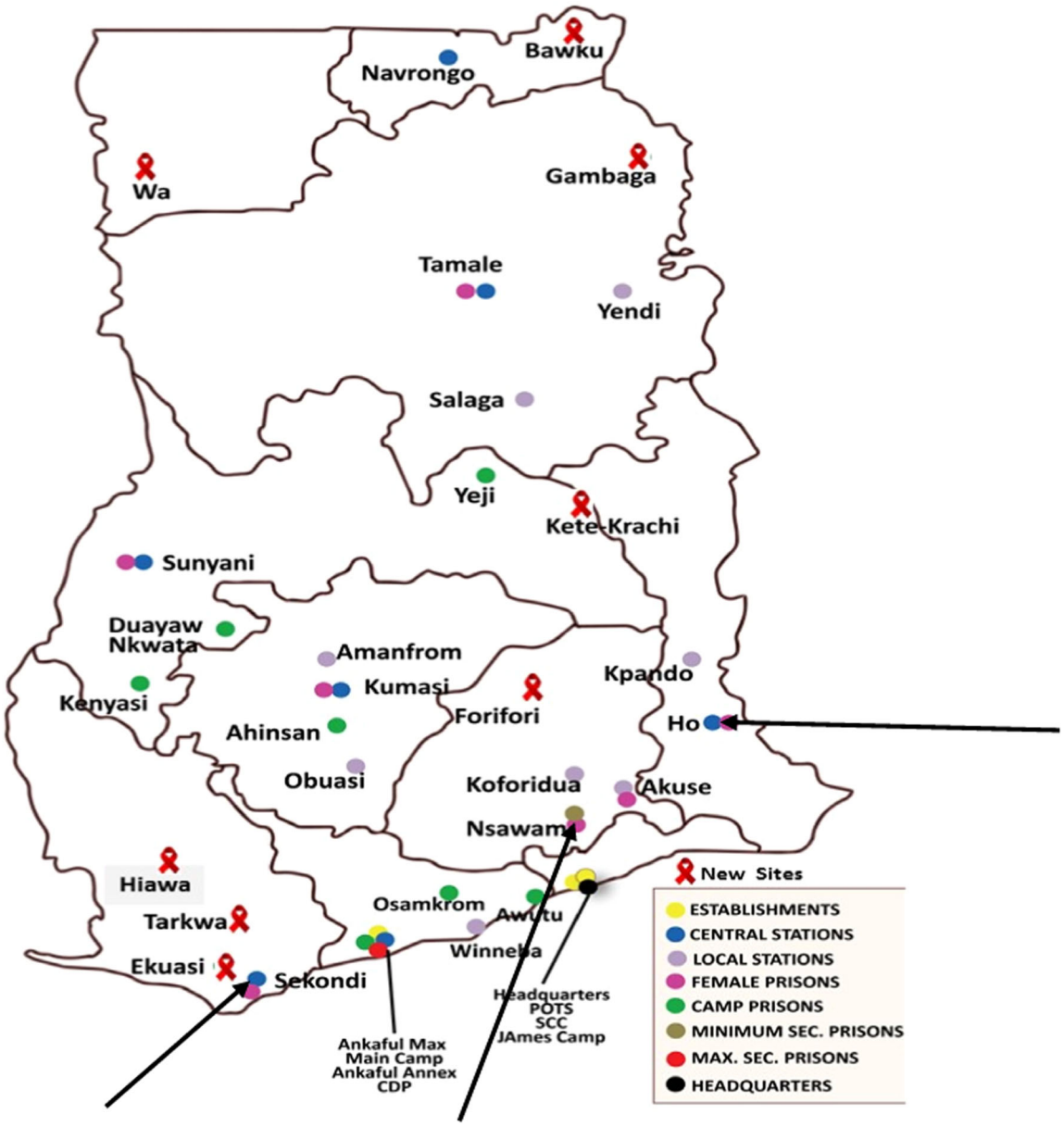

FIGURE 1 Map of Ghana showing all prisons with arrows pointing to the study sites. *Source*: https://www.ccmghana.net/index.php/2015-2017/hiv-aids/ppag/the-grant

Studies have reported varied prevalences of intestinal parasitic infections among prison inmates in different countries, ranging from 22.8%, 24.7%, and 33.5% in Nigeria,[3] Kenya,[4] and Guinea,[5] respectively and as high as 48.1% among prison inmates in Ethiopia.[6] These startling results coupled with the fact that most of these inmates would be present in the facility for years without adequate medical attention leaves little to be desired.

Studies have identified overpopulation and overcrowding as a common problem in Ghanaian prisons.[7] For example, the total population of incarcerated persons in Ghana had more than doubled from 4852 in 1982 to an estimated 14,000 in 2018.[8] The current occupancy level based on the official prison capacity is 141.7%, ranking Ghana on the 56th position on the world's most overcrowded prison system list.[9] This increase without a commensurate increase in prison infrastructure has naturally led to overcrowding as well as poor sanitation and hygienic conditions, which predisposes prison inmates to intestinal parasitic infections. This study therefore aimed to determine the epidemiology of intestinal parasitic infections among inmates of selected prisons in Southern Ghana.

2 | MATERIALS AND METHODS

2.1 | Study design/study site and population

A cross-sectional study using the stratified sampling technique was employed. The study recruited 461 prison inmates across three notable prisons, with 50 inmates from Ho Central, 357 inmates from Nsawam Medium Security, and 54 inmates from Sekondi Central

TABLE 1 Sociodemographic characteristics across study sites.

Variables	Total	Study sites			*p* Value
		Ho	Nsawam	Sekondi	
Age	38.41 ± 12.88	32.64 ± 10.53	38.72 ± 13.26	41.70 ± 10.61	0.03
Age (in years)					<0.001
Less than 20	6 (1.3)	5 (83.3)	1 (16.7)	0 (0.0)	
20–29	118 (25.6)	15 (12.7)	97 (82.2)	6 (5.1)	
30–39	171 (37.1)	21 (12.3)	129 (75.4)	21 (12.3)	
40–49	84 (18.2)	4 (4.8)	66 (78.6)	14 (16.6)	
50–59	48 (10.4)	4 (8.3)	33 (68.8)	11 (22.9)	
60–69	18 (3.9)	1 (5.6)	17 (94.4)	0 (0.0)	
70–79	16 (3.5)	0 (0.0)	14 (87.5)	2 (12.5)	
Sex					<0.99
Male	413 (89.8)	44 (10.7)	320 (77.4)	49 (11.9)	
Female	47 (10.2)	5 (10.6)	37 (78.7)	5 (10.6)	
Education					0.01
None	87 (18.9)	12 (13.8)	70 (80.5)	5 (5.7)	
Primary	78 (16.9)	8 (10.3)	54 (69.2)	16 (20.5)	
J.S.S.	138 (29.9)	21 (15.2)	100 (72.5)	17 (12.3)	
S.S.S.	107 (23.2)	6 (5.6)	87 (81.3)	14 (13.1)	
Tertiary	51 (11.1)	3 (5.9)	46 (90.2)	2 (3.9)	
Reside					<0.001
Rural	140 (30.4)	29 (20.7)	94 (67.1)	17 (12.1)	
Urban	320 (69.6)	21 (6.5)	263 (82.2)	36 (11.3)	
Duration of imprisonment					0.02
≤1 year	114 (24.7)	20 (17.5)	77 (67.5)	17 (14.9)	
2–5 years	271 (58.8)	22 (8.1)	217 (80.1)	32 (11.8)	
>6 years	76 (16.5)	8 (10.5)	63 (82.9)	5 (6.6)	

Note: Data are presented as frequencies and percentages in parentheses. $p < 0.05$ was considered statistically significant.
Abbreviations: J.S.S., Junior Secondary School; S.S.S., Senior Secondary School.

Prisons in Southern Ghana (refer to Figure 1) from January to June 2023.

2.2 | Data collection and laboratory analysis

The inmates who consented to be part of the study were assisted to complete a structured closed-ended questionnaire (adopted and modified from similar studies conducted by Mamo,[10] and Rop et al.[4]) to obtain data on personal information, behavioral factors as well as experience of symptoms of intestinal parasite infections.

A new leak-proof screw-capped plastic stool containers with wide necks and assigned unique identification numbers with permanent marker was given to each participant. Each participant was requested to provide about 2 g of stool sample within 24 h. The fecal samples were physically examined and determined to be either normal (formed) or diarrheic (watery). Diarrheic specimens were examined immediately at the various prison clinics by two certified Medical Laboratory Scientists. Samples were only declared as positive when both Scientists determined it to be so. In cases of disagreement, a third scientist assisted in the determination of the results.

Furthermore, formed stool samples were preserved in 15 mL of 10% formalin and transported under appropriate conditions to the School of Basic and Biomedical Sciences molecular laboratory of the University of Health and Allied Sciences, Ho, where Formol ether concentration and Ziehl–Neelsen (Z–N) technique were used to determine the presence of various stages of intestinal parasites (trophozoites, cysts, ova, and larvae) on each sample as described by Monica Cheesbrough.[11]

2.3 | Statistical analysis

Data extracted from the questionnaires and laboratory analysis results were first checked for correctness and entered into Microsoft Office

TABLE 2 Behavioral/lifestyle characteristics across study sites.

Variables	Total	Study sites			*p* Value
		Ho	Nsawam	Sekondi	
Handwashing after defecation					<0.001
Yes	425 (92.2)	25 (5.9)	346 (81.4)	54 (12.7)	
No	9 (2.0)	6 (66.7)	3 (33.3)	0 (0.0)	
Sometimes	27 (5.8)	19 (70.4)	8 (29.6)	0 (0.0)	
Handwashing before eating					<0.001
Yes	360 (78.1)	25 (6.9)	289 (80.3)	46 (12.8)	
No	10 (2.2)	5 (50.0)	5 (50.0)	0 (0.0)	
Sometimes	91 (19.7)	20 (22.0)	63 (69.2)	8 (8.8)	
Fingernails					<0.001
Trimmed	414 (89.8)	27 (6.5)	357 (86.2)	30 (7.3)	
Untrimmed	47 (10.2)	23 (48.9)	0 (0.0)	24 (51.1)	
Footwear					<0.001
Regularly	407 (88.3)	17 (4.2)	340 (83.5)	50 (12.3)	
Occasionally	53 (11.5)	32 (60.4)	17 (32.1)	4 (7.6)	
Not at all	1 (0.2)	1 (100.0)	0 (0.0)	0 (0.0)	
Drinking water					0.20
Pipe-borne water	443 (96.1)	46 (10.4)	346 (78.1)	51 (11.5)	
Sachet water	18 (3.9)	4 (22.2)	11 (61.1)	3 (16.7)	
Last deworming (in months)					<0.001
Not at all	18 (3.9)	18 (100.0)	0 (0.0)	0 (0.0)	
≤3	4 (0.9)	4 (100.0)	0 (0.0)	0 (0.0)	
4–6	72 (15.6)	3 (4.2)	60 (83.3)	9 (12.5)	
7–11	66 (14.3)	6 (9.1)	52 (78.8)	8 (12.1)	
≥12	301 (65.3)	19 (6.3)	245 (81.4)	37 (12.3)	

Note: Data are presented as frequencies and percentages in parentheses. $p < 0.05$ was considered statistically significant.

TABLE 3 Potential signs and manifestations of intestinal parasites stratified by study sites.

Variables	Total	Study sites			*p* Value
		Ho	Nsawam	Sekondi	
Watery stool					0.28
Yes	106 (23.0)	16 (15.1)	78 (73.6)	12 (11.3)	
No	355 (77.0)	34 (9.6)	279 (78.6)	42 (11.8)	
Constipation					<0.001
Yes	322 (69.9)	16 (5.0)	267 (82.9)	39 (12.1)	
No	139 (30.1)	34 (24.4)	90 (64.8)	15 (10.8)	
Itching skin					0.43
Yes	251 (54.5)	27 (10.8)	199 (79.2)	25 (10.0)	
No	210 (45.5)	23 (11.0)	158 (75.2)	29 (13.8)	
Anal itching					0.47
Yes	214 (46.4)	27 (12.6)	164 (76.6)	23 (10.8)	
No	247 (53.6)	23 (9.3)	193 (78.1)	31 (12.6)	
Nausea					0.46
Yes	190 (41.2)	21 (11.0)	151 (79.5)	18 (9.5)	
No	271 (58.8)	29 (10.7)	206 (76.0)	36 (13.3)	
Worm expulsion					0.02
Yes	25 (6.9)	0 (0.0)	25 (100.0)	0 (0.0)	
No	436 (93.1)	50 (11.5)	332 (76.1)	54 (12.4)	

Note: Data are presented as frequencies and percentages in parentheses. $p < 0.05$ was considered statistically significant.

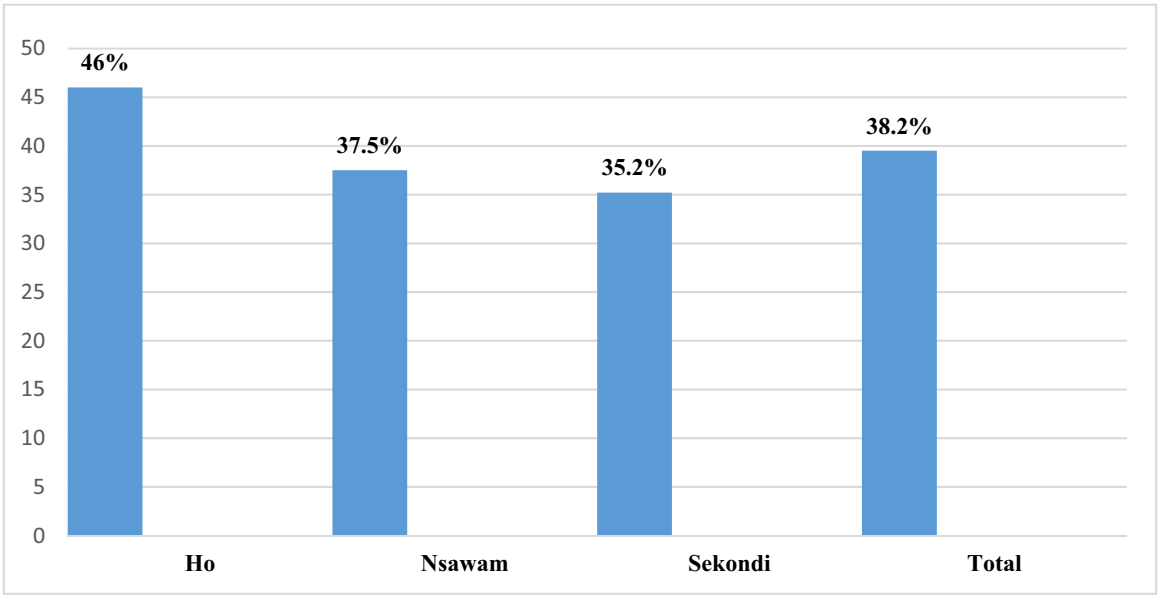

FIGURE 2 Prevalence of intestinal parasitic infections at various study sites and cumulatively.

2016 Excel Spreadsheet. Subsequently data was analyzed using Stata SE version 16 (64 bits) (Stata Corp.). Descriptive statistics was used and data was presented as frequencies and percentages with respect to inmates' sociodemographic characteristics and prevalence of intestinal parasitic infections among inmates. The association between risk factors and sociodemographic characteristics prevalence of intestinal parasitic infection was determined using the χ^2 test of association. Finally, the magnitude of the association between intestinal parasitic infections and

TABLE 4 Species-specific prevalence of intestinal parasitic infection.

Species	Frequency (%)
Protozoans	
Cryptosporidium parvum	1 (0.22)
Entamoeba histolytica	36 (7.81)
Isospora spp.	5 (1.08)
Giardia lamblia	14 (3.04)
Helminths	
Ascaris lumbricoides	61 (13.23)
Hookworm	16 (3.47)
Schistosoma mansoni	14 (3.04)
Trichuris trichiura	11 (2.39)
Coinfections	
A.L + E.H	3 (0.65)
A.L + H.W	3 (0.65)
A.L + I.B	1 (0.22)
A.L + S.M	3 (0.65)
A.L + T.T	4 (8.68)
E.H + H.W	1 (0.22)
E.H + S.M	1 (0.22)
T.T + S.M	1 (0.22)
A.L + H.W + S.M	1 (0.22)

Abbreviations: A.L, *Ascaris lumbricoides*; E.H, *Entamoeba histolytica*; H.W, Hookworms; I.B, *Isospora belli*; S.M, *Schistosoma mansoni*; T.T, *Trichuris trichiura*.

potential risk factors was then assessed using logistic regression and described in terms of odds ratio (OR) at 95% confidence interval (CI). p value less than 0.05 was considered statistically significant.

3 | RESULTS

3.1 | General characteristics of study participants

Table 1 shows the sociodemographic characteristics of study participants in the three prisons studied. The overall mean age of participants recruited was 38.41 ± 12.88 years. More than 60% of the inmates were within the ages of 20–29 years (118 [25.6%]) and 30–39 years (171 [37.1%]), respectively.

Overwhelming majority of participants were males 413 (89.8%). More than half, 245 (53.1%) had either Junior or Senior High School certificate. Furthermore, for residential status, the majority of 320 (69.9%) of the participants were found to be previously living in urban locations. With respect to the duration of imprisonment, more than half of the participants 271 (58.8%) had spent 2–5 years as inmates.

Furthermore, the vast majority of inmates 425 (92.2%) of the study participants had good hand hygiene practices and stated they washed their hands after using the toilet. Additionally, majority of 360 (78.1%) of the inmates washed their hands before meals. Majority of them had trimmed fingernails 414 (89.8%), wore footwear regularly 407 (88.3%), and drank pipe-borne water 443 (96.1%). Furthermore, more than half of 301 (65.3%) of the inmates had their last deworming activity in a year or more (Table 2).

Again, more than half 355 (77.0%) of the inmates did not experience watery stool. Also, 322 (69.9%) of inmates had constipation, and 251 (54.5%) of them had itching skin. A total of 247 (53.6%) of the participants had no anal itching, 271 (58.8%) did not experience nausea. With respect to worm expulsion, majority of 436 (93.1%) of the inmates recruited in the study did not have this experience (Table 3).

3.2 | Prevalence of intestinal parasitic infections among prison inmates

Overall, out of 461 inmates recruited across the three prisons, 176 (38.2%) presented with various intestinal parasites. Ho Central Prison had the highest site-specific prevalence with (46% [95% CI: 31.82%–60.68%]) (Figure 2). Most predominant protozoan and helminths were *Entamoeba histolytica* and *Ascaris lumbricoides* with 36 (7.81%) and 61 (13.23%), respectively (Table 4).

3.3 | Association between IPIs with sociodemographic and lifestyle/behavioral factors

No significant association was found between sociodemographic characteristics and intestinal parasitic infections (Table 5).

Table 6 displays the association between intestinal parasitic infections and lifestyle/behavioral factors. In the multivariate logistic regression, hand washing after defecation as well as trimming of fingernails were found to be associated with intestinal parasitic infections.

The odds of intestinal parasitic infections among inmates who washed their hands after defecation were 95% reduced compared to those who did not wash their hands (AOR: 0.05 [0.00–0.67]; $p = 0.02$). The odds of intestinal parasitic infections among inmates who had trimmed fingernails were 68% reduced compared to those who had untrimmed fingernails (AOR: 0.32 [0.13–0.76]; $p = 0.01$).

Table 7 shows the association between intestinal parasitic infections and signs and symptoms. After adjusting for confounders, itching skin, anal itching, nausea, and worm expulsion were found to be associated with intestinal parasitic infections.

Prison inmates who experienced itching skin had 5.99 times increased odds of intestinal parasitic infections compared to those who do not have itching skin (AOR: 5.99 [3.43–10.45]; $p < 0.001$).

TABLE 5 Prevalence of IPI by sociodemographic characteristics.

Variables	Total	IPI present	COR (95% CI)	*p* Value	AOR (95% CI)	*p* Value
Age (in years)						
Less than 20	6	3 (50.0)	1		1	
20–29	118	37 (31.4)	0.46 (0.09–2.37)	0.35	0.43 (0.10–1.86)	0.26
30–39	171	72 (42.1)	0.73 (0.14–3.71)	0.70	0.86 (0.21–3.51)	0.83
40–49	84	34 (40.5)	0.68 (0.13–3.57)	0.65	0.77 (0.19–3.18)	0.72
50–59	48	15 (31.3)	0.46 (0.08–2.52)	0.37	0.53 (0.11–2.46)	0.42
60–69	18	9 (50.0)	1 (0.16–6.35)	1.00	2.68 (0.44–16.13)	0.28
70–79	16	6 (37.5)	0.6 (0.09–3.99)	0.60	–	–
Sex						
Male	413	158 (38.3)	1		1	
Female	47	17 (36.2)	0.92 (0.49–1.71)	0.78	1.51 (0.67–3.46)	0.32
Education						
None	87	27 (31.1)	1		1	
Primary	78	33 (42.3)	1.63 (0.86–3.09)	0.13	1.17 (0.51–2.73)	0.72
J.S.S.	138	54 (39.1)	1.43 (0.81–2.52)	0.22	1.71 (0.79–3.67)	0.17
S.S.S.	107	42 (39.3)	1.44 (0.79–2.61)	0.24	1.52 (0.68–3.41)	0.31
Tertiary	51	20 (39.2)	1.43 (0.70–2.95)	0.33	1.21 (0.48–3.05)	0.69
Reside						
Rural	140	54 (38.6)	1		1	
Urban	320	121 (37.8)	0.97 (0.64–1.46)	0.88	1.15 (0.66–1.98)	0.63
Duration of imprisonment						
≤1 year	114	35 (30.7)	1		1	
2–5 years	271	111 (41.0)	1.57 (0.98–2.50)	0.06	1.74 (0.96–3.15)	0.07
>6 years	76	30 (39.5)	1.47 (0.80–2.70)	0.21	2.21 (0.95–5.19)	0.07

Note: $p < 0.05$ was considered statistically significant.

Abbreviations: AOR, adjusted odds ration; CI, confidence interval; COR, crude odds ratio; IPI, intestinal parasitic infection; J.S.S., Junior Secondary School; S.S.S., Senior Secondary School.

The odds of intestinal parasitic infections among inmates who had anal itching were 65% reduced compared to those who did not experience anal itching (AOR: 0.35 [0.19–0.62]; $p < 0.001$). Again, prison inmates who experienced nausea had 5.57 times increased odds of intestinal parasitic infections compared to those who did not experience nausea (AOR: 5.57 [3.22–9.65]; $p < 0.001$). Lastly, inmates who experienced worm expulsion had 3.80 times increased odds of intestinal parasitic infections compared to those who did not experience that (AOR: 3.80 [1.42–10.18]; $p = 0.008$).

4 | DISCUSSION

This study was conducted among three prisons, that is, Ho Central Prison, Nsawam Medium Security Prisons, and Sekondi Central Prisons, all in Southern Ghana to determine the prevalence and associated factors of intestinal parasitic infections among inmates. The overall prevalence of IPIs among inmates of the three prison studies was 38.2% (95% CI: 33.72%–42.79%). A comparable prevalence of 39.3% has been reported in Cameroon,[12] while lower prevalence of 33.5% has been found in a Guinean Prison,[5] 24.7% observed in Kenyan prisons,[4] 22.8% among inmates in Jos, Nigeria,[3] 26.5% in Malaysian prison,[13] and 6% prevalence in Nepal prison.[14] Conversely, a higher prevalence of 48.1% has been found among Arba Minch inmates in Southern Ethiopia[6] and 48.8% among inmates in Umuahia Abia State in Nigeria.[15]

The variation in prevalence among the prisons in various countries may be due to different inmate populations and overcrowding conditions as well as varying water, sanitation, and hygiene conditions. Again, the findings from the current study points to the fact that intestinal parasitic infections among the three selected prisons in Ghana are high. It is important to note that the presence of various intestinal

TABLE 6 Relationship between IPI and behavioral characteristics.

Lifestyle factors	Total	IPI present	COR (95% CI)	*p* Value	AOR (95% CI)	*p* Value
Handwashing after defecation						
Yes	425	157 (36.9)	0.47 (0.12–1.77)	0.26	0.05 (0.00–0.67)	0.02
No	9	5 (55.6)	1		1	
Sometimes	27	14 (51.9)	0.86 (0.19–3.92)	0.85	0.14 (0.01–1.96)	0.15
Handwashing after meals						
Yes	360	131 (36.4)	0.86 (0.24–3.10)	0.82	3.28 (0.50–21.63)	0.22
No	10	4 (40.0)	1		1	
Sometimes	91	41 (45.1)	1.23 (0.33–4.66)	0.76	5.28 (0.76–36.54)	0.09
Fingernails						
Trimmed	414	148 (35.8)	0.38 (0.20–0.70)	0.002	0.32 (0.13–0.76)	0.01
Untrimmed	47	28 (59.6)	1		1	
Footwear						
Regularly	407	153 (37.6)	0.79 (0.44–1.40)	0.41	1.36 (0.56–3.28)	0.49
Occasionally	53	23 (42.6)	1		1	
Not at all	1	0 (0.0)	—		—	
Drinking water						
Pipe-borne water	443	166 (37.5)	1		1	
Sachet water	18	10 (55.6)	2.09 (0.81–5.39)	0.13	2.34 (0.60–9.16)	0.22
Last deworming (in months)						
Not at all	18	9 (50.0)	1		1	
≤3	4	1 (25.0)	0.33 (0.03–3.84)	0.38	0.15 (0.01–2.90)	0.21
4–6	72	26 (36.1)	0.57 (0.20–1.60)	0.28	0.88 (0.17–4.44)	0.87
7–11	66	27 (40.9)	0.69 (0.24–1.97)	0.49	0.89 (0.17–4.61)	0.89
≥12	301	113 (37.5)	0.60 (0.23–1.55)	0.30	0.87 (0.18–4.13)	0.86

Note: $p < 0.05$ was considered statistically significant.

Abbreviations: AOR, adjusted odds ration; CI, confidence interval; COR, crude odds ratio; IPI, intestinal parasitic infection.

parasites can contribute to malabsorption of important nutrients,[16] allergic reactions,[17] anemia,[18] and could be life-threatening for immunocompromised individuals.[19] This observed prevalence therefore presents a significant cause for concern among all stakeholders.

Additionally, the current study found the prevalence of helminths (22.13%) to be higher than that of protozoa (12.15%). This finding is in line with the work of Morenikeji and colleagues, who reported helminths among prison inmates to be as high as 59.8% compared to protozoans with 42.3%.[20] Again, the current study results contradict that of Okolie[21] who reported protozoans (32.40%) to be higher than helminths (22.40%). It is important to note that eggs of helminths require sometime to be infective. Therefore, the lack of proper deworming activity provides a good environment for the thriving of intestinal helminths.

Also, the present study found an association between handwashing after defecation and intestinal parasitic infections (AOR: 0.05 [0.00–0.67]; $p = 0.02$). This finding is consistent with that of previous ones which observed that handwashing practices were significantly associated with intestinal parasitic infections among inmates in Ethiopia.[22] The finding of this current study is however different from that of others conducted among inmates from a systematic review[23] and among Ethiopian food handlers who both found hand washing to have no significant association with intestinal parasitic infection.[24]

Additionally, an association was observed between trimmed fingernails and intestinal parasitic infections (AOR: 0.32 [0.13–0.76]; $p = 0.01$). This observation in the present study is in sync with previous findings by Debisa[25] and Mardu et al.[22] in their studies conducted in Wolaita Zonal Prison, Southern Ethiopia, and Makelle Prison, Northern Ethiopia, respectively, which both pointed to the fact that trimmed fingernails among inmates were associated with intestinal parasitic infections. However, Ayu et al.[26] found no relationship between trimmed fingernails and intestinal parasitic

TABLE 7 Relationship between IPI and potential signs and symptoms.

Signs/symptoms	Total	IPI present	COR (95% CI)	*p* Value	AOR (95% CI)	*p* Value
Watery stool						
Yes	106	55 (51.9)	2.09 (1.34–3.24)	0.001	1.73 (0.97–3.11)	0.07
No	355	121 (34.1)	1		1	
Constipation						
Yes	322	131 (40.7)	1.43 (0.94–2.17)	0.09	1.51 (0.83–2.76)	0.18
No	139	45 (32.4)	1		1	
Itching skin						
Yes	251	135 (53.8)	4.80 (3.15–7.31)	<0.001	5.99 (3.43–10.45)	<0.001
No	210	41 (19.5)	1		1	
Anal itching						
Yes	214	83 (38.8)	1.05 (0.72–1.53)	0.80	0.35 (0.19–0.62)	<0.001
No	247	93 (37.6)	1		1	
Nausea						
Yes	190	109 (57.4)	4.10 (2.75–6.10)	<0.001	5.57 (3.22–9.65)	<0.001
No	271	67 (24.7)	1		1	
Worm expulsion						
Yes	25	16 (64.0)	3.07 (1.32–7.10)	0.009	3.80 (1.42–10.18)	0.008
No	436	160 (36.7)	1		1	

Note: $p < 0.05$ was considered statistically significant.

Abbreviations: AOR, adjusted odds ration; CI, confidence interval; COR, crude odds ratio; IPI, intestinal parasitic infection.

infections. Generally, trimmed fingernails facilitate a better hand-washing while untrimmed fingernails create an opportunity for parasites to hide and later be transferred to others or ingested.

Also, itchy skin was found to be associated with intestinal parasitic infections (AOR [95% CI]: 5.99 [3.43–10.43]; $p < 0.001$). The result of this current study is consistent with those of other studies conducted among pregnant women and children found skin itching to be associated with intestinal parasites such as *Strongyloides stercoralis* and Hookworms (*Ancylostoma duodenale* and *Necator americanus*).[27,28] It is important to note that unrelated factors such as allergic reactions, dermatitis, and insect bites among others can contribute to skin itching. A study by Arrais et al.[29] among Angolan school-aged children has found no significant association between skin infection and intestinal helminthic infections.

The present study also found an association between nausea and intestinal parasitic infections (AOR [95% CI]: 5.57 [3.22–9.65]; $p < 0.001$). It is important to note that nausea is a nonspecific response to intestinal parasitic infections. This owes to the fact that individual responses may vary. However, nausea in intestinal parasitic infections typically happens when the parasites migrate into the digestive systems of their hosts. This is usually seen in *Ascaris lumbricoides*, *Cryptosporidium parvum*, *Entamoeba histolytica*, and *Giardia lamblia* among others.[30]

Lastly, the study found an association between worm expulsion among inmates and intestinal parasitic infections (AOR [95% CI]: 3.80 [1.42–10.18]; $p = 0.008$). This represents a development of the worm to adult state. This is typical of a serious health situation that requires an urgent attention.

5 | CONCLUSION AND RECOMMENDATION

The study revealed that the prevalence of intestinal parasitic infections among prisons in Southern Ghana is high and is therefore an important cause for concern. The study encourages proper hand washing after defecation as well as trimming of fingernails among inmates as they have been found to be associated with intestinal parasitic infections. Additionally, inmates with itching skin, nausea, and worm expulsion should be tested and treated for intestinal parasites. Water supply should also be increased in the prison facility to improve personal hygiene and sanitation to reduce the risk of infections. Lastly, the Government of Ghana is hereby admonished to increase budgetary allocations on healthcare among inmates based on the findings of this study.

AUTHOR CONTRIBUTIONS

Albert Abaka-Yawson: Conceptualization; investigation; writing—original draft; methodology; writing—review and editing; formal

analysis; software; project administration; data curation; resources. **Daniel S. Squire**: Supervision; resources; project administration; conceptualization; methodology; validation; visualization; writing—review and editing. **Benedict Osei Tawiah**: Investigation; writing—review and editing; resources; supervision; methodology. **John Arko-Mensah**: Conceptualization; investigation; writing—original draft; methodology; validation; writing—review and editing; supervision; resources; project administration.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data supporting our findings are available on request.

ETHICS STATEMENT

Ethical approval was obtained from the University of Ghana Medical Center Institutional Review Board (UGMC-IRB) before commencement (UGMC-IRB/MSRC/002/2023) and the Ghana Prisons Service (HRG/0183/V.4/22/183/939R). Also, the study objectives and protocol were explained to heads of all three prisons and permission was sought before commencement of the study in their respective facilities.

TRANSPARENCY STATEMENT

The lead author Albert Abaka-Yawson affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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