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The Prevalence and Associated Risk Factors of Helicobacter Pylori among Peptic UIcer Patients in Nakuru Level Five Hospital, Kenya

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Abstract

Helicobacter pylori is the key causative agent of chronic gastritis, peptic ulcer disease, and gastric malignancies, affecting mostly the African population. Its infection influences more than half of the world's inhabitants. However, the specific epidemiological landscape of this infection in Nakuru County remains under-documented. This study aimed to investigate the prevalence of H. pylori infection among peptic ulcer patients at Nakuru Level Five Hospital, Kenya focusing to identify associated risk factors and provide insights to improve awareness and prevention strategies. A cross-sectional research design was employed, involving 348 symptomatic participants recruited from a target population of 2,711 patients that presented at the hospital between the months of June to December 2025. Primary data on socio-demographic status and hygiene factors were collected using pre-tested structured questionnaires. Diagnostic identification of parasites from stool samples was achieved through direct wet mount microscopy for intestinal parasites and monoclonal antigen immunoassay for H. pylori. Data were analyzed using SPSS (Version 26), utilizing univarriate analysis and multivariate logistic regression to determine prevalence and identified risk factors. The results revealed an overall prevalence of 19.3%, with a significantly higher burden in males (24.3%) compared to females (16.9%). Key risk factors included the use of unsafe drinking water (AOR 3.21, $p < 0.001$), lack of water treatment (AOR 2.48, $p = 0.005$), and open defecation practices (AOR 3.06, $p = 0.001$). These findings underscore the critical role of environmental sanitation and personal hygiene in the persistence of gastrointestinal pathogens. The study recommends that the Ministry of Health integrate regular screening for both H. pylori and intestinal parasites in symptomatic patients and intensify community health education on water safety and sanitation to interrupt the fecal-oral transmission cycle of intestinal parasitic infections.

Key Words*; Prevelance, Risk Factors, Intestinal Parasites, Helicobacter Pylori.*

I. BACKGROUND OF THE STUDY

Helicobacter Pylori is a pervasive, helical shaped, motile, gram-negative bacillus bacterium, which inhabits the gastric mucosa (Ali & AlHussaini 2023). Infection is generally acquired during the first 5 years of childhood (Nicolescu 2014). Helicobacter pylori prevalence in children ranges from 30 - 80%, with a predominance in developing countries (Mehata et al., 2021). This prevalence differs in different regions and settings in the same country (Mehata et al., 2021). Smith et al., (2021) stated that the burden of Helicobacter pylori infection (HPI) in Africa remains high with varying levels of prevalence among children and adults reported in different regions of the continent. Persistent and uneradicated HPI could result in gastric cancer, although less severe pathological outcomes have been reported among Africans – the so-called "African enigma." Analysis of endoscopic findings of the upper gastrointestinal tract demonstrates similarities with that of patients from the West. Thus, it could be asserted that the true picture of HPI in Africa is yet to be unveiled due to several challenges including inadequate health-care system, lack of treatment guidelines and standardized protocol for diagnosis, and lack of data. The method of transmission of H. pylori is still unclear. The suggested mode of transmission of H. pylori is direct contact (fecal-oral) observed among immunocompromised children and children suffering from diarrhea, vomiting, fever, and dehydration. Diagnosis of H. pylori infection is largely divided into invasive and non-invasive approaches. A combination of at least two tests is commonly used as a gold standard (Patel 2016).

Intestinal parasitic infections are distributed worldwide and are endemic in tropical and subtropical countries. Globally, about 3.5 billion individuals are infected with intestinal parasites, majority being children. Diarrhea is the most frequently presented symptom. Diarrheal diseases are globally estimated to be 1.7 billion annual cases (Njenga et al., 2022; Mesfin et al., 2025). Giardia intestinalis, Entamoeba histolytica and Cryptosporidium spp. are the most common intestinal protozoan parasites which cause acute diarrheal diseases in children (Bauhofer et al., 2020; Mesfin et al., 2025).

Helicobacter pylori and intestinal parasites are known for their high prevalence in children (Ibrahim et al., 2019). Both of them infect the gastrointestinal tract with overlapping clinical presentations. In a recent study conducted in Egypt, intestinal parasites found to co-exist with H. pylori in patients included Cryptosporidium spp. and G. intestinalis (Aniekwe et al., 2024). This co-existence may suggest the association of H. pylori infection with markers of fecal exposure (Fahim et al., 2020). Whether H. pylori provides favorable conditions for intestinal parasitosis or vice versa, still further investigations are needed with an emphasis

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upon determining correlation with gut microbiomes (Ibrahim et al., 2019). A Mexican study conducted by Tapia Pancardo et al. (2012) on gastric diseases demonstrated occurrence of a new trend in morbidity. The research aimed at identifying life habits that frequently contribute to occurrence of gastritis and colitis. The results revealed that risk factors include; long periods of daily fasting, consumption of irritant food and drink and stress.

Helicobacter pylori is a major health concern among patients in Kenya. Muma et al., (2022) in their study revealed incidence of H. pylori infection in Kenya was remarkably high. An investigation into prevalence of H. pylori in patients with dyspepsia and asymptomatic controls from the same population showed high prevalence levels in both groups. A previous study by McFarlane et al., (2000) linked infection of the gastric mucosa by H. pylori in Kenya with subsequent development of gastric atrophy. However, based on reviewed literature, little is known on prevalence, risk factors that contribute to the occurrence and persistence of co-infection. Therefore, there is need to evaluate the prevalence and associated risk factors of the infection with an aim of improving on its awareness and management.

II. CHAPTER METHODLOGY

Study Area

This study was conducted in Nakuru level five Hospital, Nakuru County, Kenya. Nakuru County covers a total area of 7,495 Km^2. According to Kenya Population and Housing Census surveillance (2019), the County is densely populated with an approximate of 2.162 million people. Nakuru Level five health facility delivers assorted medi-care services as well as training services for various groups of health workers and interns. They also provide specialized care functions besides coordinating management and extend health support to Sub Counties due to referral of patients from surrounding dispensaries and Health Centers. The hospital received an average of 171,570 patients with general ailments between January and June 2023.

Study Design

This was a cross sectional survey. It involved collection of stool samples once from each participant recruited in the study. Random sampling design was employed where patients that presented with gastrointestinal signs and symptoms were recruited because of their high probability of being infected with either Helicobacter pylori, intestinal protozoan parasites or both. Another inclusion criterion involved only individuals who resided within Nakuru County, Kenya, during the period of the study.

Sampling and Sample Size

The desired sample size of 348 study participants was selected randomly from a target population of 2,711 patients attending consultation room with gastrointestinal symptoms between June to December 2025. Yamane (2004) formula was used for calculating sample size:

$$n = \frac{N}{1+N(e)^2} \quad \text{(i)}$$

Where **n** is the sample size, **N** is the population size and **e** is the level of precision.

The study participants were informed about the study objectives and recruited upon signing an informed consent form.

Data Collection

For those samples which turned positive for H. pylori other species of parasites were equally tested via microscopy to bring in the co infection aspect.

Identification of Helicobacter pylori Status of Study Participants

Helicobacter pylori were detected using Helicobacter pylori Rapid Test (Cassette) Antibody RapiCard InstaTest stool antigen test, (Diagnostic Automation Inc., USA). Monoclonal anti-H. pylori antibodies were used to capture antibodies while peroxidase-conjugated monoclonal antibodies used for detection. A small portion of the stool sample homogenized with buffer solution and two drops was added to the test well for the immunoassay. Following a 15 min period wait, the test was analysed. The presence of both control and test lines was defined as a positive result. However, if only the control line was present, the test was deemed negative (Figure 1).

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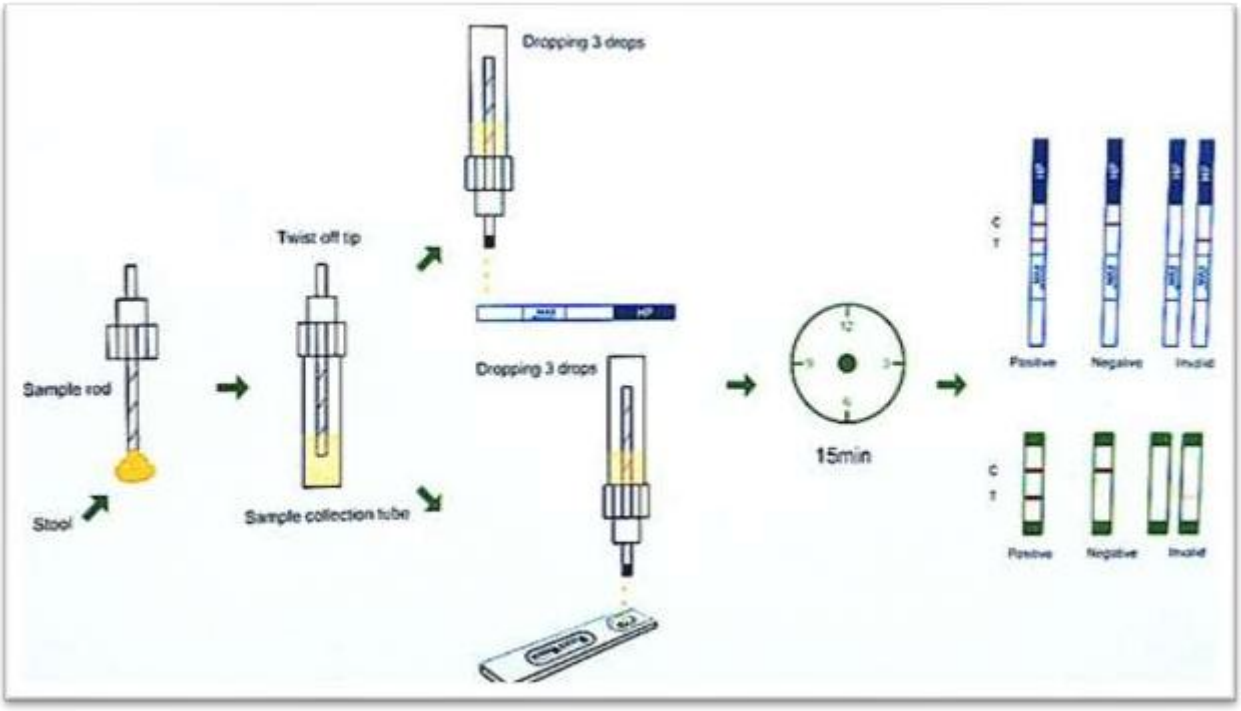


Figure 1: Pictorial presentation of serological test

Determination of Socio-demographic and hygienic Status of Study Participants

Study participants provided their socio-demographic information such as; age, sex, marital status, education, occupation, area of residence and several hygiene factors (Environmental, sanitation and hygiene-related variables). These participants filled information on these variables in a pretested questionnaire. The patients' medical files were also scrutinized and appropriate data such as patients' case investigation and definition on entry, treatment phase and co-infection retrieved and recorded.

Data Analysis

The data collected was entered in Microsoft Excel and analyzed using SPSS (Version 26).

Data on prevalence of co-infection of H. pylori and intestinal protozoan parasites was analyzed using simple proportions and percentages. A comparison between H. pylori/intestinal protozoan parasites co- infection status of the study participants and risk factors was performed using crosstabs. Univarriate analysis was used to determine the association between co- infections and risk factors. A multiple linear regression was performed for all of the analysed risk factors with regards to co-intestinal parasitic infections. The level of statistical significance will be $p<0.05$.

III. RESULTS

Prevalence of H. pylori and Intestinal Protozoan Parasites Co-infections

Overall Prevalence and Prevalence by Gender

The overall prevalence of co-infection of H. pylori and intestinal protozoan infection was 19.3%. This prevalence was higher in males (24.3%) compared to their female counterparts (16.9%) as shown in Table 1. The difference was statistically significant at univarriate analysis ($p < 0.05$).

Table 1: Prevalence by Gender

Gender	Total (N)	Positive (n)	Prevalence (%)
Male	111	27	24.3
Female	237	40	16.9
Total	348	67	19.3

The analysis of 348 peptic ulcer patients at Nakuru Level Five Hospital revealed a significant burden of intestinal protozoan parasites, with an overall prevalence of 19.3% (n=67). The presence of these parasites in nearly one-fifth of the participants suggests that protozoan infection is a common ailment among patients presenting with peptic ulcer disease in Nakuru Level Five Hospital.

Data disaggregated by sex showed a clear disparity in infection rates; male respondents demonstrated a

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higher prevalence of 24.3%, with 27 out of 111 testing positive. In contrast, female respondents, who constituted the majority of the study population (68.1%), had a lower prevalence rate of 16.9% (40 out of 237). These findings indicate that while the study sample was predominantly female, the risk of protozoan infection was higher among the male cohort (Table 1).

Prevalence by Age Group

Age group	Total (N)	Positive (n)	Prevalence (%)
< 25 years	54	7	13.0
25-35 years	65	10	15.4
36-45 years	104	17	16.6
>45 years	125	33	26.4
Total	348	67	19.3

Table 2: Prevalence by Age Group

The prevalence of the infection increased with age, peaking in the > 45 age group (Table 2.). The association between age and infection status was statistically significant ($p < 0.05$).

The higher burden among economically active age groups suggests cumulative exposure and sustained contact with environmental risk factors such as unsafe water sources and sanitation.

Prevalence by Area of Residence

Rural residents had the lowest prevalence of the co-infection. Only 12.5% (n-17; N = 136) participants from rural areas tested positive for co-infection (Table 3).

Urban areas exhibit a higher burden, with 50 confirmed positive cases. This represents approximately 23.58% of the total positive cohort detected in the study (Table 3)

Table 3: Prevalence by Area of Residence

Area of Residence	Total Population (N)	No. Positive (n)	Prevalence (%)
Rural	136	17	12.5
Urban	212	50	23.58
Total	348	67	19.3

Risk Factor Analysis

Univariate Logistic Regression Analysis

A univarriate logistic regression analysis was carried out to ascertain the association of various variables with the protozoal infections. As shown in Table 4, several demographic and environmental factors showed a significant association with protozoal infection, with odds ratios (ORs) > 1 and $p < 0.05$.

Table 4: Univarriate Logistic Regression Analysis of Variables Associated with Intestinal **Protozoan Infections**

Variable	OR	95% CI	p-value
Male sex	1.58	1.03–2.41	0.036
Age 36–45 years	2.31	1.22–4.36	0.010
Age > 45 years	3.05	1.62–5.74	<0.001
Low education level	1.89	1.11–3.22	0.019
Unsafe drinking water source	3.76	2.01–7.02	<0.001
Lack of water treatment	2.94	1.63–5.30	<0.001
Untrimmed fingernails	2.68	1.47–4.87	0.001
Irregular hand washing	2.21	1.25–3.91	0.006
Presence of domestic animals	1.72	1.01–2.93	0.046
Consumption of raw vegetables	2.09	1.18–3.71	0.012
Poor waste disposal	2.55	1.43–4.57	0.002
Overcrowding	1.98	1.10–3.56	0.023
Recent diarrhoeal illness	3.14	1.78–5.55	<0.001
Lack of health education	2.27	1.29–3.98	0.004
Open defecation practice	3.89	2.06–7.36	<0.001

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Environmental, sanitation and hygiene-related variables demonstrated stronger associations with infection compared to demographic variables.

Multivariate Logistic Regression Analysis

Variables such as education level, hand washing practice, waste disposal and overcrowding lost statistical significance after adjustment, indicating confounding by water and sanitation factors. However, variables significant at $p < 0.20$ in univarriate analysis were included in a multivariate logistic regression model to control for confounding, and results summarized in Table 4.15 below.

Table 5: Multivariate Logistic Regression Analysis of Variables Associated with Intestinal Protozoan Infections

Variable	AOR	95% CI	p-value
Male sex	1.42	1.01–2.16	0.041
Age > 45 years	2.67	1.38–5.15	0.003
Unsafe drinking water source	3.21	1.69–6.10	<0.001
No water treatment	2.48	1.31–4.69	0.005
Poor sanitation facility	2.11	1.12–3.98	0.021
Open defecation practice	3.06	1.58–5.91	0.001
Recent diarrhoeal illness	2.73	1.49–5.00	0.001

Environmental and WASH-related factors had stronger associations with infection than demographic factors.

IV. DISCUSSION

Prevalence of H. pylori and Intestinal Protozoan Parasites

The gender pattern of the participants involved in this survey (68.1% females' vs 31.9% males) reflects the general observations that women engage more in health-related surveys than men. Men are perceived to be persevering and self-reliant, hence seeking health care or joining research is often seen as a weakness (Chavalala et al., 2025; Mokua et al., 2024). Chavalala et al. (2025) demonstrated that masculine norms drive men to avoid routine check-ups and postpone treatment until emergencies. This defiance discourages several men from joining health-related surveys.

In the current survey conducted at Nakuru Level Five Hospital, the prevalence of H. pylori and intestinal protozoan co-infection is 19.3%. This observed prevalence falls within the extensive spectrum of results reported in recent African studies, though it is lower than the continental average. Regionally, a recent study in a Rwandan Teaching Hospital reported a co-infection rate of 12.1% (Munezero et al., 2025). This suggests that the burden in Nakuru is notably higher compared with similar high-level medical facilities in Rwanda. In Ethiopia, studies among patients with gastrointestinal symptoms reported co-infection rates of 20.7%. (Lamesa 2025). At the continental level, a 2025 meta-analysis involving multiple African countries found a pooled prevalence of 31.03% for these co-infections (Wondmagegn et al., 2025). The highest rates were seen in Egypt (39.84%), while Ethiopia had some of the lowest recorded rates at 5.86% (Wondmagegn et al., 2025). In contrast, studies in newly industrialized or middle-income regions like Turkey show a much lower association; for instance, a 2024 study in Siirt reported that while H. pylori was present in 13.4% of patients, only 20.3% of those cases also had intestinal parasites (Munezero et al., 2025).

The moderate prevalence of these co-infections in Nakuru County may reflect partial access to improved water sources or sanitation facilities among some participants, as well as heterogeneity in exposure patterns. Nonetheless, the persistence of infection in nearly one-fifth of the population indicates on-going transmission and insufficient interruption of protozoal life cycles. The results of this study demonstrates a clear male predominance in co-infection; 24.3% in males vs. 16.9% in females. The higher prevalence observed in males may be attributed to socio-economic and behavioural factors prevalent in Nakuru County.

These include higher occupational exposure to contaminated soil and water through manual labour or differences in hygiene practices. These results align with those of a previous study on dyspeptic patients in Kenya where 50.7% of H. pylori-positive cases were males (Mwangi et al., 2020). In the aforementioned study, this pattern was attributed to males being "naturally more active and less hygienic" in occupational roles like manual labour. This finding is also consistent with several studies conducted in Africa and Asia. Wondmagegn et al. (2025) and Almaw et al. (2024) reported higher infection rates among males, attributing this to occupational exposure, reduced hand hygiene compliance, and greater contact with contaminated water sources. Behavioural and sociocultural factors may therefore play a more important role than biological susceptibility in shaping sex-specific risk profiles for protozoal infections. On the global scale, a similar male-skewed risk for H. pylori was reported in Yemen, where infection was significantly associated with being male (Almashhadany et al., 2023). In contrast, some studies such as the one conducted in Turkey found no significant relationship between gender and infection status (Almashhadany et al., 2023). This indicates that local socio-economic roles play a major part in gender-based risk in Nakuru County.

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Helicobacter pylori-Protozoan co-infection prevalence varied significantly across age groups, with the highest prevalence observed among individuals aged above 45 years (26.4%), followed by those aged between 35 and 45 years (16.6%). Lower prevalence was observed among participants aged below 25 years (13%). The peak prevalence in patients over 45 years suggests that cumulative lifetime exposure to environmental pathogens and age-related declines in mucosal immunity may contribute to higher susceptibility in older individuals. This pattern is increasingly recognised in adult-focused community surveys. Ogalo & Kariuki (2025) reported that economically active adults often experience higher exposure due to occupational activities, increased mobility, and frequent contact with contaminated environments. However, another Kenyan study at Mbagathi Hospital in Nairobi found that H. pylori infection peaked earlier, in the 31–40 age-group (32.4%) (Nyakaba et al., 2023). The continued rise into the >45 age group in Nakuru may reflect cumulative environmental exposure and long-term persistence of untreated infections in older adults. Nevertheless, studies in Ethiopia and Uganda highlighted significant burdens of H. pylori and intestinal parasite co-infections in school going children (20.1%–23.0%) (Ankarklev et al., 2012; Munezero et al., 2025). This was probably due to their immature immune systems and high pathogen exposure in schools.

Overall, while only 12.5% of the total co-infected patients in Nakuru County reside in rural areas, 23.58% of positive cases originate from urban environments. These findings corroborate national trends in Kenya where urban prevalence for these pathogens remains significantly higher (62.4% vs 45.2% in rural areas) (Wondmagegn et al., 2025). The association between urban/peri-urban residence and high prevalence in Nakuru is driven by several socio-environmental factors identified in broader Kenyan research: First, the urban and peri-urban settings in Nakuru are often characterized by high population density. This study has shown that shared housing with more than five people in the household is a major risk factor (OR 1.98) for H. pylori transmission. Secondly, in Nakuru, residents of informal settlements often rely on shared toilets (64.1%) and varying water sources, including the Njoro River, which has been identified as a reservoir for multiple Cryptosporidium species (Essendi et al., 2024). Finally, the feacal-oral route shared by both H. pylori and protozoa is more easily facilitated in Nakuru informal settlements which are characterized by compromised sanitation infrastructure (Chege et al., 2020).

Risk Factor Analysis

Univariate Analysis

The results of this study indicates that males have a significantly higher risk of co-infection (AOR = 1.61, p = 0.036). This finding is consistent with studies in Ethiopia, which reported that male sex was a significant predictor for H. pylori and intestinal parasite concomitant infection (AOR: 1.61) (Seid et al., 2018). The higher risk in males may be attributed to behavioural factors or occupational exposures that increase contact with contaminated environments. However, Almashhadany et al. (2023) did not find any significant association between gender and co-infection rates in their study conducted in in Siirt, Turkey.

Patients aged above 45 years showed the strongest association with co-infection (OR = 3.05, p < 0.001), followed by those aged 36-45 years (OR = 2.31, p = 0.010). This aligns with H. pylori prevalence findings in this study, where it was found to peak in individuals aged above 45 years (26.4%). Regionally, studies in Ethiopia and Tanzania observed a similar trend whereby though H. pylori is often acquired in childhood, clinical co-infections and symptoms frequently manifest in early to middle adulthood (Melese et al., 2019; Kibira & Tungu 2025).

The use of unsafe drinking water sources (OR = 3.76, p < 0.001) and a lack of water treatment (OR = 2.94, p < 0.001) are among the strongest independent predictors of protozoal infection in this study. This is corroborated by international data; for instance, a study in Northwest Ethiopia reported that drinking surface water increased the risk of co-infection tenfold (AOR: 10.7) (Gebeyehu et al., 2026). Similarly, research in Yemen found that non-filtered water was a significant contributing factor (OR = 3.67) (Yohannes et al., 2025). This variable presented the highest odds ratio in the dataset (OR = 3.76, p < 0.001), stressing the feacal-oral route as the primary route of transmission. Global meta-analyses have repeatedly demonstrated that lack of water treatment increases the risk of protozoal infections by two- to four-fold (Freeman et al., 2017; Wondmagegn et al., 2025). The cysts of protozoan parasites, especially those of Giardia and Entamoeba, are highly resistant to low-level chlorination. This makes untreated water a persistent transmission vehicle (Omarova et al., 2018).

Poor waste disposal (OR = 2.55, p = 0.002) also significantly contributes to the infection cycle. This mirrors the findings of a previous study in Nakuru informal settlements where improper garbage and sewage disposal were linked to high parasite prevalence (Chege et al., 2020). Poor feacal waste disposal in Kenya, such as use of flying toilets, is a well-documented driver for both H. pylori and protozoans like Entamoeba histolytica and Giardia lamblia in resource-limited settings (Chege et al., 2020). Similar associations have been reported in Bangladesh, where communities practising open defecation consistently show higher protozoal prevalence (Humphrey et al., 2019). These findings reflect direct contamination of soil, water, and food with protozoan cysts, perpetuating transmission cycles.

Untrimmed fingernails (OR = 2.68, p = 0.001) and irregular hand washing (OR = 2.21, p = 0.006) were significant risk factors. These results are consistent with Ethiopian studies where untrimmed fingernails were identified as a major contributing factor to co-infection (AOR: 4.9) (Hussein et al., 2022). Aliyo (2024) identified Entamoeba histolytica and Giardia lamblia as the most common parasites found in the fingernail debris of individuals, particularly in high-risk groups like food handlers and street

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children. While most studies show a strong, direct link, some research has not found a statistically significant correlation between nail trimming and parasite presence. For instance, a study in Saudi Arabia among food handlers did not find a significant difference in infection rates based on nail trimming habits, although they noted that untrimmed nails are a potential source of contamination (Alqarni et al., 2023).

The results of this survey demonstrated that eating raw vegetables is associated with a two-fold increase in risk in co-infections (OR = 2.09, p = 0.012). This reflects international trends where vegetable-based diets and consumption of unwashed vegetables are linked to higher rates of protozoan cyst ingestion (Vafae Eslahi et al., 2014). Tawana et al. (2023) and Abdoli et al. (2024) both emphasised fresh produce as an increasingly important route of protozoal transmission in both rural and peri-urban settings. Raw vegetables can become contaminated during irrigation with unsafe water or through contact with contaminated soil.

Contact with animals showed a significant, though slightly lower, association (OR = 1.72, p = 0.046). This supports the "One Health" perspective that emphasizes zoonotic transmission of protozoans like Cryptosporidium from livestock to humans (Tawana et al., 2023; Ali et al., 2024; Utami 2024). Several protozoa, particularly Giardia species, are zoonotic and circulate between humans, livestock, and companion animals. Recent epidemiological studies have demonstrated zoonotic transmission of Cryptosporidium parasites in Njoro water shed, Nakuru County (Essendi et al., 2021).

Living in overcrowded conditions (OR = 1.98, p = 0.023) facilitates person-to-person transmission. This is a typical risk factor globally, particularly in IDP camps and informal settlements where large family sizes and shared living spaces are common (Munezero et al., 2025). Larger family sizes may limit family members' access to proper sanitary facilities as the family's resources are shared (Feleke et al., 2019). In large families, there may also be overcrowding, which facilitates intestinal protozoan parasites transmission (Dobo 2018). Moreover, some children in large families may also not receive enough care as their families may not have the time to provide adequate care to all of their children (Tsegaye et al., 2018).

Low levels of education (OR = 1.89, p = 0.019) and a lack of health education (OR = 2.27, p = 0.004) were both strongly associated with co-infection. Mesfin et al. (2025) demonstrated a strong direct link between low levels of education, specifically, illiteracy in parents or limited formal education in individuals and higher rates of infection with intestinal protozoan parasites. Low education is a critical socioeconomic factor that increases the risk of infection by reducing health awareness, particularly regarding sanitation and hygiene practices.

Patients who had recently suffered from diarrhoeal illness were 3.14 times more likely to have a co-infection ($p < 0.001$). Previous studies in Mozambique (Bauhofer et al., 2021) and Iraq (Downs et al., 2015) demonstrated a strong association between acute, recent diarrhea and intestinal protozoan infections, particularly among children under-five and in regions with poor sanitation. Protozoan parasites, such as Giardia lamblia, Entamoeba histolytica, and Cryptosporidium, are frequently identified in the stool of patients with recent diarrhea, with prevalence rates in diarrheal cases ranging from 10.85% to 59.3% in various studies. A recent episode of diarrhea likely reflects the synergistic effect of co-infection, where the presence of multiple pathogens aggravates gastrointestinal symptoms and weakens the host's mucosal immunity.

Multivariate Interpretation and Global Comparison

Multivariate analysis revealed that male sex is a significant independent predictor of co-infection in Nakuru (AOR 1.42, p=0.041). This is strongly supported by regional data from Northeast Ethiopia, where males also showed higher susceptibility (AOR 1.61) (Seid et al., 2018), and Yemen, where H. pylori was significantly linked to male patients (p=0.035) (Almashhadany et al., 2023). Interestingly, individuals aged over 45 years in Nakuru faced the highest risk (AOR 2.67, p=0.003). While most global literature identifies childhood as the primary acquisition period due to immature immune systems, studies in Nigeria also show a high burden in adults aged 31–40, likely due to occupational exposures and persistent environmental reservoirs (Emerenini et al., 2021).

Environmental sanitation variables proved to be the most potent predictors of co-infection. In Nakuru County, unsafe drinking water (AOR 3.21) and lack of water treatment (AOR 2.48) were major drivers. This reflects a universal trend; in Ethiopia, drinking surface water increased co-infection risk tenfold (AOR 10.7) (Woku & Alemu 2025), and in Yemen, non-filtered water was a significant contributor (AOR 3.67) (Almashhadany et al., 2023). Open defecation remained a critical risk in Nakuru (AOR 3.06), aligning with studies across East Africa and Nigeria that highlight poor sanitation as the primary facilitator of the feacal-oral transmission route.

The data shows that recent diarrhoeal illness is strongly associated with co-infection (AOR 2.73, p=0.001). This supports the biological hypothesis that H. pylori and intestinal protozoa act synergistically. H. pylori produce urease enzyme, which neutralizes gastric acid, thereby reducing the stomach's "acid barrier" and allowing protozoan cysts like Giardia lamblia and Entamoeba histolytica to successfully colonize the gut. Studies in Rwanda further suggest that such co-infections intensify the severity of symptoms like abdominal pain (AOR 2.88) and can complicate clinical diagnosis due to overlapping manifestations.

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