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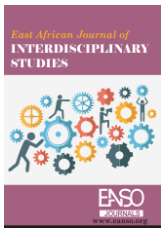

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Original Article

Prevalence of Commonly Consumed Drugs in Mbarara City, Uganda

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ABSTRACT

Pharmaceutical consumption is rising globally, with significant implications for environmental pollution and antimicrobial resistance (AMR). In sub-Saharan Africa, weak prescription control, widespread self-medication, and insufficient wastewater treatment amplify risks of pharmaceutical residues entering aquatic systems. Studies in Uganda have detected active pharmaceutical ingredients in urban waters, including River Rwizi, a critical domestic and agricultural water source for Mbarara City. However, systematic data linking patterns of drug consumption to environmental risks in Mbarara City remain scarce. Through a descriptive cross-sectional survey, drug use prevalence across public and private healthcare outlets in Mbarara City was assessed, focusing on 30 essential medicines listed in the Uganda Clinical Guidelines (2023). Data was collected from 81 drug outlets in strategically selected clusters adjacent to the River Rwizi and analysed using descriptive statistics. Results show extremely high prevalence of paracetamol (97.5%), amoxicillin (96.3%), ibuprofen (93.8%), azithromycin (86.4%), ciprofloxacin (82.7%), metronidazole (84.0%), coartem (80.2%), ceftriaxone (77.8%), and doxycycline (76.5%), indicating a narrow subset of medicines that dominate urban consumption. These drugs address the city's burden of febrile illnesses, malaria, and bacterial infections, but their widespread and unregulated use heightens risks of AMR development and pharmaceutical pollution. The findings indicate an urgent need for integrated pharmaceutical stewardship, improved wastewater treatment, and environmental monitoring of the River Rwizi. By establishing a baseline of commonly consumed drugs in Mbarara City, this study provides essential evidence for guiding rational drug use policies, waste management strategies, and interventions to safeguard both public health and aquatic ecosystems.

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INTRODUCTION

Pharmaceutical Use, Rivers, and Antimicrobial Resistance

Globally, analgesics, antibiotics, antimalarials, and chronic-disease medicines are among the most consumed classes of drugs in communities (Koirala, 2022). Their extensive use translates into environmental loading because parent compounds and active metabolites are excreted after treatment, while unused medicines are often discarded improperly, especially in developing countries. A worldwide survey of 1,052 river sites across 104 countries detected pharmaceutical residues on every continent and found concentrations above the levels of ecological concern at one quarter of sampled locations (Wilkinson *et al*., 2022). This environmental footprint is tightly coupled to the human health crisis of antimicrobial resistance (AMR), where, in 2019, 1.27 million deaths were attributed to bacterial AMR and 4.95 million were associated with AMR worldwide (Naghavi *et al.*, 2024)

Globally, insufficient wastewater treatment amplifies these risks. The most recent tracking by the United Nations shows that only 56–58% of domestic wastewater is safely treated, and reporting on industrial effluent remains sparse (NYIKA & OLUMANA, 2025). Where treatment coverage is low and treatment plants are under-performing, APIs such as ciprofloxacin, metronidazole, carbamazepine, and other common NSAIDs persist in effluent and accumulate in receiving waters, facilitating selection pressure for resistant organisms and disrupting aquatic communities (Wilkinson *et al.,* 2022).

Across sub-Saharan Africa (SSA), a dual burden of infectious diseases (malaria, TB, HIV) and rising non-communicable diseases drives sustained demand for antibiotics, antimalarials, and chronic-care drugs (Goswami, 2024). Weak regulation, stock fluctuations, and patient-driven self-medication increase inappropriate access to drugs in SSA settings, which results in improper disposal practices (Worrell, 2025). Wastewater and sanitation infrastructure still lags, possibly due to irresponsible disposal of medicines in water systems: SDG 6 tracking estimates that only 19% of domestic wastewater in SSA is safely treated, underscoring the high probability that APIs reach rivers with minimal reduction in concentration, activity, and toxicity (Tella *et al*., 2025).

Medicine Usage Patterns and Environmental Signals

In Uganda, essential antibiotics such as amoxicillin, azithromycin, ciprofloxacin, antimalarials (artemether–lumefantrine/Coartem), and analgesics (paracetamol, ibuprofen) are widely available through public facilities, private pharmacies, and drug shops, non-prescription sales, and self-medication (Lubwama *et al.,* 2021; Niwandinda *et al.,* 2020; Uganda MoH, 2021). Ciprofloxacin, metronidazole, sulfamethoxazole, and carbamazepine have been detected in surface and groundwater samples from Kampala district, indicating that human pharmaceutical residues are already entering Ugandan waters (Sanusi *et al.*, 2025). National reports acknowledge low sewerage

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coverage outside some urban centres and emphasise the need to expand and modernise wastewater treatment to protect receiving water bodies (NWSC, 2025).

Drug Prevalence and River Rwizi Vulnerability

Mbarara City, located in southwestern Uganda, is the largest urban centre in the Western Region and a critical hub for health, education, and commerce. The city lies along the River Rwizi, which serves as the primary water source for domestic use, agriculture, and small-scale industries in the region (Sanusi *et al.*, 2024). With a population estimated at 195,000 in 2014 and projected to exceed 250,000 by 2025, Mbarara is experiencing rapid urbanisation, accompanied by increased demand for healthcare and pharmaceuticals (UBOS, 2020).

Health infrastructure in the city is anchored by Mbarara Regional Referral Hospital (MRRH), a tertiary-level teaching hospital affiliated with Mbarara University of Science and Technology (MUST). The hospital, together with numerous private clinics, community pharmacies, and informal drug shops, makes Mbarara one of the urban centres that is densely supplied with medicines outside Kampala (Lubwama *et al.,* 2021). Pharmacies and drug outlets in the city provide both prescription-only and over-the-counter medicines, and studies have documented frequent dispensing of antibiotics without prescriptions, reflecting challenges in pharmaceutical regulation (Niwandinda *et al.*, 2020).

As a regional business centre, Mbarara City experiences a high turnover of transient populations, including truck drivers, students, and cross-border traders. This mobility contributes to the circulation of infectious diseases such as malaria, respiratory tract infections, and sexually transmitted infections (Uganda Ministry of Health, 2021). The consequent demand for antibiotics, antimalarials, and analgesics is reinforced by the socio-economic profile of the city. Many residents rely on informal vendors and private pharmacies for quick access to affordable medicines, often without professional consultation (Ocan *et al*., 2014)

Environmental management has not kept pace with this growth. Large sections of Mbarara city lack adequate sewerage coverage, with only 15–20% of households estimated to be connected to piped sewer systems (NWSC, 2025). Wastewater from the city residences is often discharged untreated into the River Rwizi, raising concerns about the accumulation of pharmaceutical residues in the aquatic environment (Sanusi *et al.,* 2024). This presents a dual challenge: sustaining the river as a safe domestic and agricultural water source while minimising the ecological and public health risks linked to pharmaceutical pollution and antimicrobial resistance. This study, therefore, intends to determine the prevalence and consumption of commonly dispensed drugs in Mbarara City drug outlets and to discuss the public health and environmental risks associated with pharmaceutical consumption, particularly their contribution to antimicrobial resistance and contamination of River Rwizi.

MATERIALS AND METHODS

Study Design

A descriptive cross-sectional survey was used to determine the human pharmaceutical drugs that are most frequently prescribed and used by the population in Mbarara City. This design was adopted because the study sought to estimate the prevalence of use of the most frequently prescribed human pharmaceutical drugs in Mbarara City at a specific point in time, without examining causal relationships and temporal changes. This design enables systematic, population-based data collection, supports efficient assessment of current medication-use patterns, and allows for reliable prevalence estimation within limited time and resource constraints (Setia, 2016).

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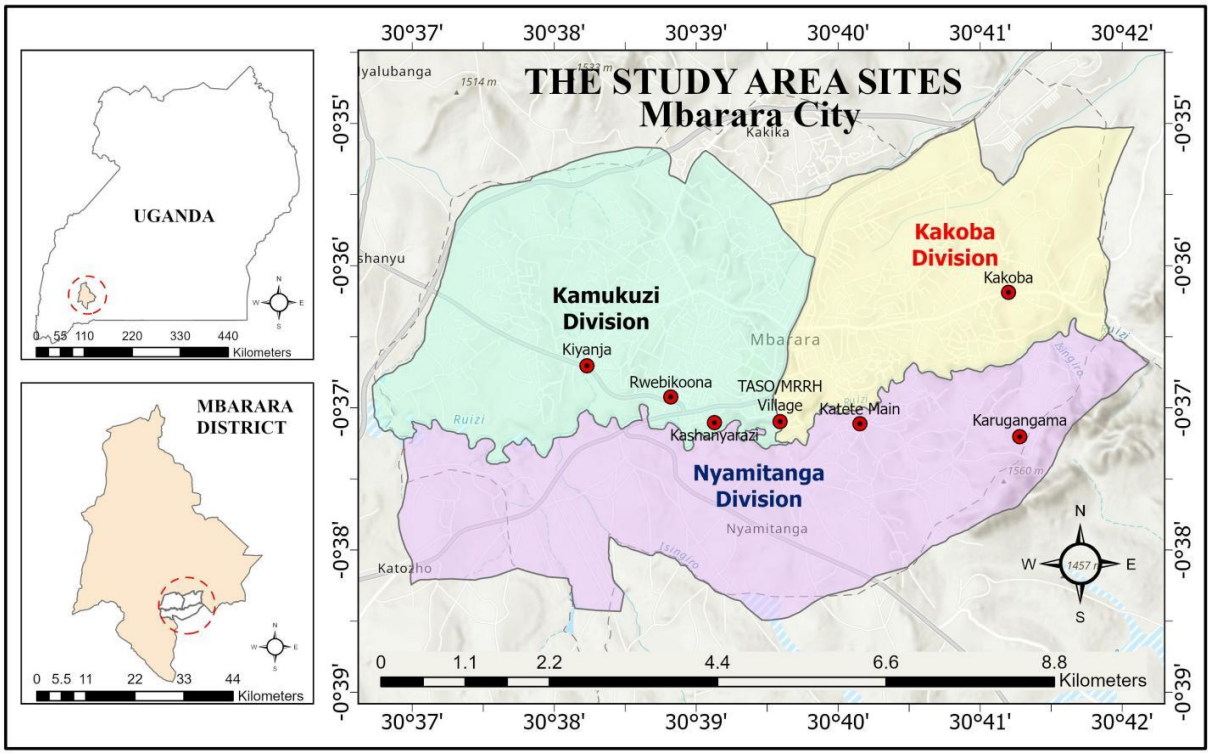
Study Area

The study was conducted in selected sections of Mbarara City, located in southwestern Uganda. The study area comprised urban neighbourhoods that lie in proximity to the River Rwizi. A cluster sampling was used to select areas situated near the Rwizi River catchment due to their potential contribution to the pharmaceutical pollution load. The selected clusters included areas of Kiyanja (0.616°S, 30.636°E), Rwebikona (0.616°S, 30.663°E), Kashanyarazi (0.619°S, 30.652°E), TASO/MRRH Village (0.617°S, 30.656°E), Katete Main (0.618°S, 30.669°E), Karugangama (0.619°S, 30.687°E) and Kakoba (0.603°S, 30.686°E. These areas are located within the urban drainage zones that directly discharge into the River Rwizi. They have relatively high population density, numerous drug outlets and healthcare facilities, and mixed land use that includes residential, commercial, and institutional establishments. Drug outlets from these areas participated in the survey aimed at identifying the most commonly prescribed and used human pharmaceutical products among local populations. The selection of this cluster reflected the environmental relevance of these locations to the River Rwizi ecosystem and their public health significance in understanding local patterns of drug utilisation.

Figure 1: Location of the Study Area in Western Uganda in Mbarara City, Showing Sampling Sites



(Source: *Generated from shape files using ARC-GIS software*)

Study Setting

To find out which medications are most commonly prescribed and consumed in Mbarara City, a questionnaire was utilised to collect quantitative data. The data was accessed from owners and managers of establishments that might be sources of pharmaceutical residues, including clinics, pharmacies, and pharmacy stores that sell human pharmaceuticals. The drugs that are on the market and used by the population are numerous, and the questionnaire was used to bring out those that are commonly consumed by the population. These are

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drugs that appeared in the upper quartile in terms of percentage prevalence and usage to treat common illnesses.

The Uganda Clinical Guidelines (2023) provides a list of the first thirty commonly prescribed drugs in Uganda. These drugs appeared on the questionnaire from which respondents selected the commonly prescribed drugs in the context of Mbarara city. The dugs include; Paracetamol, Ibuprofen, Amoxicillin, Cotrimoxazole, Sulfamethoxazole, Metronidazole, Artemether/Lumefantrine, Quinine, Azithromycin, Erythromycin, Ceftriaxone, Chlorphenamine, Salbutamol, Beclomethasone, Omeprazole, Ranitidine, Oral Rehydration Salts (ORS), Zinc Sulfate, Albendazole, Mebendazole, Nifedipine, Hydrochlorothiazide, Atenolol, Enalapril, Insulin, Glibenclamide, Ferrous Sulfate, Folic Acid, Oxytocin, Magnesium Sulfate and Levonorgestrone.

Sample Size Determination for the Survey

The sample size for the number of drug outlets (pharmacies, drug shops, and clinics) that were considered for the study was obtained using a formula by Bernardi *et al*. (2009) because of its widest application and relevance for survey studies for a known finite population.

$$\text{Sample size, N1} = \frac{NZ^2(SD)^2}{d^2(N-1)+Z^2(SD)^2}$$

Where: SD is standard deviation (23.4 from a related previous study)

Z is a Z statistic for a particular level of confidence (1.96 using 95% confidence level)

d is the precision level (5% to match the difference from the confidence level)

N is the population size (2000 from NDA reports)

N_1 is the sample size with a finite population correction

$$N_1 = \frac{2000 \times 1.96^2 \times 23.4^2}{5^2(2000-1) + 1.96^2 \times 23.4^2}$$

$N_1 = 81$ *samples of drug outlets*

Sampling Procedure

Mbarara City was subdivided into two clusters based on the Kampala highway as a dividing line, where the cluster of interest was the one that neighbours the river Rwizi, and this cluster has areas of Nyamitanga, Katete, Mbarara University, Mbarara RRH, Kakoba, and was named cluster two.

The second clustering was done in cluster two to obtain sections from which participating drug outlets were obtained. The clusters that were obtained are: Kashanyarazi, Kyanja Trading centre, Mbarara RRH, Katete main, TASO Village, Karugangama, and Kakoba. Cluster sampling was used since the population of drug outlets is geographically dispersed (Lindsay *et al.*, 2018).

The number of drug outlets in each of these clusters was obtained using a population census survey. The specific number of drug outlets in the cluster that participated in the study was obtained from the total number of drug outlets in that cluster using the concept of ratios and proportions (Da Silva, 2016)

$$\boldsymbol{Number\ of\ drug\ outlets\ to\ participate\ in\ a cluster} = \frac{\boldsymbol{C}}{\boldsymbol{C_T}} \times \boldsymbol{N_1}$$

Where C is the number of drug outlets in a cluster from a census survey

C_T represents the total number of drug outlets from all the selected clusters from a census survey

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$N_1 = 81$ Samples of the drug outlets that are needed for the study

The participating drug outlets from each cluster were selected from the outlets of the whole cluster by systematic sampling, since a complete list of the homogeneously distributed drug outlets was available (Daniel, 2012). The starting point on the sampling frame was determined by simple random sampling, where every k^{th} drug outlet was chosen from the list (Etikan & Bala, 2017).

Data Management and Analysis

The data collected was entered in Excel software and analysed using SPSS (Version 20) to generate descriptive statistics of frequencies, percentages, and bar graphs to show the most prescribed drugs.

RESULTS

Human Pharmaceutical Drug Prevalence in Mbarara City

The results demonstrate that some drugs, particularly essential analgesics, antibiotics, and antimalarials, are consistently prevalent across all the selected study areas in Mbarara City, while others display uneven usage depending on location, prescriber preferences, and local disease burdens. These patterns reflect the accessibility of drugs within pharmacies and health facilities, as well as patient-driven practices such as self-medication. When compared to previous studies conducted in Mbarara City, such as Lule *et al*. (2024), in private pharmacies and Niwandinda *et al.* (2020) among university students, this study expands the evidence base by incorporating both public and private healthcare outlets and by considering broader demographic groups. This city-wide perspective is essential for understanding how prescribing practices, supply chains, and community demands interact to shape drug utilisation. The following discussion examines the prevalence of individual drugs, explores reasons behind the differences observed, and relates the results to existing literature and public health concerns.

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Table 1: The Detailed Percentage Prevalence of the First 30 Drugs in the Selected Areas around Mbarara City

Drug	N = 81	Karugangama (n = 3)	Katete (n = 26)	Taso/MRRH (n = 5)	Kakoba (n = 5)	Kashanyarazi (n = 10)	Kiyanja (n = 15)	Rwebikona (n =17)	p-value
Azithromycin	70 (86.4)	3(100.0)	24(92.0)	4(80.0)	4(80.0)	8(80.0)	13(87.0)	14(82.0)	0.90
Paracetamol	79 (97.5)	3(100.0)	25(96.0)	5(100.0)	5(100.0)	10(100.0)	14(93.0)	17(100.0)	0.89
Amoxicillin	78 (96.3)	3(100.0)	25(96.0)	5(100.0)	5(100.0)	10(100.0)	14(93.0)	16(94.0)	0.96
Doxycycline	62 (76.5)	2(67.0)	25(96.0)	3(60.0)	4(80.0)	6(60.0)	10(67.0)	12(71.0)	0.16
Ceftriaxone	63 (77.8)	2(67.0)	24(92.0)	2(40.0)	5(100.0)	8(80.0)	11(73.0)	11(65.0)	0.094
Ciprofloxacin	67 (82.7)	3(100.0)	23(88.0)	2(40.0)	4(80.0)	7(70.0)	12(80.0)	16(94.0)	0.11
Levofloxacin	39 (48.1)	2(67.0)	17(65.0)	0(0.0)	3(60.0)	3(30.0)	7(47.0)	7(41.0)	0.12
Atenolol	20 (24.7)	0(0.0)	8(31.0)	0(0.0)	1(20.0)	2(20.0)	3(20.0)	6(35.0)	0.61
Carbamazepine	23 (28.4)	0(0.0)	9(35.0)	1(20.0)	2(40.0)	1(10.0)	5(33.0)	5(29.0)	0.67
Chloraphenicol	26 (32.1)	1(33.0)	8(31.0)	1(20.0)	1(20.0)	3(30.0)	6(40.0)	6(35.0)	0.98
Diazepam	43 (53.1)	1(33.0)	15(58.0)	2(40.0)	5(100.0)	3(30.0)	9(60.0)	8(47.0)	0.23
Ampiclox	60 (74.1)	2(67.0)	21(81.0)	2(40.0)	5(100.0)	7(70.0)	11(73.0)	12(71.0)	0.46
Amphetamine	60 (74.1)	3(100.0)	17(65.0)	3(60.0)	5(100.0)	7(70.0)	10(67.0)	15(88.0)	0.36
Forfenicol	9 (11.1)	0(0.0)	4(15.0)	0(0.0)	1(20.0)	2(20.0)	1(7.0)	1(6.0)	0.75
Lincomycin	10 (12.3)	0(0.0)	5(19.0)	0(0.0)	2(40.0)	1(10.0)	1(7.0)	1(6.0)	0.33
Piroxicam	55 (67.9)	2(67.0)	23(88.0)	4(80.0)	3(60.0)	4(40.0)	6(40.0)	13(76.0)	0.02
Ibuprofen	76 (93.8)	3(100.0)	24(92.0)	5(100.0)	5(100.0)	9(90.0)	14(93.0)	16(94.0)	0.98
Roxithromycin	10 (12.3)	0(0.0)	4(15.0)	0(0.0)	2(40.0)	1(10.0)	1(7.0)	2(12.0)	0.50
Trimethoprin	13 (16.0)	0(0.0)	4(15.0)	1(20.0)	1(20.0)	1(10.0)	3(20.0)	3(18.0)	0.98
Flucamox	29 (35.8)	0(0.0)	13(50.0)	1(20.0)	2(40.0)	1(10.0)	7(47.0)	5(29.0)	0.20
Coartem	65 (80.2)	3(100.0)	21(81.0)	3(60.0)	3(60.0)	8(80.0)	14(93.0)	13(76.0)	0.53
Diclofenac	12 (14.8)	0(0.0)	3(12.0)	0(0.0)	1(20.0)	2(20.0)	3(20.0)	3(18.0)	0.88
Citrizine	57 (70.4)	3(100.0)	16(62.0)	5(100.0)	4(80.0)	6(60.0)	10(67.0)	13(76.0)	0.48
Ketoprofen	12 (14.8)	0(0.0)	5(19.0)	0(0.0)	3(60.0)	1(10.0)	1(7.0)	2(12.0)	0.089
Metformin	41 (50.6)	1(33.0)	11(42.0)	1(20.0)	4(80.0)	5(50.0)	10(67.0)	9(53.0)	0.39
Metronidazole	68 (84.0)	2(67.0)	19(73.0)	5(100.0)	5(100.0)	9(90.0)	12(80.0)	16(94.0)	0.36
Dexamethason	49 (60.5)	2(67.0)	20(77.0)	1(20.0)	4(80.0)	4(40.0)	9(60.0)	9(53.0)	0.15
Meclofenamic acid	17 (21.0)	0(0.0)	6(23.0)	0(0.0)	3(60.0)	0(0.0)	2(13.0)	6(35.0)	0.060
Naproxen	16 (19.8)	0(0.0)	10(38.0)	0(0.0)	2(40.0)	2(20.0)	1(7.0)	1(6.0)	0.048
Sulfamethoxazol	20 (24.7)	1(33.0)	8(31.0)	3(60.0)	2(40.0)	2(20.0)	2(13.0)	2(12.0)	0.29

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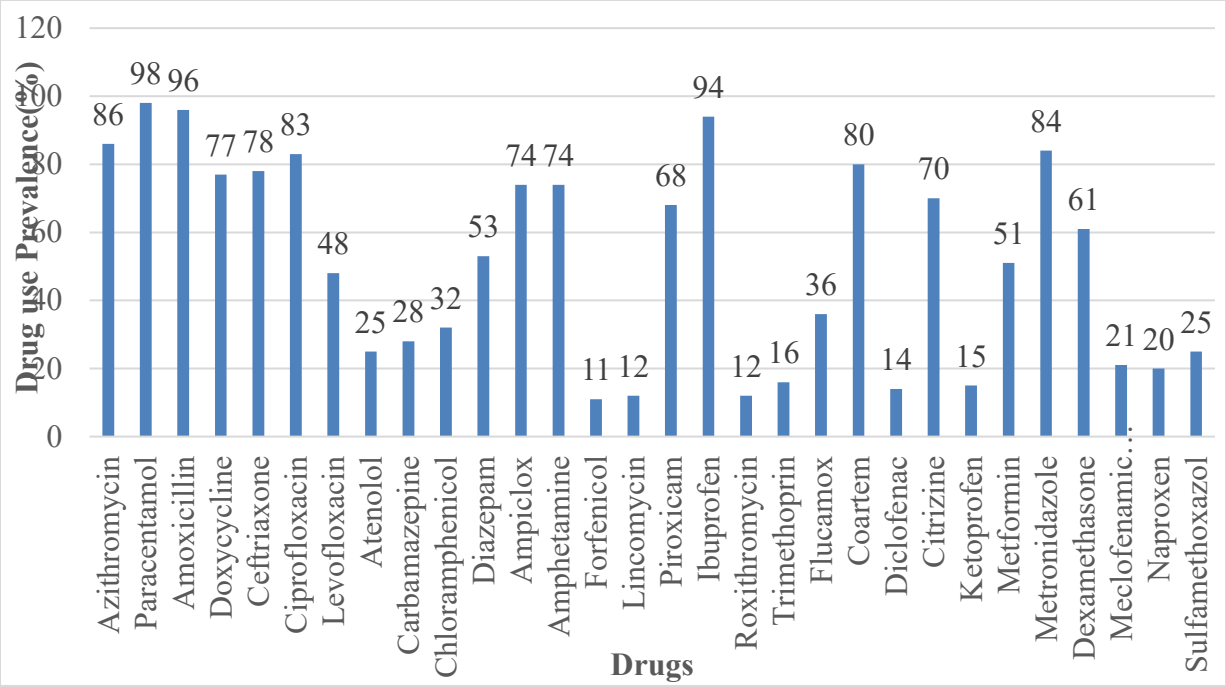
The majority of the respondents reported these highly prevalent drugs with no significant difference in the levels of being reported by all drug outlets in the selected study areas. These drugs include: Paracetamol (97.5%, p = 0.89), Amoxicillin (96.3%, p = 0.96), Ibuprofen (93.8%, p = 0.98), Azithromycin (86.4%, p = 0.90), Ciprofloxacin (82.7%, p = 0.11), Coartem (80.2%, p = 0.53), Metronidazole (84.0%, p = 0.36), Ceftriaxone (77.8%, p = 0.094), and Doxycycline (76.5%, 0.16). The least prevalent drugs with no significant difference in their levels of being reported as less prevalent by all drug outlets in the selected study areas include: Carbamazepine (28.4%, p = 0.67), Chloramphenicol (32.1%, p = 0.98), Roxithromycin (12.3%, p = 0.50), Lincomycin (12.3%, p = 0.33), and Florfenicol (11.1%, p = 0.75) (See table 1)

Figure 1: A Bar Graph Showing a Summary of the Percentage Prevalence of Each Drug



DISCUSSION OF RESULTS

Drugs with Very High Prevalence across all the Selected Sections of Mbarara City

The extremely high prevalence of paracetamol (97.5%) and ibuprofen (93.8%) across all sampled sections of Mbarara City highlights their role in formal health care settings and self-medication practices. Fever, headache, and musculoskeletal pain are among the most frequent complaints in outpatient departments at Mbarara Regional Referral Hospital (MRRH) and private clinics, as well as among patients who seek over-the-counter remedies at community pharmacies (Niwandinda *et al.*, 2020). The popularity of paracetamol is also attributed to its low cost and safety profile, because it is frequently prescribed in both public and private facilities as a first-line antipyretic for febrile illnesses such as malaria and respiratory tract infections, which are common in the city (Uganda Ministry of Health, 2021). Ibuprofen, though slightly less prevalent than paracetamol, is widely stocked in drug shops and informal vendors and often chosen for musculoskeletal pain among the working-class populations in peri-urban areas like Kakoba, where manual labour is a primary source of livelihood (Lubwama *et al.,* 2021). The high reliance on these analgesics points to patterns of self-care in Mbarara, where households often

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bypass formal consultation and opt for cheap, readily available drugs to manage symptoms. This trend may mask underlying conditions and delay hospital visits, thereby contributing to late-stage presentation of illnesses in referral facilities (Najjuka *et al.,* 2021).

The approximate universal presence of amoxicillin (96.3%) and azithromycin (86.4%) underscores the heavy infectious disease burden in Mbarara City. Amoxicillin is widely prescribed for pediatric respiratory infections, urinary tract infections, and some gastrointestinal conditions, which are among the most common reasons for outpatient attendance at MRRH and community health centres (MoH, 2021). Its high prevalence reflects both clinical guidelines, which report it as a first-line antibiotic. This makes it a default drug in both pharmacies and household medicine boxes (Lule *et al*., 2024). The strong prevalence of azithromycin highlights the influence of both local and global prescribing trends. Locally, it is often prescribed for respiratory tract infections and sexually transmitted infections (STIs), which are significant public health challenges in Mbarara due to its status as a trading and transport hub that attracts transient populations (Niwandinda *et al.*, 2020). Globally, during the COVID-19 pandemic, azithromycin gained popularity as part of empirical treatment regimens, a trend that could have influenced the prescribing and stocking practices in Ugandan cities, including Mbarara City drug outlets (WHO, 2021).

The uniform prevalence of these drugs across Karugangama, Rwebikona, Kakoba, Kashanyarazi, and Taso illustrates how urban health systems and informal drug markets interact in Mbarara. Mbarara City has a high density of drug shops and small private pharmacies, especially in peri-urban neighbourhoods like Kakoba and Taso. These outlets are the first point of care for many residents and often dispense antibiotics without prescriptions, despite regulatory restrictions (Lubwama *et al.,* 2021). Drugs such as paracetamol, amoxicillin, and ibuprofen are affordable, making them accessible even to low-income households. This affordability and frequent stock-outs in public facilities reinforce their high prevalence (Ayukekbong *et al.,* 2017).

Widespread access to these drugs ensures rapid relief for common conditions like fever and respiratory infections. However, uncontrolled overuse of amoxicillin and azithromycin is strongly linked to the growing threat of antimicrobial resistance (AMR) in Uganda (MoH, 2021; WHO, 2021). While paracetamol and ibuprofen are relatively safe, their frequent use in self-medication masks serious illnesses such as malaria and pneumonia, particularly in children (Lubwama *et al.,* 2021). There is an overlooked concern, which is the pollution of the River Rwizi with pharmaceutical residues. Improper disposal of medicines, hospital effluents, and untreated wastewater introduces antibiotics, analgesics, and other active compounds into the river system. These residues may persist in aquatic environments, contribute to antimicrobial resistance, and disrupt aquatic ecosystems, while also contaminating water sources used for domestic and agricultural purposes. This presents a dual threat for communities that depend on water from the River Rwizi through ecological degradation and heightened public health risks (Martins *et al.,* 2020). Addressing this concern requires strengthened pharmaceutical waste management, investment in wastewater treatment infrastructure, and regular monitoring of river water quality

Moderately High but Variable Prevalence

The moderately high but variable prevalence of ciprofloxacin, ceftriaxone, and doxycycline in Mbarara City reflects structural and behavioural determinants of antibiotic access. The differences across neighbourhoods such as Karugangama, Rwebikona, Kakoba, Kashanyarazi, and Taso highlight differences in pharmacy distribution, health facility capacity, and prescriber habits (Lubwama *et al.,* 2021). Ciprofloxacin (82.7%): Its presence in Karugangama and Rwebikona suggests that prescribing doctors in these neighbourhoods

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might prefer ciprofloxacin, due to its affordability and patient familiarity. The noted lower prevalence in Kakoba (40%) could be linked to socioeconomic disparities and limited stocking of ciprofloxacin in peri-urban outlets, where cost sensitivity is higher (Ayukekbong *et al.,* 2017). Ceftriaxone (77.8%): Its high prevalence in Kashanyarazi (100%) compared to Taso (40%) likely reflects the role of health infrastructure. Kashanyarazi, being close to major health facilities and private clinics, has the injection capacity to administer ceftriaxone, while Taso (an area with more informal or primary-level providers) may lack cold-chain storage and trained staff for injectable drugs (Najjuka *et al*., 2021). Doxycycline (76.5%): The widespread use of doxycycline can be tied to its multi-purpose utility in Mbarara City, covering sexually transmitted infections (STIs), malaria prophylaxis, and respiratory tract infections. The variation across neighbourhoods (60–96%) indicates both different burdens of disease and prescriber preferences, influenced by local epidemiology (For example, malaria exposure in peri-urban areas) and treatment guidelines adherence (WHO, 2021). The variability in antibiotic prevalence in Mbarara City is related to the broader Ugandan health care system context. Pharmacy and Drug Shop Distribution: Urban centres like Mbarara City have uneven clustering of pharmacies, with better-stocked outlets near teaching hospitals (Mbarara Regional Referral Hospital) and sparser, less-regulated outlets in peri-urban areas like Kakoba. This directly influences the availability of antibiotics (Lubwama *et al.,* 2021). Prescribing Culture: Prescribers near referral hospitals may favour broad-spectrum antibiotics like ceftriaxone for severe infections, while private drug shop attendants often dispense oral antibiotics like ciprofloxacin and doxycycline on patient demand and sometimes without prescriptions (Najjuka *et al.*, 2016). Socioeconomic Differences: Wealthier neighbourhoods tend to have greater access to higher-priced antibiotics, while poorer communities rely on cheaper generics or incomplete doses, contributing to variability (Ayukekbong *et al.*, 2017). The leading Public Health Implication is that uneven access and variable prescribing contribute to antimicrobial resistance (AMR).

Distinct Geographical Variations of Non-Steroidal Anti-Inflammatory Drugs

Geographical variation in the prescribing and dispensing of non-steroidal anti-inflammatory drugs (NSAIDs) was observed across some sections of the study area. Piroxicam (67.9%) and Naproxen (19.8%) displayed statistically significant differences in the study areas ($p = 0.020$ and $p = 0.048$, respectively). Piroxicam utilisation was higher in Katete (88%), whereas uptake was lower in Kashanyarazi and Kiyanja (40%). These variations could be influenced by pharmacy stocking preferences, prescriber confidence, and patient familiarity with certain NSAIDs. Although ibuprofen remains the standard NSAID globally, alternative agents such as piroxicam and naproxen are often selected when managing patients with chronic musculoskeletal pain, inflammatory disorders, or when ibuprofen is either unavailable or contraindicated due to gastrointestinal intolerance. This substitution pattern aligns with broader trends in sub-Saharan Africa, where stock fluctuations and local supply chains heavily dictate availability and clinical decision-making (Chao *et al.*, 2014).

Lule *et al.* (2024) documented similar high levels of NSAID utilisation, particularly diclofenac and ibuprofen, in private pharmacies within Mbarara city. This study revealed that pain management remains a dominant driver of pharmaceutical consumption, reflecting a heavy reliance on analgesics for both acute and chronic conditions. This suggests that the variations observed in the present study may not only be attributable to prescriber preference but also to patient-driven demand for effective pain control in resource-limited settings. After consumption, NSAIDs and their metabolites are excreted in urine and faeces. There is a possibility of improper disposal of unused medicines, which end up in surface water bodies through erosion. In Mbarara city, many areas lack

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strong pharmaceutical waste management practices, which increases this risk. Pharmacies, clinics, and hospitals in areas with high NSAID use may discharge wastewater, unused drugs, or contaminated materials without proper regulations. If there is no proper treatment, these can enter sewer systems or direct runoff, which find way into the River Rwizi.

Moderately Prevalent Drugs (30–60%)

Diazepam (53.1%), Metformin (50.6%), Dexamethasone (60.5%), and Levofloxacin (48.1%) were reported by approximately half of the respondents in the drug outlets. Diazepam was very high in Kashanyarazi (100%) but lower in Kiyanja (30%). Its selective use reflects its role in anxiety, insomnia, and seizures. Metformin's variability (20–80%) points to uneven patterns of diabetes care, linked to NCD management. Dexamethasone's presence (60.5%) reflects wide indications, amplified during the COVID-19 pandemic. These patterns illustrate that disease-specific drugs show patchy distribution based on local disease prevalence and prescriber specialisation.

Low-Prevalence Drugs (<30%)

The low prevalence of drugs such as Carbamazepine (28.4%), Chloramphenicol (32.1%), Roxithromycin (12.3%), Lincomycin (12.3%), and Florfenicol (11.1%) in Mbarara City outlets reflects their restricted therapeutic indications, evolving safety profiles, and gradual replacement by modern alternatives. Chloramphenicol has been widely phased out in many healthcare systems due to its association with severe and fatal adverse effects, especially aplastic anaemia (Chao *et al.*, 2014). Although still used in some low-resource settings for some infections where alternatives are unavailable, its prescription has been increasingly discouraged by both the World Health Organization and national guidelines (WHO, 2019). This explains its sporadic rather than routine presence in drug outlets. Carbamazepine, an antiepileptic and mood stabiliser, has a narrow spectrum of use confined to chronic neurological conditions such as epilepsy and trigeminal neuralgia (Shorvon, 2016). Unlike commonly dispensed antibiotics or analgesics, it is not indicated for acute or high-burden community illnesses such as fever, malaria, or bacterial infections. Consequently, its relatively low prevalence in Mbarara reflects the limited patient population requiring long-term neurological care.

Roxithromycin and Lincomycin are older antibiotics that have been largely substituted by safer and more effective macrolides (azithromycin, clarithromycin) and lincosamides (Clindamycin) (Cattoir & Leclercq, 2017). Their low prevalence in drug outlets suggests residual stock or niche prescribing rather than active use, consistent with global prescribing trends that prioritise newer agents with improved pharmacokinetics, safety, and resistance profiles. Florfenicol, on the other hand, is primarily a veterinary antibiotic structurally related to chloramphenicol, with limited application in human medicine (Perovic *et al*., 2018). Its occasional presence in drug outlets may reflect cross-use or misclassification, but does not represent a major component of human pharmaceutical consumption. Generally, the low prevalence of these drugs indicates that their presence in Mbarara City drug outlets could be attributed to residual availability or specialized use rather than intentional prescribing. This pattern is consistent with the global shift toward safer and more accessible alternatives, which dominate the local therapeutic landscape.

Interpretation of p-values

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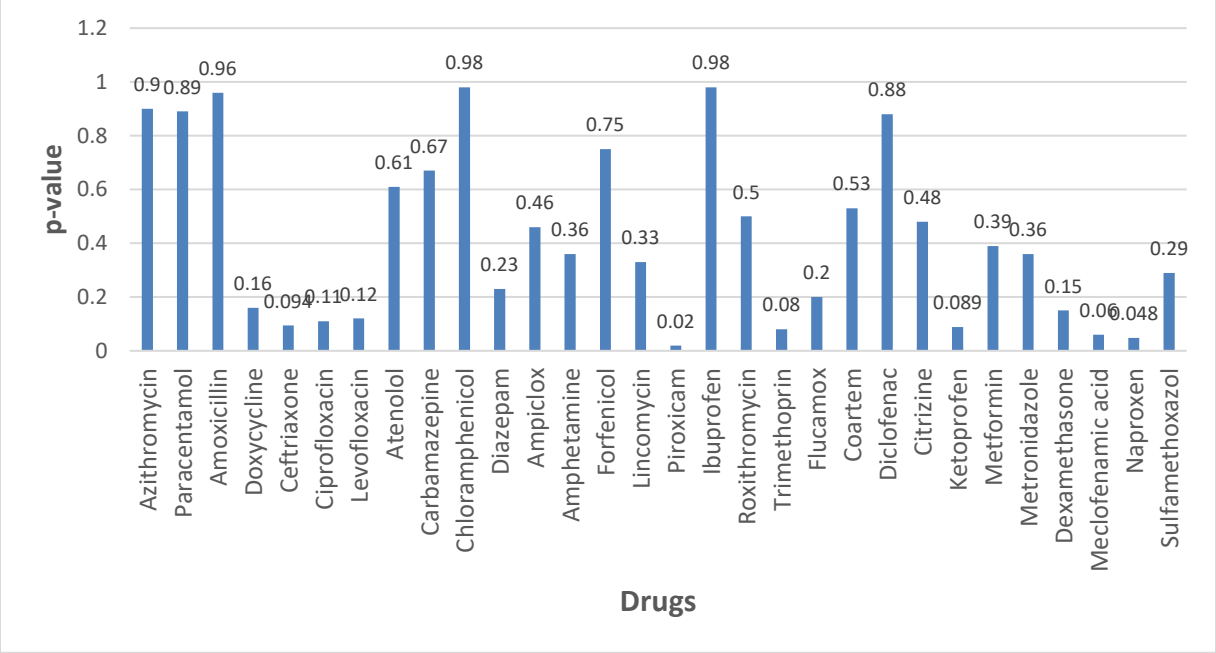
Figure 2: A Bar Graph Showing the p-values that Indicate Significance in Drug Use Reporting



The majority of the drugs assessed in this study demonstrated p-values > 0.05, indicating no statistically significant variation in prevalence across the surveyed sections of Mbarara City. The findings suggest uniformity of access to commonly used medicines across neighbourhoods. This uniformity reflects the shared pharmaceutical supply chains that serve both central and peripheral outlets, with drugs for high-burden conditions (antibiotics, antihypertensives, and analgesics) being distributed widely. In Mbarara City, the existence of multiple wholesalers and the proximity of health facilities and pharmacies may contribute to this observed evenness in drug availability (Petersen *et al.*, 2020). However, exceptions were noted for piroxicam (p = 0.02) and naproxen (p = 0.048), which showed significant differences in drug prevalence. These inequalities may be attributed to localised prescribing preferences, variations in patient demand, and stocking choices by individual pharmacies. In study areas with a higher burden of chronic pain and musculoskeletal disorders, piroxicam may be stocked more frequently, while in others, prescribers may rely more on familiar and widely available alternatives such as ibuprofen. Similarly, the presence of naproxen and Meclofenamic acid may reflect niche use in certain facilities, particularly where clinicians have experience in prescribing these alternatives for inflammatory conditions.

This variability in drug access reflects broader urban health inequalities. Pharmacies in centrally located study areas (Kashanyarazi, Katete) may have stronger purchasing power and more reliable supplier networks compared to peri-urban divisions like Kiyanja. This mirrors patterns observed elsewhere in Uganda, where medicine availability often correlates with socioeconomic status and proximity to health infrastructure (Kibirige *et al.,* 2019; Ocan *et al.,* 2014). Beyond patient access, these unequal distribution patterns may also have environmental consequences. Study areas with higher stocking and utilisation of drugs like piroxicam or naproxen could contribute disproportionately to pharmaceutical residues entering River Rwizi, given the challenges with waste management and untreated effluent discharge in Mbarara City (Sanusi et al., 2024). This means that inequalities in drug access not only affect therapeutic equity but may also result in localised hotspots of pharmaceutical pollution, especially in

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River Rwizi, and this further complicates the public and environmental health in Mbarara City.

Broader Context and Comparison with Literature

The observed dominance of paracetamol, antibiotics (amoxicillin, ciprofloxacin, azithromycin, metronidazole, doxycycline, ceftriaxone), and antimalarials (Coartem) in Mbarara City aligns with and extends the evidence provided by earlier research. Lule *et al*. (2023) documented the high use of NSAIDs, corticosteroids, and antihypertensives within private pharmacies, reflecting patterns of chronic disease management and pain relief. Similarly, Niwandinda *et al.* (2020) reported frequent self-medication practices among university students, with paracetamol, ibuprofen, and antibiotics on top of the list. These findings point to a culture of widespread access and reliance on easily available medicines for both acute and chronic conditions.

The current results expand the scope of these earlier studies by incorporating data not only from private pharmacies but also from public facilities and across diverse socio-demographic groups. This broader coverage reveals that the prevalence of commonly consumed drugs is not confined to specific sub-populations (students) or restricted outlets (private pharmacies and drug shops), but instead represents citywide consumption patterns. Particularly, the consistently high prevalence of antibiotics across all study areas underlines their centrality in healthcare-seeking behaviour in Mbarara City, raising concerns of potential misuse and the development of antimicrobial resistance (AMR) (WHO, 2020).

The high prevalence of paracetamol and ibuprofen is related to global trends, where these analgesics are among the most frequently purchased and consumed over-the-counter medicines due to their affordability, accessibility, and perceived safety (Auta *et al.*, 2019). The widespread reliance on Coartem underscores the continuing burden of malaria in Mbarara City and southwestern Uganda in general, despite public health campaigns and preventive measures (Augustino, 2022). The widespread use of antibiotics such as azithromycin and ciprofloxacin is also consistent with WHO reports highlighting inappropriate antibiotic prescribing and self-medication in low- and middle-income countries, often driven by patient demand and weak regulations (Hassan, 2018).

CONCLUSION

This study reveals that although a wide variety of drugs are available across Mbarara City drug outlets, a smaller subset dominates consumption, with several agents showing extremely high prevalence across all divisions. These include Paracetamol (97.5%), Amoxicillin (96.3%), Ibuprofen (93.8%), Azithromycin (86.4%), Ciprofloxacin (82.7%), Coartem (80.2%), Metronidazole (84.0%), Ceftriaxone (77.8%), and Doxycycline (76.5%). The concentration of use around this subset reflects the prevailing burden of febrile illnesses, infections, and malaria, combined with affordability, accessibility, and prescribing patterns. While these findings provide a valuable baseline for guiding rational drug use and equitable distribution, they also carry profound environmental and public health implications.

The dominance of antibiotics, analgesics, and antimalarial drugs suggests a high likelihood that residues of these same compounds may be entering River Rwizi through improper disposal, excretion, or wastewater discharge. This raises the possibility of pharmaceutical pollution in the river, with risks of antimicrobial resistance development, ecological disruption, and downstream health effects. To address this emerging threat, it is imperative to conduct quantitative analysis of these drug residues in River Rwizi. This data will provide a scientific basis for evidence-driven mitigation strategies, including wastewater treatment improvements, pharmaceutical waste management, and policies to strengthen rational drug use. Without this crucial step, efforts to ensure both public health and environmental protection will remain incomplete.

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