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Prevalence, anatomic-pathologic findings, and associated factors of nontraumatic ileal perforations among patients with gut perforation: a multicenter cross-sectional study

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Abstract

Background Nontraumatic ileal perforation is a cause of obscure peritonitis characterized by severe toxicity and high mortality. This burden is disproportionately greater in LMICs due to poor hygiene practices, burden of HIV infection, and other comorbidities.

This study aimed at determining the prevalence, anatomic-pathologic findings, and factors associated with nontraumatic ileal perforation a multicenter cross-sectional study at 3 selected hospitals in Uganda.

Methods This was a cross-sectional study of 149 consecutive sample participants that used a structured checklist. We conducted logistic regression analyses using SPSS v21.0 (IBM), Variables with $p < 0.20$ in the bivariate analysis were entered into the multivariable logistic regression model, and $p < 0.05$ was considered statistically significant.

Results Nontraumaticileal perforation was more prevalent among males (20.1%; 149) and peasants/farmers (41.6%; 149) of rural residence (22.1%; 149). The majority of the study participants had typhoid perforations (79.1%; 149). Most ileal perforations occurred 20-39 cm from the ileocecal junction (76.4%; 149), a perforation size/diameter of 0.5-1cm was more common (58.1%; 149), and a single isolated perforation was more common (74.4%; 149). However, all perforations mainly occurred at the ante mesenteric border. Being an HIV-positive person was associated with greater odds of developing NTIP than was being a non-HIV-positive person. AOR 8.344, $p = 0.015$ ($p<0.05$). Additionally,

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patients treated with open and closed pit latrines were more likely to develop nontraumatic perforation than were those treated with water flash latrines. AOR 12.971, p = 0.004 (p < 0.05).

Conclusion This study established that nontraumaticileal perforation is more prevalent among male peasants living in rural areas and with typhoid fever and most of ileal perforations were due to typhoid fever.

Keywords Ileal perforation, Anatomic-pathologic, Typhoid, Uganda

Background

Non-traumatic ileal perforation (NTIP) is defined as a physician-diagnosed loss of continuity of the ileum in the absence of trauma or mechanical bowel obstruction, resulting in the spillage of intestinal contents into the peritoneal cavity [1, 2]. Most perforations are single, unlike the multiple perforations commonly observed in typhoid-related cases [3]. This condition leads to inflammation, widespread peritonitis, sepsis, and significant morbidity and mortality [4].

Globally, more than 33 million cases of peritonitis occur annually, resulting in over 500,000 deaths [5]. The exact cause of complications remains unclear, but severe complications arise in 10% to 15% of patients [5]. The case fatality rate can reach 10%–30%, particularly when the disease persists for two or more weeks without effective treatment [2]. In a meta-analysis, Tochie et al. reported that peritonitis due to perforation affects approximately 9.3 patients per 1,000 hospital admissions and requires appropriate preoperative resuscitation to prevent significant perioperative morbidity and mortality [6].

The infectious causes of NTIP are a global public health concern, with a high prevalence in low- and middle-income countries (LMICs), leading to substantial morbidity and mortality (7). This disease places a significant burden on individuals, families, and community resources due to the costs associated with managing complications [2]. While NTIP is primarily infectious in origin in LMICs, its prevalence varies by region. In high-income countries (HICs), such as the UK, USA, and Canada, NTIP is rare, with most cases of ileal perforation attributed to complications from celiac disease, Crohn's disease, lymphomas, radiation, and other non-infectious causes [8].

However, these conditions are more frequently observed in patients with diabetes, hypertension, HIV, and those who smoke, consume excessive alcohol, or lead sedentary lifestyles [9]. The situation differs in LMICs, such as those in Asia, sub-Saharan Africa, and Latin America, where ileal perforation is predominantly caused by infectious agents [10]. The major infections contributing to ileal perforation in these regions include typhoid, tuberculosis, *Taenia*, *Ascaris*, and *Entamoeba histolytica*, often exacerbated by the burden of HIV [11].

Currently, no single diagnostic modality can accurately identify the site of ileal perforation, as most cases are diagnosed intraoperatively [12]. However, methods for identifying the etiological agent have evolved, ranging from stool analysis, IgM testing, and blood cultures to more advanced techniques such as polymerase chain reaction (PCR) and histological analysis of ulcer edge biopsies [10]. Notably, histology is more sensitive and specific for identifying etiologic agents than earlier methods [13].

Numerous studies from low-income countries indicate that infectious agents are the leading cause of non-traumatic ileal perforation. However, findings from anatomical pathology studies vary. Therefore, the objective of this study was to present the prevalence, anatomic-pathological findings, and associated factors of non-traumatic ileal perforation in patients undergoing exploratory laparotomy.

Methods

This is a cross-sectional multi-centre study which was conducted in the emergency rooms of the operating theatre of the general surgery departments of selected hospitals from 1st August 2022 to 31st December 2022. These hospitals provide specialized general surgery services, including those for the management of patients with no traumatic ileal perforation; additionally, the hospitals are located in the Forte-portal district, Hoima district and Kiryandongo District of the Western Region Uganda.

Study population

Participants with features of gut perforation on erect thoracoabdominal radiographs requiring exploratory laparotomy were selected for participation in the study.

Inclusion criteria

Participants with an intraoperative diagnosis of ileal perforation were included.

Exclusion criteria

Participants with traumatic perforation, participants who were re-explored or participants who had previously undergone abdominal surgery were excluded from the study.

Sample size

For sample size estimation, the Kish Leslie formula (1965) wasused to determine the sample size in a study conducted at two Gulu hospitals in northern Uganda; the prevalence was 10.9% [14], and the final sample included 149 participants as demonstrated below:

$$N = \frac{z^2 \rho\ (1 - \rho\ )}{r^2}$$

Whereby:

N = sample size.

Z = Normal Standard Deviation (1.96 for a 95% confidence interval).

P= According to a study conducted at two Gulu hospitals in northern Uganda, the prevalence is 10.9% (Amone et al. 2020).

r = the acceptable error margin (0.05).

N= $(1.96)^2 \times (0.109) \times (1\text{-}0.109)/ (0.05)^2$

N = $(3.8416 \times 0.109 \times 0.891)/0.0025$.

N = 149 Sample size = 149.

The sample size was calculated using the Kish–Leslie formula based on a previously reported prevalence of ileal perforation of 10.9% from a Ugandan study. The minimum calculated sample size was 149 participants. Because the number of patients with non-traumatic ileal perforation could not be predetermined, all consecutive eligible patients presenting with features of gut perforation and requiring exploratory laparotomy were recruited until the target sample size of 149 participants was achieved.

Participants were enrolled using a consecutive sampling approach, whereby all eligible patients presenting during the study period were recruited in the order in which they arrived at the participating hospitals. Eligibility was initially based on clinical suspicion of gut perforation, including radiological findings such as free sub-diaphragmatic air or pneumoperitoneum on chest or abdominal radiographs. The diagnosis was subsequently confirmed intraoperatively during exploratory laparotomy.

Written informed consent was obtained from all participants prior to enrolment. Participants who were unable to write provided consent through a thumbprint, while guardians or caregivers provided consent on behalf of patients younger than 18 years of age or those who were critically ill and unable to consent. Data were collected using a structured checklist capturing socio-demographic characteristics, environmental exposures, and other associated clinical factors. Based on the recommendations of the Royal College of Radiologists, chest X-ray is the gold standard for detecting hollow viscus perforationin patients with acute abdomen [15, 16]. Resuscitationwas performed routinely, and fluid, antibiotic, analgesic, and anaesthetic team assessments were performed on all participants to ensure clinical and hemodynamic stability during surgery for general anaesthesia/major procedures. The surgical services were provided at no cost at any of the selected government hospital facilities where the surgical team performed explorative laparotomy following all routine protocols adopted by the Ministry Health of Uganda [17]. The explorative findings of each participant were documented on the theatre register and our checklist, based on the type of perforated gut involved, size, site and location. The parameters were measured using sutures and converted into ruler millimetres and centimetres. Routine perforation site specimens from all our participants were harvested in a plain bottle containing 10% formalin solution. However, only ileal perforation specimens were transported to KIU-TH Ishaka during the study period for pathologic evaluation bearing identification labels on each container following established guidelines [18].These specimens were prepared for paraffin sectioning by a trained laboratory technologist and then examined under light microscopy by a pathologist, with assistance from the principal investigator using the techniques detailed in the guidelines adopted by Uganda [18, 19]. All the participants were given routine treatment according to Uganda's clinical guidelines [17], as we continued to follow up on the pathological findings. The findings of the perforation were clustered into variables related to the ileum to achieve the objectives of our study, and these methods were successfully used earlier in many studies [9].

All collected data were checked for completeness and consistency before analysis. Each questionnaire was reviewed at the time of data collection to ensure that all variables were fully completed. Consequently, no missing data were identified for the variables included in the analysis, and all observations were retained in both the bivariate and multivariable analyses. The data were subsequently entered into Excel, cleaned and exported to SPSS v21.0 (IBM), for analysis.

The percentages and counts of individuals with non-traumatic ileal perforation were computed for prevalence. The percentage and frequency were used to describe the anatomic-pathology findings. Logistic regression analysis was also performed. All factors that scored a $p < 0.2$ in the bivariate analysis qualified for multivariate analyses for factors associated with NTIP. $p < 0.05$ indicated statistical significance.

Some exposure variables in this study, particularly household sanitation characteristics such as latrine type, were obtained through participant self-report. Self-reported environmental and behavioral factors may be subject to recall bias or misclassification, especially in settings where participants may not clearly distinguish between sanitation facility categories. However, efforts were made to minimize this risk by using structured questionnaires with predefined sanitation categories and by clarifying the type of facility during interviews. Any remaining misclassification is likely to be non-differential, which would tend to bias the estimates toward the null rather than create spurious associations.

In addition, certain exposures such as latrine type may be closely linked with underlying socioeconomic status, which could act as a confounding factor. To address

this, variables reflecting socioeconomic position (such as education level, occupation, household characteristics, or residence) were considered during the analysis and included in the multivariable regression model where appropriate. This approach allowed adjustment for potential confounding and enabled estimation of the independent association between sanitation-related exposures and the study outcome. Nevertheless, residual confounding from unmeasured or imperfectly measured socioeconomic indicators cannot be completely excluded.

Participants were recruited voluntarily and with informed consent. Informed consent was obtained, and participants signed after being fully informed about the study's specifics; they were not coerced into participating and were free to withdraw from the study whenever they chose without having their right to care violated. To avoid the risk of contracting COVID-19 and combating Ebola disease transmission, standard procedures for preventing COVID-19 and Ebola infection were used at all levels of this study. These included ensuring that the researcher and the team that collected the data from the participants always had a facemask and hand sanitize before administering the data tool/checklist; for the case of respondents who were unable to read and write, the researcher ensured that a distance of at least 2 m was kept to avoid transmission. The caretakers and patients were encouraged to put on masks and use hand sanitize according to the SOPs laid down by the Ministry of Health of Uganda [20].

During the course of this study, the information from the participants was obtained by examining participants in a clinical room.

The Western Campus Research and Ethics Committee at Kampala International University approved this study. The study was registered with the Uganda National Council for Science and Technology. UNCSTREG No-KIU-2022-155.

This study was designed and reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to ensure transparency and completeness in reporting observational research.

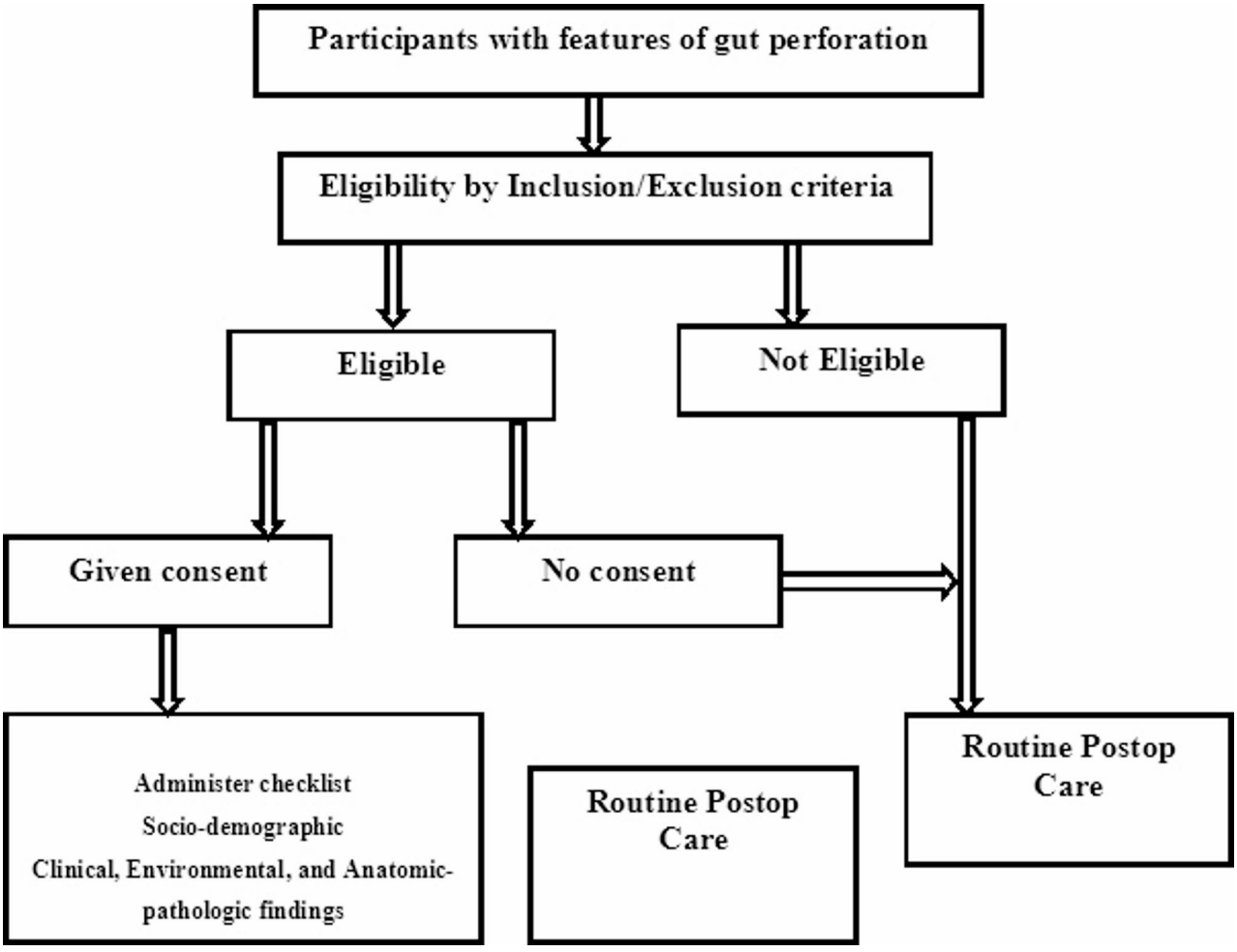


Fig. 1 Participants flow chart. Source: Developed by the researcher

Results

During the study period, 149 patients with features of gut perforation were included, and ileal perforation was found in 43 patients. Of the 43 patients who had perforations, 34 were found to be caused by typhoid fever, 9 had no specific inflammatory ileal perforation, and 1 had tuberculosis ileal perforation. The flow of how participants were recruited in this study is found in Fig. 1.

Sociodemographic characteristics of the study participants

In this study, the majority of participants were male (68.5%, 95% CI: 61.0–75.9) and from rural areas (77.2%, 95% CI: 70.4–83.9). The most common age group was 25–34 years (38.3%, 95% CI: 30.5–46.1), had a history of alcohol intake (93; 62.4% CI: 54.6–70.2), did not smoke (112; 75.2% CI: 68.3–82.1). The remaining sociodemographic characteristics are shown in Table 1 below.

Histopathological findings among participants with ileal perforation.

Out of the 43 patients who had perforations, 34 (79.1%) were found to be caused by typhoid fever, 9 (26.5%) had no specific inflammatory ileal perforation, and 1(0.007%) had tuberculosis ileal perforation.

as showed in the Figs. 2 and 3.

Prevalence of nontraumaticileal perforations at HRRH, FPRRH and KGH

In this study, ileal perforations were found in 43 participants, accounting for 28.9% of the participants who underwent surgery for gut perforation. The rest of the perforation sites are shown below in Fig. 3.

Anatomical-pathological findings of nontraumaticileal perforation at HRRH, FPRRH, and KGH

In this study, the majority of the ileal perforations were found 5–10 cm from the ileocecal junction, accounting for 29(67.4%) of all ileal perforations. The majority of the participants had a single perforation (32 [74.4%] of whom was not more than 1 cm). The main pathological type was typhoid, accounting for 34(79.1%) of all ileal perforations. The rest of the patterns are shown in Table 2.

According to our bivariate analysis, the variables that had a p value less than 0.2 were eligible for further analysis, as shown in Table 3 below.

According to the multivariate analysis, the factors that were independently associated with the presence of ileal perforation were comorbidity type and type of latrine. In relation to comorbidities, a participant who was HIV positive was 8.344 times more likely to have an ileal perforation than was a participant who was HIV negative (AOR = 8.344, CI = 1.501–46.377; $P = 0.015$). In relation to the type of latrine, a participant who had a nonshelter (-shelter) pit latrine was 12.971 times more likely to have

Table 1 Sociodemographic characteristics of the study participants

Characteristic	Frequency	Percentage	95% CI
Age category WHO			
5–14 yrs	17	11.4	6.3–16.5
15-24yrs	22	14.8	9.1–20.5
25-34yrs	57	38.3	30.5–46.1
35-44yrs	29	19.5	13.1–25.8
45-54yrs	19	12.8	7.4–18.1
55-64yrs	5	3.4	0.5–6.3
Sex			
Male	102	68.5	61.0–75.9
Female	47	31.5	24.1–39.0
Residence			
Urban	34	22.8	16.1–29.6
Rural	115	77.2	70.4–83.9
Religion			
Christian	48	32.2	24.7–39.7
Muslim	37	24.8	17.9–31.7
Others	64	43.0	35.1–50.9
Marital status			
Single	82	55.0	47.0–63.0
Married	58	38.9	31.1–46.7
Divorced	5	3.4	0.5–6.3
Widowed	4	2.7	0.1–5.3
Education Level			
Primary	51	34.2	26.6–41.8
Secondary	74	49.7	41.7–57.7
Tertiary	6	4.0	0.9–7.2
None	18	12.1	6.9–17.3
Occupation			
Student	21	14.1	8.5–19.7
Civil Servant	6	4.0	0.9–7.2
Buss/Self Employed	24	16.1	10.2–22.0
Casual Worker	36	24.2	17.3–31.1
Peasant/Farmers	62	41.6	33.7–49.5
Income			
Low	70	47.0	39.0–55.0
Middle	46	30.9	23.5–38.3
High	8	5.4	1.8–9.0
None	25	16.8	10.8–22.8
Smoking			
Yes	37	24.8	17.9–31.7
No	112	75.2	68.3–82.1
Alcohol			
Yes	93	62.4	54.6–70.2
No	56	37.6	29.8–45.4
Recreational drug use			
Yes	21	14.1	8.5–19.7
No	128	85.9	80.3–91.5
Hospital			
Hoima	60	40.3	32.5–48.1
Forte portal	46	30.9	23.5–38.3
Kiryandongo	43	28.9	21.7–36.1

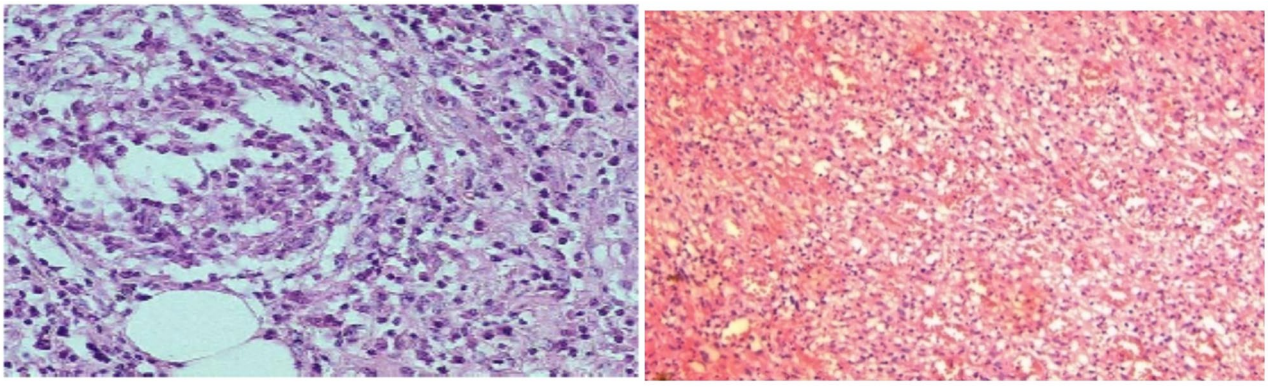


Fig. 2 Pathologic findings. Below are microscopy images of a typical perforation of (**A**) typhoid and **(B)** nonspecific pathology in participants. (H/E stain × 100 mag) **B.** (H/E Stain x 40 mag). Legend: **A** Described pathologic slide of a typical typhoid ileal perforation. This showed marked proliferation of reticuloendothelial cells in the lymphoid follicles and the presence of mononuclear phagocytes or erythrophagocytosis. **B** Described pathologic image of a typical nonspecific ileal perforation. This showed an ulcer covered by necrotic purulent exudates with underlying granulation tissue and acute inflammatory cellular infiltration

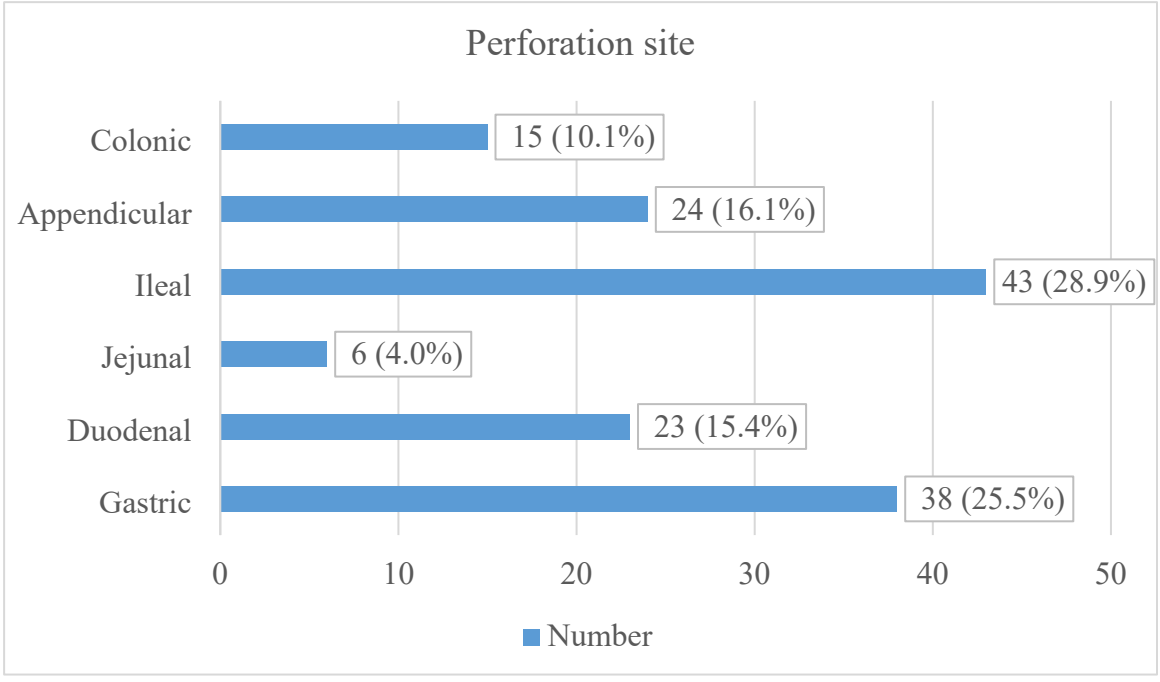


Fig. 3 Sites of gut perforation among the study participants

an ileal perforation than was one who had a water flush toilet type (AOR = 12.971, CI = 2.260–74.440; $P = 0.004$). Additionally, compared to a participant who used a water flush toilet, a patient who used a shelter pit (+ shelter) latrine was 5.805 times more likely to have an ileal perforation (AOR = 5.805, CI = 1.196–28.172; $P = 0.029$). The detailed multivariate analysis is shown below Table 4.

Discussion

In this study, 149 participants underwent exploratory laparotomy, with 43 cases (28.9%) identified as non-traumatic ileal perforations (NTIP). Ileal perforations were more common (28.8%) compared to gastric (25.5%), duodenal (15.4%), jejunal (4.0%), appendicular (16.1%), and colonic (10.1%) perforations. These findings align with previous studies, such as Mala et al. in India, who reported a 20% incidence of ileal perforations post-emergency laparotomy [21]. Similarly, Admasu et al. in Ethiopia observed a predominance of male patients (53.6%) and a high proportion of rural residents (73%), consistent with our study, where rural communities (22%) with low socioeconomic status exhibited a high prevalence of NTIP [22].

Contrastingly, the incidence of ileal perforations in some African regions has declined from 30% in the early

Table 2 Anatomic-pathological findings of nontraumaticileal perforation at HRRH, FPRRH, and KGH

Category	Frequency	Percentage
Distance from Ileocecal junction		
5–10 cm	29	67.4
11–15 cm	9	20.9
16–20 cm	3	7.0
21 cm >	2	4.7
Perforation size		
up to 1 cm	25	58.1
1.5 cm	9	20.9
2 cm	5	11.6
2 cm>	4	9.3
Number of perforations		
One	32	74.4
Two	9	20.9
Three	2	4.7
Pathologic findings		
Typhoid perforation	34	79.1
Nonspecific perforation	9	20.9

Factors associated with nontraumaticileal perforation at HRRH, FPRRH and KGH

1990s to 15.4% in 2011, likely due to improved medical technology and health-seeking behaviors [10]. However, Arsath & Harish in Pakistan reported a significantly higher incidence (70.8%-75.55%), possibly due to a larger sample size and extended follow-up [23].

Regarding anatomical findings, most participants (74.4%) had a single perforation, consistent with studies by Singh et al. (91.1%) in India [24], Verma et al. (78%), and Türkoğlu et al. (70%) in Turkey [12]. In Nigeria, Grema et al. reported that 54.5% of perforations were single, primarily due to typhoid fever [25]. The predominant site of perforation was the antimesenteric border of the terminal ileum (67.4%) within 5–10 cm of the ileocecal valve, similar to reports from Nigeria and Bangladesh, where variations in perforation distance may be attributed to racial differences and sample size [5, 24].

The predominant perforation size in our study was up to 1 cm (58.1%), aligning with findings by Shyamkumar Gupta et al. in India (73% <0.5 cm) and Khanam et al. in Bangladesh (median diameter of 5.0 mm) [1, 13]. Similar trends were reported in Nigeria [26] by Agu and in India by Singh et al., where perforations ranged from 1 to 8 cm within 5–60 cm of the ileocecal junction [9]. These findings are consistent across different geographical locations.

Our anatomical pathological findings demonstrated typhoid fever causing ileal perforation in 79.7%, followed by nonspecific inflammation (20.9%). Similar studies in India by Mala et al. (85.2%), Gupta et al. (58%), and Verma et al. also identified typhoid as the leading etiology [1, 12, 21]. Differences in prevalence across studies may result from variations in study design, sample size, and urban versus rural settings. For instance, Anam et al. [27] in Pakistan (11%) and India (24.4%) reported lower rates, likely due to the inclusion of traumatic and iatrogenic ileal perforations however, the prevalence was found higher in Bangalore by Poornima et al. [28], with typhoid ileal perforation of 92.19%. Mutiibwa et al. in Uganda previously reported an 84.6% prevalence of typhoid-related perforations, a finding that may have changed over time due to evolving public health interventions [29].

Risk factor analysis revealed that HIV infection, type of sanitation facility, and socioeconomic factors significantly contributed to NTIP. HIV-positive participants were 8.34 times more likely to develop ileal perforations (AOR = 8.344, CI = 1.501–46.377, $P = 0.015$), consistent with findings by Chalya et al. [30] in Tanzania (21.2%) and Biccard et al. [31] in South Africa (11%). Unlike these studies, Mutiibwa et al. in Uganda [29] found no HIV-positive cases, potentially reflecting regional differences in epidemiology.

Environmental factors, particularly sanitation, were significant contributors. Participants using non-sheltered pit latrines were 12.97 times more likely to develop NTIP than those with flush toilets (AOR = 12.971, CI = 2.260–74.440, $P = 0.004$). Similarly, users of sheltered pit latrines had a 5.81 times higher risk (AOR = 5.805, CI = 1.196–28.172, $P = 0.029$). Poor sanitation facilitates typhoid transmission via contaminated food and water, a finding consistent with studies from Uganda, Kenya, Nigeria, and Ethiopia. Reports from central Uganda indicate that 86% of households rely on pit latrines, of which 84% lack proper covers and 70% lack hand washing facilities, increasing exposure to fecal-oral pathogens.

Overall, this study highlights the significant burden of NTIP in LMICs, emphasizing the need for improved sanitation, enhanced disease surveillance, and targeted public health interventions to reduce the incidence of ileal perforations, particularly those caused by typhoid fever.

Findings in this study has been reported according to the Strobe for Observational studies [32].

Strengths and limitations

This study has several strengths. The multicenter design allowed the inclusion of participants from different referral hospitals serving large populations in western Uganda, thereby improving the representativeness of the findings. In addition, histopathological confirmation of ileal perforation etiology enhanced the diagnostic accuracy of the study.

However, some limitations should be considered when interpreting these findings. The relatively small sample size may have limited the statistical power to detect weaker associations between certain risk factors and ileal perforation. Furthermore, the cross-sectional study design limits the ability to establish causal relationships

Table 3 Bivariate analysis of factors associated with nontraumaticileal perforation at HRRH, FPRRH and KGH

Characteristic	No ileal perforation *N* = 106 *n* (%)	ileal perforation *N* = 43 *n* (%)	Bivariate analysis		
			cOR	80% CI	*P* value
Age category in years WHO					
5–14	13(8.7)	4(2.7)	Ref		
15–24	15(10.1)	7(4.7)	1.517	0.361–6.373	0.570
25–34	38(25.5)	19(12.8)	1.625	0.466–5.664	0.446
35–44	21(14.1)	8(5.4)	1.238	0.310–4.947	0.763
45–54	15(10.1)	4(2.7)	0.867	0.180–4.176	0.858
55–64	4(2.7)	1(0.7)	0.813	0.069–9.522	0.869
Sex					
Male	72(48.3)	30(20.1)	Ref		
Female	34(22.8)	13(8.7)	0.918	0.426–1.978	0.826
Residence					
Urban	24(16.1)	10(6.7)	1.035	0.446–2.401	0.935
Rural	82(55.0)	33(22.1)	Ref		
Religion					
Christian	32(21.5)	16(10.7)	Ref		
Muslim	25(16.8)	12(8.1)	0.960	0.385–2.393	0.930
Others	49(32.9)	15(10.1)	0.612	0.266–1.409	0.249
Marital status					
Single	60(40.3)	22(14.8)	Ref		
Married	38(25.5)	20(13.4)	1.435	0.692–2.976	0.331
Divorced	4(2.7)	1(0.7)	0.682	0.072–6.437	0.738
Widowed	4(2.7)	0(0.0)	N/A		
Education Level					
Primary	36(24.2)	15(10.1)	1.083	0.328–3.577	0.896
Secondary	54(36.2)	20(13.4)	0.963	0.304–3.047	0.949
Tertiary	3(2.0)	3(2.0)	2.600	0.387–17.451	0.325
None	13(8.7)	5(3.4)	Ref		
Occupation					
Student	15(10.1)	6(4.0)	0.727	0.247–2.142	0.563
Civil Servant	5(3.4)	1(0.7)	0.364	0.040–3.312	0.369
Busines/self	**19(12.8)**	**5(3.4)**	**0.478**	**0.157–1.458**	**0.195**
Casual	27(18.1)	9(6.0)	0.606	0.242–1.515	0.284
Peasant/Farmers	40(26.8)	22(14.8)	Ref		
Income					
Low	49(32.9)	21(14.1)	Ref		
Middle	31(21.5)	14(9.4)	1.021	0.454–2.294	0.960
High	8(5.4)	0(0.0)	N/A		
None	17(11.4)	8(5.4)	1.098	0.411–2.936	0.852
Smoking					
Yes	25(16.8)	12(8.1)	1.254	0.562-2.800	0.580
No	81(54.4)	31(20.8)	Ref		
Alcohol					
Yes	68(45.6)	25(16.8)	0.776	0.376–1.601	0.493
No	38(25.5)	18(12.1)	Ref		
Recreational drug use					
Yes	15(10.1)	6(4.0)	0.984	0.354–2.731	0.975
No	91(61.1)	37(24.8)	Ref		
Eating place					
Home	38(25.5)	17(11.4)	Ref		
Restaurant	49(32.9)	15(10.1)	0.684	0.303–1.543	0.361
Mixed	19(12.8)	11(7.4)	1.294	0.507–3.304	0.590

Table 3 (continued)

Characteristic	No ileal perforation *N* = 106 *n* (%)	ileal perforation *N* = 43 *n* (%)	Bivariate analysis		
			cOR	80% CI	*P* value
Meals/day					
One	51(34.2)	18(12.1)	1.324	0.388–4.514	0.654
Two	40(26.8)	21(14.1)	1.969	0.580–6.688	0.278
Three	15(10.1)	4(2.7)	Ref		
Last travelled					
< 30 days	8(5.4)	5(3.4)	1.644	0.494–5.468	0.418
31–60 days	6(4.0)	4(2.7)	1.753	0.459–6.699	0.412
61–90 days	21(14.1)	7(4.7)	0.877	0.334–2.297	0.789
91 + days	71(47.7)	27(18.1)	Ref		
Time to presentation					
< 48 h	37(24.8)	11(7.4)	Ref		
49–72 h	37(24.8)	16(10.7)	1.455	0.596–3.552	0.411
> 73 + hours	32(21.5)	16(10.7)	1.682	0.683–4.144	0.259
Abdominal pain					
Yes	33(22.1)	18(12.1)	1.593	0.766–3.312	0.213
No	73(49.0)	25(16.8)	Ref		
Nausea/vomiting					
Yes	33(22.1)	16(10.7)	1.311	0.624–2.755	0.475
No	73(49.0)	27(18.1)	Ref		
Constipation					
Yes	15(10.1)	0(0.0)	N/A		
No	91(61.1)	43(28.9)	Ref		
Fever					
Yes	17(11.4)	6(4.0)	0.849	0.310–2.323	0.750
No	89(59.7)	37(24.8)	Ref		
Confusion					
Yes	3(2.0)	0(0.0)	N/A		
No	103(69.1)	43(28.9)	Ref		
Self-medication					
Yes	41(27.5)	17(11.4)	1.037	0.502–2.142	0.923
No	65(43.6)	26(17.4)	Ref		
Traditional medication					
Yes	82(55.0)	37(24.8)	1.805	0.681–4.786	0.235
No	24(16.1)	6(4.0)	Ref		
Comorbidity type					
PUD	32(21.5)	7(4.7)	0.469	0.184–1.191	0.111
HTN	9(6.0)	0(0.0)	N/A		
HIV	**2(1.3)**	**8(5.4)**	**8.571**	**1.708–43.015**	**0.009**
DM	3(2.0)	0(0.0)	N/A		
None	60(40.3)	28(18.8)	Ref		
Water source					
Stream	92(61.7)	36(24.2)	1.370	0.272–6.907	0.703
Bore hole	7(4.7)	5(3.4)	2.500	0.357–17.500	0.356
Tap	7(4.7)	2(1.3)	Ref		
Latrine type					
-shelterpit	**15(10.1)**	**12(8.1)**	**9.600**	**1.881–48.999**	**0.007**
+Shelter pit	**67(45.0)**	**29(19.5)**	**5.194**	**1.151–23.438**	**0.032**
Water flush	24(16.1)	2(1.3)	Ref		
Waste disposal					
Open dump	85(57.0)	37(24.8)	1.741	0.353–8.597	0.496

Table 3 (continued)

Characteristic	No ileal perforation *N* = 106 *n* (%)	ileal perforation *N* = 43 *n* (%)	Bivariate analysis		
			cOR	80% CI	*P* value
Land fill	13(8.7)	4(2.7)	1.231	0.182–8.330	0.831
Incineration	8(5.4)	2(1.3)	Ref		

Ref= Reference category, *cOR*= Crude odds ratio, *CI*= Confidence interval, *HTN*= Hypertension, *DM*= Diabetes mellitus, *HIV*= Human immunodeficiency Virus, *PUD*= peptic ulcer disease

Table 4 Details of the multivariable analysis of factors associated with nontraumaticileal perforation at HRRH, FPRRH and KGH

Characteristic	Multivariate analysis		
	AOR	95% CI	*P* value
Occupation			
Student	0.541	0.164–1.791	0.315
Civil Servant	0.447	0.044–4.493	0.494
Buss/Self Employed	0.461	0.133–1.598	0.222
Casual Worker	0.506	0.177–1.441	0.202
Peasant/Farmers	Ref		
Comorbidity type			
PUD	0.413	0.154–1.103	0.078
HTN	N/A		
HIV	**8.344**	**1.501–46.377**	**0.015**
DM	N/A		
None	Ref		
Latrine Type			
-Shelter pit	**12.971**	**2.260–74.440**	**0.004**
+Shelter pit	**5.805**	**1.196–28.172**	**0.029**
Water flush	Ref		

AOR= Adjusted odds ratio, *Ref*= Reference category, *CI*= Confidence interval, *HTN= Hypertension, HIV*= Human immunodeficiency Virus, *PUD*= peptic ulcer disease, *DM= Diabetes mellitus*

between identified risk factors and the occurrence of ileal perforation. Potential sources of bias may also have occurred. Recall bias could have affected self-reported information such as alcohol intake, smoking habits, sanitation practices, and prior medication use. In addition, selection bias may have occurred because the study included only patients who presented to hospital and underwent exploratory laparotomy, potentially excluding patients with less severe disease or those who were unable to access surgical care. Some exposure variables, such as household latrine type, were self-reported and may be prone to misclassification. Structured questionnaires and interviewer clarification were used to minimize this, but residual non-differential misclassification could bias effect estimates toward the null. Certain exposures may also be closely linked to socioeconomic factors, which could act as confounders. Variables reflecting socioeconomic position were included in the multivariable model to adjust for potential confounding, although residual confounding from unmeasured indicators cannot be excluded.

Additionally, some of the adjusted odds ratios observed were relatively large (e.g., AOR 12.97), which may reflect small cell counts or sparse data in certain exposure categories. Given the total sample size of 149 participants and the number of predictors included in the multivariable analysis, there is a potential risk of model overfitting, which can inflate effect estimates and widen confidence intervals. These findings should therefore be interpreted with caution, and future studies with larger sample sizes are recommended to confirm these associations.

Implications for clinical practice and public health

The findings of this study highlight the continued burden of infectious causes of ileal perforation in low-resource settings. Strengthening public health interventions aimed at improving sanitation, access to clean water, and hygiene practices may play a critical role in reducing typhoid transmission and subsequent intestinal perforations. Additionally, early HIV testing and treatment programs may contribute to reducing the risk of severe gastrointestinal complications in affected populations. Future research should focus on larger multicenter prospective studies to better understand the epidemiology, clinical outcomes, and long-term prognosis of patients with nontraumatic ileal perforation in sub-Saharan Africa.

Recommendations

We recommend public health campaigns to sensitize people in our community to test for HIV, and if they are found to be positive, they should initiate HAART and regular follow-ups.

We recommend effective public health education with the provision of clean, potable water good waste disposal systems, and periodic inspection of public/residential toilet/latrine facilities would dramatically retard the disease, as was done in HICs.

We recommend vaccination as one of the most effective infection prevention measures for limiting disease transmission and protecting individuals and communities, especially through the use of typhoid conjugate vaccines (TCVs).

Future studies should include long-term prospective cohorts to establish patient-centered and clinical outcomes for patients with nontraumaticileal perforation.

Conclusions

This study established that nontraumaticileal perforation is more prevalent in typhoid infection and among male patients living in rural areas. Being HIV positive, the use of non sheltered and sheltered pit latrines was associated with higher odds of nontraumaticileal perforation than was the use of water flushing toilets and being HIV negative.

Abbreviations

AP	Acute abdomen
A&E	Accident and emergency
AF	Associated Factors
AH	Adhesion
AP	Acute peritonitis
CDC	Center of disease control
CP	Colon perforation
CU	Critical unit
DALYs	Disability-adjusted life years
DOT	Death on table
DP	Duodenum perforation
EC	Escherichia coli
FPRRH	Forte-portal regional referral hospital
GFC	Google feed.com
GP	Gastric perforation
HDU	High dependent unity
HICs	High-income countries
HRRH	Hoima regional referral hospital
IBM	International business machine
ICU	Intensive care unit
IL	Ileum perforation
JP	Jejunum perforation
KIU	Kampala International University
KIU-TH	Kampala International University Teaching Hospital
KM	Kilometre
LMICs	Low mild income countries
LBO	Large bowel obstruction
M	Mile
NSQIP	National surgical quality improvement program
NSI	Non specific inflammation
NTIP	Non-traumatic ileal perforation
NTSBP	Non-traumatic small bowel perforation
SP	Severe peritonitis
SBP	Small bowel perforation
SSA	Sub-saharan african
TB	Tuberculosis
TBIP	Tuberculous ileal perforation
TIP	Typhoid ileal perforation
TP	Typhoid perforation
UBS	Uganda Bureau of Statistic
WHO	World health organization

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Authors' contributions

MAW and AV conceived the concept. MAW and BMV wrote the main manuscript, designed the survey and critically reviewed the manuscript. MAW, NBG, KS, FM, FKS, JM, SMK, BPK and BMV collected data. MAW, AV, AR, AKL, WJ, ME, AJP, NBG, KS, FM, FKS, JM and BMV reviewed the manuscript development, revised the methodology and critically reviewed the manuscript. All authors reviewed and approved the final manuscript.

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Data availability

The data used to support the findings of this study are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate

The study and attendant protocols were approved by the Kampala International University Research Ethics Committee (KIU-REC) and registered with the Uganda National Council for Science and Technology (UNCSTREG No-KIU-2022-155); informed consent was obtained from all participants, and all procedures were conducted in accordance with relevant guidelines and regulations, including the ethical principles of the Declaration of Helsinki and applicable national ethical standards.

Consent for publication

Consent to publish on part of the participants is not applicable since there is no identifying information.

Competing interests

The authors declare no competing interests.

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