学 位 論 文

Water, Sanitation, and Hygiene Access, Practices, and Health Outcomes
in Peri-Urban Households of Lusaka, Zambia
（ザンビア・ルサカ都市周縁地域における
世帯の水・サニテーション・衛生（WASH）アクセス、行動、および健康影響）

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Abstract

Access to Water, Sanitation, and Hygiene (WASH) is a fundamental human right essential to public health. However, access to WASH remains critically low in low-income settings such as peri-urban areas. Evidence on behaviour sustainability, WASH coverage, and context-specific determinants is limited for peri-urban areas. While national reports compile WASH data by rural and urban divisions, peri-urban areas have unique characteristics that distinguish them from their urban counterparts. Therefore, this study aimed to evaluate access to WASH facilities, the determinants of hygiene behaviours, and their association with diarrhoeal diseases in peri-urban communities of Zambia. With a greater emphasis on hand hygiene, this research set out to: (i) Investigate hand hygiene practices, facility availability, and associated factors; (ii) Explore the barriers to and facilitators of handwashing behaviour; (iii) Assess the prevalence of diarrhoea and its association with household WASH access and practices.

A mix of quantitative and qualitative research approaches was used. First, a repeated cross-sectional survey was conducted in the Kanyama peri-urban area located west of Lusaka's city centre. This survey included data collected in 2018, after a cholera outbreak, and in 2022, during the COVID-19 pandemic. Each survey included 318 participants. Second, a cross-sectional survey was conducted concurrently with focus group discussions in the peri-urban areas of Kafue Town, located 40 km West of Lusaka city centre. The cross-sectional survey included 374 participants from four peri-urban communities. Two focus group discussions were conducted in three of these areas, each with 8-9 participants, for a total of 50 participants. Quantitative data analysis used descriptive statistics to summarise the participants' sociodemographic and WASH characteristics, including diarrhoea prevalence. Pearson's Chi-square and Fisher's exact tests were used to examine associations between variables. Logistic regression was used to assess the strength of the associations and predict outcomes. A framework approach to thematic analysis was used to analyse the qualitative data.

Quantitative analysis revealed a decline in access to handwashing facilities and hygiene practices. Households without handwashing facilities increased by 20%, whereas households with handwashing facilities, including soap and water, decreased from 14% to 0%. The decline extended to soap-and-water use between 2018 and 2022 ($p \leq 0.05$). The chances of handwashing with soap and water were lower among males, those over 40 years old, those who were married or living with a partner, and those who were employed. Similarly, in peri-urban

communities in Kafue, only 12% of households had a handwashing station with both water and soap. Furthermore, while 83% had improved sanitation, three-quarters shared toilets with multiple households. Most households (96%) had improved water sources, and slightly more than half (57%) were satisfied with the quality. The two-week diarrhoea prevalence was 15.5%. Households with unimproved sanitation (AOR = 2.34; 95% CI: 1.04–5.15; $p = 0.039$) and those with inconsistent handwashing after toilet use (AOR = 5.32; 95% CI: 2.55–11.26; $p < 0.0001$) had significantly higher odds of experiencing diarrhoea than those who washed consistently. The risk of diarrhoea also varied among peri-urban communities.

The qualitative enquiry into the determinants of handwashing identified infrastructural, sociocultural, and behavioural factors that served as both facilitators and barriers. Infrastructural facilitators included the presence of a handwashing station with soap and water and proximity to a toilet facility. The socioeconomic and social enablers were higher income and education levels, knowledge of handwashing, fear of disease, a desire to protect the family, feelings of disgust, early introduction of handwashing education, and positive social influence from neighbours. Conversely, the structural barriers included the lack of handwashing facilities, insufficient and unreliable water supply, water scarcity caused by floods and droughts, vandalism, and theft of stations. Socioeconomic and cultural factors included the high cost of handwashing stations, limited soap availability, low income and education levels, and cultural aversion to soap scents, particularly for handwashing before eating.

Overall, this research illustrates that hand hygiene behaviour, WASH access, and diarrhoeal disease in peri-urban Zambia are best understood as interdependent phenomena shaped by uneven and limited access to WASH resources, structural instability brought by external contexts, social norms, and cultural meaning constructs that shape choices and priorities. A fundamental insight is that households' capacity to maintain hygienic practices is deeply entangled with broader contextual conditions in which they live. Hand hygiene behaviours fluctuate in response to shifting public health contexts, highlighting a vulnerability to external pressures that reflect deeper systemic fragility and instability, and offering an opportunity for change that could be sustained with the proper measures in place. Furthermore, cultural norms and gendered roles shape hygiene practices, revealing that these behaviours are not merely technical or mechanical. The persistence of diarrhoeal disease despite the presence of improved WASH facilities in most households further underscores that infrastructure alone does not ensure protection; rather, its effectiveness depends on reliability, usability, and households' ability to integrate hygienic routines into environments marked by scarcity and unpredictability.

Abbreviations and acronyms

BCD	Behaviour Centred Design
CBV	Community-Based Volunteer
CDC	Centre for Disease Control and Prevention
COM-B	Capability, Opportunity, Motivation Behaviour Model
COVID-19	Coronavirus Disease 2019
DALY(s)	Disability-Adjusted Life Year(s)
DHS	Demographic and Health Survey
ERES	Excellence in Research Ethics and Science
GRZ	Government of the Republic of Zambia
HBM	Health Belief Model
IBM-WASH	Integrated Behavioural Model for Water, Sanitation and Hygiene
JMP	Joint Monitoring Programme (WHO/UNICEF)
K/ZMW	Zambian Kwacha
MLGH	Ministry of Local Government and Housing (Zambia)
MOH	Ministry of Health (Zambia)
NGO	Non-Governmental Organisation
OCV	Oral Cholera Vaccine
RANAS	Risks, Attitudes, Norms, Ability and Self-Regulation
SARS	Severe Acute Respiratory Syndrome
SDG(s)	Sustainable Development Goal(s)
SSA	Sub-Saharan Africa
UN	United Nations
UNDP	United Nations Development Programme
UN-HABITAT	United Nations Human Settlements Programme
VIP	Ventilated Improved Pit (latrine)
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WHO-UNICEF	World Health Organisation / United Nations Children's Fund
ZNPHI	Zambia National Public Health Institute

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Chapter 1

Introduction

1.1 Global, regional and local WASH context

1.1.1 WASH access and SDG 6

Access to Water, Sanitation, and Hygiene (WASH) is a fundamental human right essential for individual and overall community well-being. Given the importance of WASH in global public health, ensuring universal access to these resources remains a critical priority. The United Nations has specifically highlighted this issue by establishing Goal 6 of the Sustainable Development Goals (SDGs), which aims to achieve universal access to safe water and sanitation (UNDP, 2015). To achieve this goal, specific targets include universal and equitable access to safe and affordable drinking water, as well as equitable sanitation and hygiene for all, with a focus on eliminating open defecation (UNDP, 2015). Progress has been made towards these targets, with more people accessing WASH services; however, the progress remains slow.

Globally, 74% of households have access to safely managed drinking water services, an increase from 68% in 2015 (WHO-UNICEF, 2025). Safely managed drinking water is water from an improved source that is accessible on the premises, available when needed, and free from faecal and priority chemical contamination (WHO-UNICEF, 2018). For sanitation, the coverage of safely managed sanitation services (use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or removed and treated off-site) increased by 10% from 48% in 2015 to 58% in 2024 (WHO-UNICEF, 2025). Meanwhile, the coverage of basic hygiene services (availability of handwashing facilities with soap and water at home) increased from 66% in 2015 to 80% in 2024 (WHO-UNICEF, 2025).

Sub-Saharan Africa (SSA) is among the regions with the lowest WASH coverage. In 2024, of the 287 million people who used limited water services, over half lived in sub-Saharan Africa (SSA) (WHO-UNICEF, 2025). Limited water service is defined as drinking water from an improved source, for which the round-trip collection time exceeds 30 minutes, including queuing. Furthermore, SSA had the highest prevalence of shared sanitation and the highest proportion of the population lacking handwashing facilities at home.

In Zambia, access to sufficient WASH remains a significant public health challenge, particularly in poor and vulnerable communities, such as peri-urban areas. According to the 2024 Demographic and Health Survey national estimates, only 62% of the Zambian population has access to basic drinking water services, and less than half (37%) have access to basic sanitation services. Furthermore, only 31% of the population has access to handwashing facilities with soap and water (Zambia Statistics Agency et al., 2024).

1.1.2 WASH and health

A significant burden of disease is attributed to unsafe WASH. According to the World Health Organisation (WHO), approximately 1.4 million deaths and approximately 74 million disability-adjusted life years (DALYs) were attributed to unsafe WASH in 2019 (WHO, 2019). Specifically, 69% of the total diarrhoeal disease burden, 14% of acute respiratory infections, 10% of undernutrition, and 100% of soil-transmitted helminthiases were attributable to unsafe WASH. Substantial regional variations exist in the distribution of disease burden attributable to unsafe WASH.

Africa and Southeast Asia bear the greatest burden, with 76% and 66% of diarrhoeal disease attributed to unsafe WASH, respectively (Prüss-Ustün et al., 2019; WHO, 2019). The existing regional challenges, including rapid urbanisation, extreme poverty, and poor governance, exacerbate the challenge of unsafe WASH and the associated health implications. Climate change impacts, including extreme weather events such as droughts and flooding,

further compound the existing disease burden associated with WASH. In Zambia, WASH-related diarrhoeal diseases have consistently been among the top five causes of morbidity and are responsible for 4 in 5 hospital visits (Ministry of Health, 2021). Additionally, poor WASH has been associated with frequent cholera outbreaks which are particularly severe in the densely populated informal settlements (Mwaba et al., 2020).

The significance of WASH in disease prevention can be illustrated using the F diagram, one of many tools used to visualise the spread of pathogens via the faecal-oral route (Lanoix JN & Wagner EG, 1958). The diagram provides a visualisation of the various pathways of pathogen transmission through fluids (drinking water), flies, fields (crops/soil), fingers, fomites (surfaces and objects) and food. The diagram also shows how safe WASH disrupt these transmission routes by implementing primary barriers, such as protecting water sources and separating faeces from the environment, alongside secondary barriers, such as hand-washing, covering food, and controlling flies. Figure 1.1 shows the F-diagram, which is an expanded adaptation of the original.

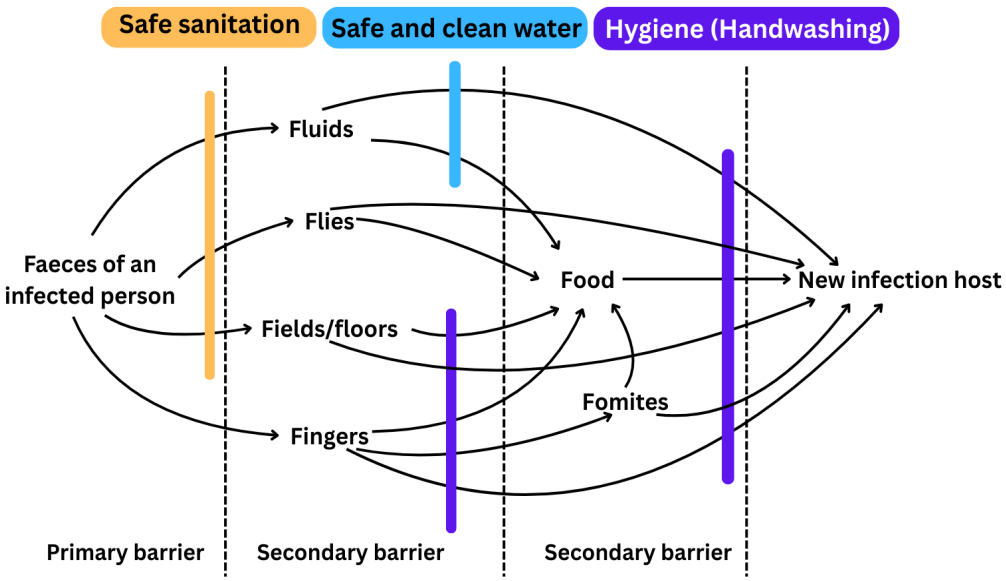

Figure 1.1: The F-diagram showing the faecal-oral pathogen transmission routes and protective barriers
Note: The figure is adapted from the original to include more exposure pathways (Lanoix JN & Wagner EG, 1958)

1.1.3 Peri-urban settings and WASH

More than half of the world's population lives in urban areas, and projections indicate that by 2050, approximately 80% of Africa's population will live in urban areas, with urbanisation rates reaching around 64% (Ritchie H et al., 2024; United Nations, 2025). This rapid urban growth, especially in peri-urban regions, places considerable pressure on existing infrastructure and services. Of the urban population, 1 in 4 people live in slum households, which are typically characterised by limited access to improved water and sanitation, insufficient living area and housing with non-durable materials (Ritchie H et al., 2024). As the urban population continues to grow, more people are likely to live in peri-urban areas, increasing the need for WASH access.

In Zambia, about 70 per cent of the urban population resides in the peri-urban with slum like conditions (UN-HABITAT, 2024). Housing in these areas is generally dense and unplanned, and they are located in areas with increased vulnerability to climate-related hazards such as flooding. The environmental pressure from the expanding peri-urban populations extends to water contamination, poor drainage, and increased solid waste generation, all of which contribute to the persistence and spread of WASH-related diseases.

The majority of the peri-urban residents have low income and education and often engage in informal work as their main source of income (Aydamo et al., 2023a; Nyambe et al., 2021; Zgambo et al., 2025). This restricts households' ability to invest in improved WASH facilities. The expansion of WASH infrastructure in the urban areas frequently lags behind population growth, leading to overstretched water supply systems, insufficient sanitation facilities, and inadequate waste management, especially for the urban poor in the peri-urban areas. Additionally, peri-urban areas often lack formal recognition, complicating efforts to extend municipal services. The complexity of rapid urbanisation, economic constraints, and environmental challenges in peri-urban settings creates a unique challenge for WASH access

and associated health outcomes. This complexity is reflected in Zambia, where poor WASH conditions in densely populated informal settlements contribute to frequent cholera outbreaks and high rates of diarrhoeal diseases, which remain among the leading causes of morbidity and hospital visits (Mwaba et al., 2020).

1.1.4 WASH in outbreak contexts

The COVID-19 pandemic and those similar, such as the SARS outbreak, have emphasised the crucial role of hand hygiene as a key preventive measure against the spread of infectious diseases (Fung & Cairncross, 2007; Hannah et al., 2020). During the COVID-19 pandemic, there was a global emphasis on hand hygiene and improving access to hand hygiene facilities, especially in public spaces. Similarly, recurring cholera outbreaks in peri-urban Zambia have prompted WASH interventions following their associated link to the cause of the outbreaks (Mwaba et al., 2020). These outbreaks, alongside the COVID-19 pandemic, elicited different public health responses, influencing WASH practices and access to facilities.

In Zambia, cholera outbreaks and the COVID-19 pandemic prompted a multisectoral response involving collaboration among government ministries, NGOs and international organisations. The response included surveillance, case management, public health interventions, and community engagement (Kapata et al., 2018; Mudenda et al., 2022). However, the nature of these interventions and the government's resource allocation differed because of the distinct transmission routes, public health challenges, and sociopolitical priorities associated with each disease. For cholera, the government emphasised transmission reduction through the faecal-oral routes. While hand hygiene was promoted, the primary interventions were ensuring access to clean water through chlorination, emergency water tanks, and targeted oral cholera vaccination (OCV) campaigns in high-risk areas (Kateule et al., 2024; MOH/ZNPHI/WHO, 2018; Sinyange et al., 2018). Public messaging focused on the importance of safe water, proper sanitation, and hygiene practices. In contrast, the COVID-19

response expanded beyond WASH measures to include social distancing, mask-wearing, mass testing, and national vaccination campaigns (Ministry of Health, 2020, 2023; Mudenda et al., 2022). Hand hygiene was a key preventive measure during the COVID-19 pandemic, and the government mandated the provision of handwashing stations in public spaces (Ministry of Health, 2020).

While public health responses to outbreaks such as cholera and COVID-19 have emphasised hand hygiene, they also reveal gaps in the effectiveness of these interventions in improving household-level handwashing facilities and sustaining practice. Both outbreaks exposed vulnerabilities in peri-urban areas, where shared WASH facilities and resource limitations amplified the transmission risks. Understanding how public health interventions, alongside socioeconomic and infrastructural barriers, influence behaviour is vital for designing effective interventions.

1.1.5 Behavioural dimensions of WASH

Various theoretical frameworks guide the understanding of WASH access and practices in peri-urban communities and have been applied across different contexts. The Capability, Opportunity, Motivation → Behaviour model (COM-B) serves as a fundamental framework for examining behaviour through an interplay between individual capability (knowledge and skills), environmental opportunity (infrastructure, water and soap availability), and motivation (risk perception, attitudes, emotional drivers) in influencing behaviour (Michie et al., 2011). In addition, the Behaviour-Centred Design (BCD) guides the design, implementation, and assessment of interventions such as handwashing promotion programmes. The framework provides a behavioural determinant taxonomy that classifies influences into five domains. The domains include the brain (factors such as knowledge, risk, motives, reactions, and psychological trade-offs), the body (individual characteristic traits), the behaviour setting

(infrastructure, props, roles, routines and norms), the environment (the physical and social environment) and the broader external context (Aunger & Curtis, 2016).

The Risks, Attitudes, Norms, Ability, and Self-regulation framework (RANAS), created for water, sanitation, and hygiene interventions, also offers a systematic approach for designing, implementing, and evaluating behaviour change interventions. It identifies specific psychosocial and normative factors that affect WASH behaviour, such as perceived vulnerability and benefits, cultural norms, social expectations, perceived ability, and behavioural planning. Interventions can then be planned based on the most influential factors (Mosler H, 2012). The Integrated Behaviour Model for WASH (IBM-WASH) framework incorporates contextual, psychosocial, and technological factors across societal, community, household, and individual levels to understand the multilevel and multidimensional factors influencing WASH access and health outcomes in infrastructure-constrained settings (Dreibelbis et al., 2013). Together, these frameworks provide a comprehensive lens on peri-urban WASH access, practices, and associated health risks.

1.2 Research focus

1.2.1 Problem statement and justification

Access to adequate WASH services remains critically low in many peri-urban areas in Zambia. Residents often navigate daily life with limited water availability, unreliable sanitation systems, and inconsistent opportunities to practise basic hygiene (Hubbard et al., 2020a; MLGH, 2015; Nyambe et al., 2021). These structural challenges are compounded by widespread gaps in hygiene behaviours, which are shaped by crowded living conditions, economic constraints, and competing household priorities (MacLeod et al., 2025; UN-HABITAT, 2024). The consequences are profound, including poor WASH conditions that continue to drive recurrent and sometimes severe cholera outbreaks, alongside a persistently high burden of diarrhoeal diseases that disproportionately affect vulnerable groups, particularly

children (Kateule et al., 2024; Mwaba et al., 2020; Nanzaluka et al., 2020; Sinyange et al., 2018).

Despite numerous governmental and partner-led efforts to expand WASH infrastructure and promote healthier behaviours, most interventions have struggled to produce sustained change (Berendes et al., 2022; Nelson et al., 2021). The challenges limiting these efforts could be partly attributed to the complex interplay of socioeconomic, cultural, and environmental determinants that shape WASH access and use in peri-urban communities (Okesanya et al., 2024). Additionally, the siloed approach of the WASH sector in addressing WASH challenges restricts a comprehensive understanding of WASH components, neglecting how infrastructural limitations, behavioural norms, community dynamics, and systemic barriers interact to perpetuate cycles of poor hygiene and disease transmission (UN, 2025).

A systematic review examining hand hygiene interventions in community settings found that, in most cases, interventions did not address identified barriers or enablers, limiting their potential impact. The review also highlighted that very few interventions were grounded in theory and focused on action knowledge, such as handwashing instructions, rather than on physical environment requirements, such as functional handwashing stations with soap and water (Prasad et al., 2025). Moreover, broader analyses of WASH programming attribute persistent failure to the project-centred approach of WASH interventions, where short-term, budget-constrained projects prioritise inputs and outputs over outcomes. This situation leaves little room for accountability for long-term service delivery and user engagement (Barrington et al., 2025). Collectively, this indicates that peri-urban programmes typically do not translate self-reported or knowledge-based gains into actual soap use; overlook essential infrastructure and resource constraints; and lack sustained, accountable implementation, resulting in modest or short-term behavioural improvements (Abdulhadi et al., 2024; Barrington et al., 2025; Prasad et al., 2025).

A comprehensive understanding of both the structural barriers that constrain access to reliable WASH services and the behavioural determinants that shape how households engage with available resources is essential in achieving sustainable WASH improvements in peri-urban settings (Abdulhadi et al., 2024; Okesanya et al., 2024). Understanding these dynamics requires research that examines behaviour within the broader contextual realities of the peri-urban households. This justifies this research, which examined household-level practices, the conditions of WASH infrastructure, and health outcomes in an integrated approach. In addition, given the complexity of the determinants of hygiene behaviour, research that examines them in a logical manner, rather than in isolation, was necessary to provide a realistic picture of the facilitators and barriers to hygiene practice. This information is vital for supporting the design and implementation of interventions that not only strengthen physical WASH infrastructure but also foster lasting behavioural change.

1.2.2 Research questions

The following research questions guided this study.

1. What are the levels of handwashing facility availability and hand hygiene practices, along with associated factors, in peri-urban Zambia?
2. What are the barriers and facilitators influencing handwashing behaviour in peri-urban communities in Zambia?
3. What is the prevalence of diarrhoea and its association with household WASH access and practices in peri-urban Zambia?

1.2.3 Overall aim

The main objective of this study was to evaluate access to Water, Sanitation, and Hygiene (WASH) facilities, the determinants of hygiene behaviours, and their association with diarrhoeal diseases in peri-urban communities of Zambia.

1.2.4 Specific objectives

The specific objectives were as follows:

1. To investigate hand hygiene practices, facility availability, and associated factors in peri-urban Zambia.
2. To explore the barriers and facilitators influencing handwashing behaviour in peri-urban Zambia.
3. To assess the prevalence of diarrhoea and its association with household WASH access and practices in peri-urban Zambia.

1.2.5 Thesis outline

This thesis is organised into five chapters. Chapter 1 introduces the peri-urban WASH context in Zambia, outlines the research problem, and presents the overall aim and specific objectives of the study. Chapter 2 presents Study 1, which examines changes over time in household hand hygiene practices and in the availability of handwashing facilities. Chapter 3 presents Study 2, which explores the barriers to and facilitators of handwashing behaviour in peri-urban communities. Chapter 4 presents Study 3, which assesses access to water, sanitation, and hygiene services and examines their association with diarrhoeal disease. Finally, Chapter 5 synthesises the findings from all three studies and presents the overall conclusions and recommendations for peri-urban WASH policy and practice.

Chapter 2

Changes in access to household handwashing facilities and hygiene practice in peri-urban Zambia

(Zgambo, J., Nyambe, S., & Yamauchi, T., 2025. Changes in access to household handwashing facility and hygiene practice in Kanyama peri-urban, Zambia - a repeated cross-sectional study. *International journal of environmental health research*. https://doi.org/10.1080/09603123.2025.2478249)

2.1 Chapter summary

This chapter outlines the research from the first study of this thesis. The aim of this study was to assess handwashing facilities and practice of hand hygiene in a peri-urban community of Zambia – Southern Africa. A repeated cross-sectional survey was conducted in Lusaka in 2018 and 2022 on 318 households for both surveys. Data were collected using a Water Sanitation and Hygiene (WASH) questionnaire and checklist on household and handwashing facility characteristics, participants' sociodemographic characteristics and methods of hand hygiene practice. Descriptive analysis, chi-square and logistic regression tests were used to analyse the data. Households without handwashing facilities increased by 20%, while those with handwashing facilities with soap and water reduced from 14% to 0%. Using soap and water was higher in 2018 than 2022 ($p \leq 0.05$). The chances of handwashing with soap and water were reduced in males, those over 40 years old, married/living with a partner, and employed. The study revealed a decline in access to handwashing facilities and hygiene practices, indicating the need for strategies to enhance hand hygiene in peri-urban areas and individuals of all demographics.

2.2 Methods and participants

2.2.1 Study design

This study utilised a repeated community-based cross-sectional design selected for its capacity to assess population changes over time (Brady & Johnston, 2015). Additionally, considering the mobility and short tenancy of the population in the peri-urban area, the design was instrumental in ensuring sample representativeness by mitigating attrition. The first survey was conducted from September to October 2018, following a cholera outbreak (Nyambe et al., 2020a). The second survey was carried out in August 2022, during the fourth wave of the COVID-19 pandemic.

2.2.2 Study area

This study was conducted in Kanyama peri-urban, located west of Lusaka's city centre. In addition to being one of the largest peri-urban settlements in Lusaka, it is also known for persistent cholera outbreaks, often acting as an epicentre (Sinyange et al. 2018; Kateule et al. 2024). It has predominantly flat terrain with poorly drained soils on an impermeable rock bed, making it prone to seasonal flooding. As with many other peri-urban areas, housing in this settlement is typically overcrowded, poorly constructed, and lacks proper WASH and waste disposal facilities. The study area comprised three out of the 13 administrative zones of Kanyama purposively selected using a multistage consultative process to ensure optimal representation of peri-urban WASH. The selection process of these zones was described in our previous research, which served as the baseline (Nyambe et al. 2020b). The zones were selected based on the availability of WASH facilities, public services, and distance from the main road. Based on this criterion, one of the three zones was where a local hospital and several government schools were located, and another was where the settlement's biggest market was located and had the second-largest number of households among the 13 zones. The third zone selected was off the main road, providing variation in zone characteristics.

2.2.3 Sample size and sampling procedure

The study population included consenting resident adults aged 18 years or older who were either household heads or individuals capable of providing information on behalf of the household head. For the first survey, the sample size was determined using the single population proportion formula, with a 95% confidence level, a 5% expected margin of error, a proportion of 50, and a 20% non-response contingency. This calculation yielded a sample size of 480, although a final sample of 369 was achieved (Nyambe et al., 2020a). For consistency, the goal was to match this sample size in the 2022 survey. After verifying the completeness of data on participant and household characteristics, hygiene practice variables, and household location coordinates, a final sample of 318 households was obtained for each survey. Technical challenges due to intermittent GPS failures during geocoordinate collection in the first survey, led to data loss during data cleaning. Research assistants experiencing device malfunctions were promptly followed up in the field, and devices were replaced as needed to ensure data accuracy.

The final sample size reduction marginally increased the margin of error to 5.4% (from the initial 5.0%), which remains within acceptable limits for population-level surveys. For comparison, national estimates report that 36% of urban residents have access to basic handwashing facilities (margin of error: 5.2% at 95% CI), a proportion likely lower in peri-urban areas (Zambia Statistics Agency et al. 2019). Despite the reduction, the study retained sufficient statistical power (>80% power to detect a 10% difference in proportions at $\alpha = 0.05$). Non-response bias was assessed by comparing the demographic characteristics of respondents and non-respondents, revealing no significant differences ($p > 0.05$).

The same location was surveyed in both surveys, although not the same households. Given the susceptibility of hand hygiene to reporting bias, sampling different households was useful in reducing bias arising from grooming or learning effects from previous interviews.

Systematic random sampling was employed to select households in the study area (Mostafa & Ahmad, 2018). The area had a mix of structured and semi-structured housing layouts. This made completely random sampling logically challenging without a complete listing of households beforehand. Systematic sampling allowed for even coverage, reducing the risk of clustering or omitting a population segment. Sampling involved selecting the fifth household from a predetermined central communal location in the community, agreed upon by data collectors, and then selecting households along the street until reaching the street/zone boundary. The central location was chosen as a practical starting point to ensure spatial neutrality but did not influence the sample's representativeness. Research assistants were trained to follow zone boundaries, ensuring that all parts of the community were equally represented. If multiple dwellings were present in a single household plot/yard, only one household (the fifth) was selected. The following household was chosen if no eligible person was present in the fifth household. This was done to avoid clustering of the data points as multiple dwellings in one yard are a common feature in the peri-urban of Zambia. Furthermore, due to the shared nature of water and sanitation infrastructure in multiple-dwelling housing arrangements, selecting one household did not significantly result in a loss of diversity in the sample.

2.2.4 Data collection tools and procedures

Primary data were collected using a household demographic and WASH questionnaire and a household WASH checklist. The tools were developed using the WHO-UNICEF (2017) Joint Monitoring Programme (JMP) guidelines. The WHO-UNICEF (2018) JMP guidelines were utilised as they provide standardised core questions for assessing handwashing behaviour and infrastructure (WHO/UNICEF, 2018). While other frameworks exist (White et al., 2020), JMP guidelines provide a standardised and globally recognised framework for assessing hand hygiene practices and facilities, ensuring consistency and comparability with other studies. The

guidelines are particularly suited for household-level assessments in low-income settings, aligning with the study's focus on peri-urban communities. JMP guidelines also enable direct comparison with national and global WASH monitoring data, enhancing the study's policy relevance.

Assessment of handwashing facilities

The checklist focused on observable factors such as presence of handwashing stations and availability of soap and/or water. Observation of handwashing stations has been used as a proxy for handwashing behaviour in surveys and has been shown to provide acceptable quality of evidence in the absence of observed handwashing practices (White et al. 2020; WHO/UNICEF 2018). Handwashing facilities included a sink with tap water, buckets with taps, tippy-taps, and jugs or basins designated for handwashing. Soap encompassed soap or detergent in bar, liquid, powder, or paste form. Handwashing facilities were categorised based on the WHO/UNICEF JMP service ladder for hygiene (WHO/UNICEF, 2018). According to this criterion, households with basic hygiene service levels possessed a designated handwashing station with soap and water. Households with limited hygiene service had a designated handwashing facility without water and/or soap. No service referred to households with no designated handwashing facility. Data collectors took pictures of the observed handwashing stations and recorded GPS coordinates of the household and the handwashing facility. GPS coordinates were collected to visually depict the distribution of handwashing facilities in the study area.

Assessment of handwashing practice

Self-reported data on handwashing practices were collected. Participants were asked to report instances of handwashing during their daily activities**.** Handwashing was considered in seven critical situations which included before, during, and after food preparation; before eating food; after using the toilet; after blowing the nose, coughing, or sneezing; after handling

garbage; when hands are visibly dirty; and after touching an animal, animal feed, or animal waste (CDC 2023). Research assistants documented responses in the questionnaire using predefined categories. Research assistants probed further if participants omitted any of the predefined categories. For each reported instance, participants were asked to specify the handwashing method i.e. soap and water, water only, or hand sanitiser. The structured approach minimised variability and enabled a detailed analysis of handwashing practices.

Data were collected by six data collectors who resided in Chawama and Kanyama peri-urban areas. They were trained in data collection and received refresher training before undertaking the second survey. The same team of data collectors administered the questionnaire and checklist using standardised procedures. This helped to minimise variations arising from differences in data collection practices and ensured consistency in the methodology. Additionally, the data collection process was piloted to identify and rectify potential inconsistencies in how the questionnaire and checklist were used. Tablets were used to collect data, with the questionnaire and checklist loaded onto the Kobo Toolbox platform. Access to the tools and details of the questionnaire and checklist were provided by Nyambe et al. (2020).

Variables

The outcome variable was hand hygiene practice, operationalised as either washing hands with water and soap or using alcohol-based hand sanitisers. The method of hand hygiene was further categorised based on materials used (i.e. water and soap, water only or alcohol-based hand sanitiser). Several explanatory variables were explored, including sex, age, marital status, education level, employment status, income type, and number of household members.

2.2.5 Data analysis

Descriptive statistics were used to describe the participant characteristics, hand hygiene practice, and the method of hand hygiene practised in critical situations. Pearson's Chi-square

and Fisher's exact tests were used to examine inter-survey differences. The study used 'coverage' to refer to the proportion of households with handwashing facilities according to WHO/UNICEF (2018) JMP hygiene service ladder classification. Spot maps of handwashing stations were created using Quantum Geographic Information System (QGIS) software version 3.28.0 for MacOS, an Open-Source GIS software. The X and Y coordinates, associated attributes of households, handwashing stations, and survey year, were saved in a comma-separated values (CSV) format Excel file and uploaded into the software for further analysis. The WGS 1984 UCS coordinate system was used, with the OpenStreetMap serving as the base map.

Hand hygiene practice was transformed into a binary variable for multivariable logistic regression analysis. The binary variable had two categories: washing hands with soap and water and/or using sanitiser (as good practice) and washing hands with water only (as poor practice). Selected explanatory variables for logistic regression models included sex, age, marital status, education level, employment status, income type, and number of household members. Separate logistic regression models were constructed for each of the selected critical situations. Machine-led stepwise forward logistic regression was employed to create regression models. Model entry criteria used a cut-off point of $p \leq 0.25$. However, the survey year was included in all models to control for the effect of inter-survey changes. Akaike Information Criteria (AIC) was used to select the best-fit model. Statistical significance was considered at a 95% confidence level with $p \leq 0.05$. JMP Pro version 16.1.0 (SAS Institute Inc., Cary, NY, 2016) statistical software was used for the analyses.

2.2.6 Ethical considerations

The study received ethical approval from the ERES Converge Ethical Approval Board, Lusaka (Ref. No. 2017-Mar-012) and the Faculty of Health Sciences, Hokkaido University, Japan (Ref. No. 21-77).

2.3 Results

Participant characteristics

The participants' characteristics were similar in 2018 and 2022 regarding their marital status, education, and the number of household occupants, with no statistically significant differences. Notable changes between 2018 and 2022 were also observed of participants' age, sex, employment and income type. In 2018, participants were mostly below 40 years (59%, $p < 0.001$) with a median age of 35 (IQR:26-46). The majority were female (81%, $p < 0.001$), unemployed (63%, $p < 0.001$), and with an irregular income source (74%, $p < 0.001$). In contrast, participants in 2022 were 40 years and older (66%, $p < 0.001$) with a median age of 46 (IQR: 36-52). Most were male (56%, $p < 0.001$), employed (72%, $p < 0.001$), and with a regular income source (51%, $p < 0.001$). Participants' sociodemographic characteristics are shown in Table 2.1.

Table 2.1: Characteristics of participants

		Survey Year		
		2018 (n=318)	2022 (n=318)	P-Value
Characteristics	**Categories**	**n (%)**	**n (%)**	
Age (years)[#]	*Median (IQR)*	*35 (26-46)*	*46 (36-52)*	
	Overall median (IQR): 40 (30-50)			
Age group (years)	Below 40	189 (59)	109 (34)	< 0.001
	40 and above	129 (41)	209 (66)	
Sex	Female	258 (81)	139 (44)	< 0.001
	Male	60 (19)	179 (56)	
Marital status	Not Married	117 (37)	108 (34)	0.5
	Married/living together	201 (63)	210 (66)	
Education level	Primary and lower	138 (43)	136 (43)	0.92
	Secondary and higher	180 (57)	182 (57)	
Employment status	Unemployed	201 (63)	89 (28)	< 0.001
	Employed	117 (37)	299 (72)	
Income type	Irregular	225 (74)	155 (49)	< 0.001
	Regular	79 (26)	163 (51)	
Number of household members	5 and less	200 (63)	182 (57)	0.27
	6 and more	118 (37)	136 (43)	

Note: IQR: Interquartile range

[#]Mean age [in 2018 was 38 (SD14.7 and in 2022 was 45 (SD11.9)]

Availability of hand hygiene facilities and hand hygiene practice

The analysis revealed a reduction in the availability of basic hygiene service (designated handwashing stations with soap and water) from 14% in 2018 to zero in 2022. Limited hygiene service (designated handwashing facility without water and/or soap) accounted for 52% and 46% in 2018 and 2022, respectively. There was a 20% increase in no hygiene service (no designated handwashing facility) from 34% in 2018 to 54% in 2022. The spatial distribution of handwashing facilities is shown in Figures 2.1 (a) and (b). Basic hygiene service was clustered in one location of the study area in 2018. Variations in the spatial distribution of handwashing facilities across surveys reveal a shift in household hygiene service levels in the study area, from clusters of basic facilities to limited or non-existent ones.

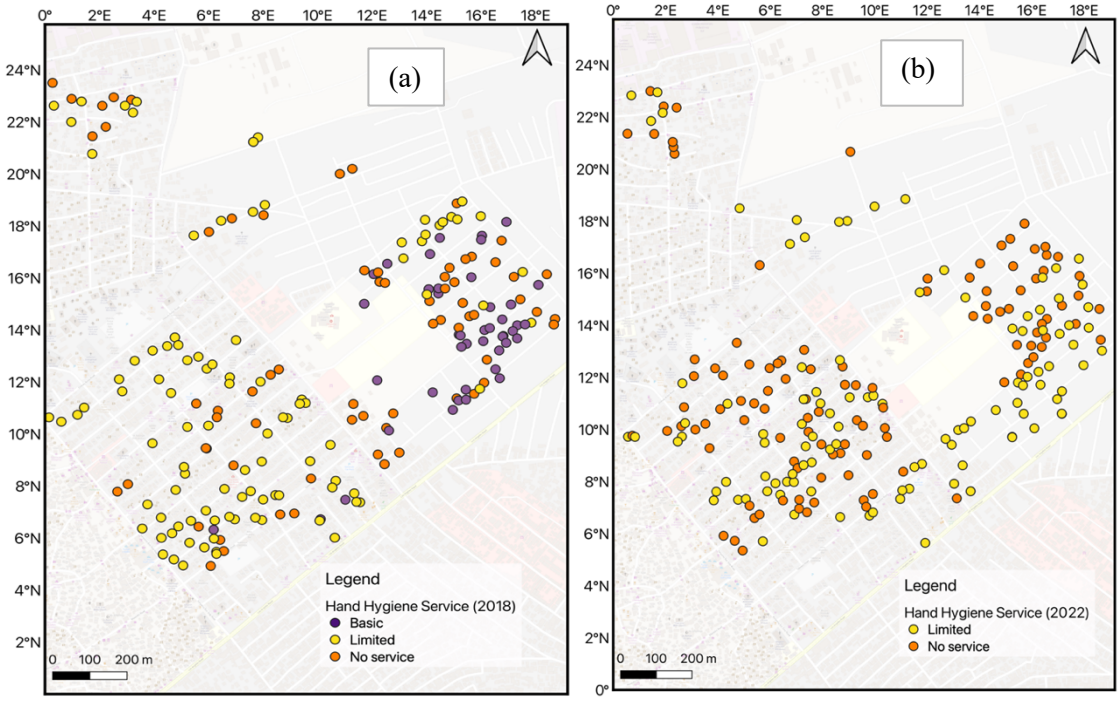

Figure 2.1 (a) and (b): Distribution of hand hygiene stations according to UNICEF/WHO_JMP service level in 2018 (n=224) and 2022 (n=224)

Handwashing with soap and water was more common among participants in 2018 in nearly all critical situations, with proportions of over 50%, as shown in Table 2.2. The exception was handwashing before eating food (64%), during which participants indicated washing their hands with water only. Nonetheless, handwashing with water only was more

common in 2022 except after using the toilet (80%). Worthy of note was the rise in the use of hand sanitiser, particularly after blowing the nose, coughing, and sneezing, from 4% to 31% between 2018 and 2022. Table 2.2 shows that disparities in hand hygiene practice among participants in 2018 and 2022 were statistically significant ($p \leq 0.05$). Our study found that most participants who reported using soap and water or hand sanitiser in 2018 had limited handwashing facilities after using the toilet (48%, $p \leq 0.05$) and after blowing nose, coughing or sneezing (58%, $p \leq 0.05$). While in 2022, 56% ($p \leq 0.05$) of those reporting soap use had limited handwashing service.

Table 2.2: Method of hand hygiene practice in selected critical situations

Critical situation	Method of hand hygiene practice	2018 (n=318) [a] n [b] (%)	2022 (n=318) [a] n [b] (%)	P-Value
Before during and after preparing food	Water and soap	137 (51)	40 (18)	<0.0001*
	Water only	131 (48)	187 (82)	
	Hand sanitiser	3 (1)	0	
Before eating food	Water and soap	106 (35)	54 (17)	<0.0001*
	Water only	195 (64)	255 (83)	
	Hand sanitiser	4 (1)	0	
After using the toilet	Water and soap	202 (70)	248 (80)	0.015
	Water only	81 (28)	57 (18)	
	Hand sanitiser	5 (2)	4 (1)	
After blowing nose, coughing, or sneezing	Water and soap	86 (64)	7 (24)	<0.0001
	Water only	43 (32)	13 (45)	
	Hand sanitiser	6 (4)	9 (31)	
After handling garbage	Water and soap	137 (65)	76 (42)	<0.0001
	Water only	71 (34)	105 (58)	
	Hand sanitiser	2 (1)	0	
When hand is visibly dirty	Water and soap	63 (58)	55 (41)	0.0031*
	Water only	43 (40)	79 (59)	
	Hand sanitiser	2 (2)	0	
After touching animal, animal feed or animal waste	Water and soap	66 (69)	7 (37)	<0.0001*
	Water only	30 (31)	11 (58)	
	Hand sanitiser	0	1 (5)	

Note: [a] Only those who indicated practicing hand hygiene were included in this table (Supplemental Information (S1) has details of those who did not practice hand hygiene). [b] Number of people who mentioned to practice hand hygiene in the critical point. *P-values derived from Fishers exact Chi-square test (Those not indicated were derived using Pearsons Chi-square)

Factors associated with hand hygiene practice

The odds of good hand hygiene practice were 83% lower in males than females (AOR = 0.17, 95% CI: 0.05 - 0.57) after touching an animal, animal feed, or animal waste. Conversely, individuals with at least secondary education had six times higher odds of good hand hygiene practice than those with primary and lower education (AOR = 5.97, 95% CI: 2.15 - 16.62) for the same critical situation. Those in employment had three times higher odds of good hand hygiene than those unemployed (AOR = 3.42, 95% CI: 1.01 - 11.59) in the same critical situation. In the critical situation after blowing the nose, sneezing, and coughing, age was the only variable significantly associated with hand hygiene practice. Individuals aged 40 years and above were 62% less likely to practice good hand hygiene than their younger counterparts (AOR = 0.38, 95% CI 0.19-0.76). After using the toilet, the odds of good hand hygiene practice were higher by 60% in households with six or more members than in those with less than six (AOR = 1.6, 95% CI: 1.06 - 2.42). However, for the same critical situation, those employed showed reduced odds of good hand hygiene practice than those not employed (AOR = 0.59, 95% CI: 0.38 - 0.90).

In cases where hands were visibly dirty, participants who were married or living with their partner were 54% less likely to practice hand hygiene (AOR = 0.46, 95% CI: 0.26 - 0.81) compared to those who were not married. Conversely, those with at least a secondary level of education and households with six or more members had higher odds of good hand hygiene practice when hands are visibly dirty [(AOR = 1.9, 95% CI: 1.1 - 3.29). Also, households with more than five members had two times higher odds of washing hands with soap and water and/or using hand sanitiser when hands were visibly dirty than those with five or fewer members (AOR = 1.91, 95% CI: 1.08 - 3.38). Figure 2.2 presents the results of the adjusted logistic regression analysis of hand hygiene practice.

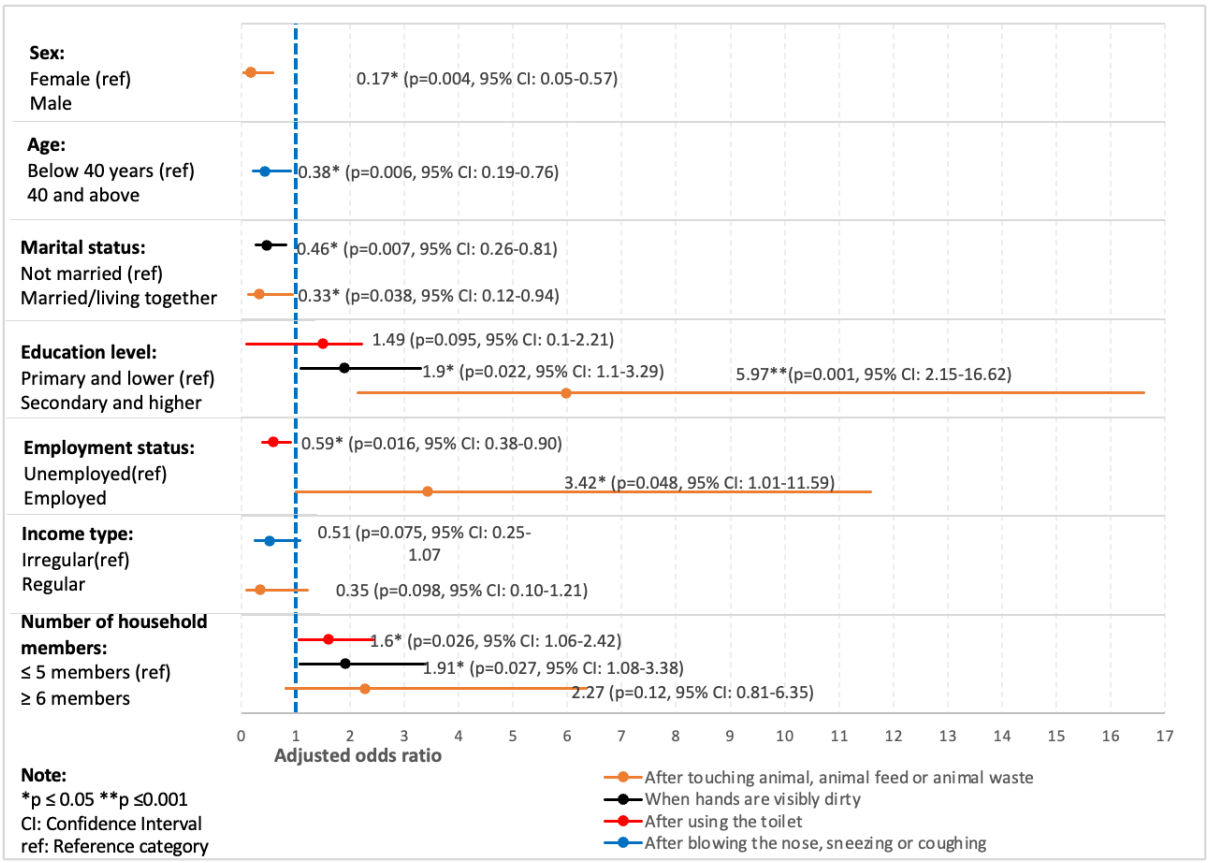

Figure 2.2: Adjusted logistic regression analysis of hand hygiene practices with soap and water and/or sanitiser

2.4 Discussion

2.4.1 *Hand hygiene facility availability and practice*

The limited availability of well-functioning handwashing stations as revealed in our study was consistent with the evidence in broader research indicating low coverage of basic hand hygiene services and higher limited to no hand hygiene service coverage, especially in Sub-Saharan Africa (Brauer et al., 2020a; Endalew et al., 2022; Odo & Mekonnen, 2021). Literature suggests that access to hand hygiene facilities is vital to hand hygiene practices (V. Curtis et al., 2011; Jumaa, 2005). Consistently, this study observed a decline in proper hand hygiene practices (utilisation of soap and water or alcohol-based hand sanitiser) in situations important for preventing the spread of infections**.** Others have observed an increase in combined use of hand sanitiser with handwashing with soap and water, particularly in the

advent of COVID-19 (Choi et al., 2021). However, only a slight increase in hand sanitiser use, especially after respiratory symptoms, was observed in this study. The reduction in handwashing facilities and practice indicates significant health implications, mainly as it indicates a regression to pre-epidemic behaviour. This decline is a threat to public health, particularly in the peri-urban, where poor WASH has been associated with numerous cholera outbreaks (Sasaki et al. 2009; Sinyange et al. 2018; Mwaba et al. 2020; Nanzaluka et al. 2020). In previous cholera outbreaks, WASH interventions significantly decreased cases, highlighting their effectiveness (Sinyange et al., 2018). Literature also indicates a 30% reduction in childhood diarrhoea risk by interventions promoting handwashing with soap and water in low- and middle-income settings (Wolf et al., 2022).

Consideration of the prevailing survey conditions is essential in understanding the observed changes in handwashing and facility availability, which are prone to influence by disruptions to social, physical, and biological environments (White et al., 2020). The initial survey (2018) followed a cholera outbreak, whereas the second survey (2022) occurred during the COVID-19 pandemic. Although these were both periods of heightened awareness of WASH, disruptions caused by the outbreaks varied.

The 2017-2018 cholera outbreak in Zambia was linked to environmental factors such as poor WASH (Sinyange et al., 2024). The response involved targeted environmental and community interventions including increased temporal water supply in the peri-urban through delivery by water bowsers and the erection of temporal tanks and tap stands (Kapata et al., 2018). The study area, Kanyama, was the outbreak's epicentre and received the highest number of temporary water stands and pipes (MOH/ZNPHI/WHO, 2018). In addition, Community-Based Volunteers (CBV) engaged in household door-to-door outreach, providing health promotion messages and handwashing demonstrations (MOH/ZNPHI/WHO, 2018). The personalised approach and immediate access to clean water directly addressed barriers to

maintaining hand hygiene at the household level. The rapid increase in the number of cases recorded (Sinyange et al., 2018) and personalisation of the intervention likely heightened the community's perception of the disease and their motivation to adhere to preventive measures, including handwashing.

In response to COVID-19, Zambia adopted the World Health Organization (WHO) recommended prevention guidelines, emphasising public health measures such as hand hygiene, masking, physical distancing, avoidance of crowds and staying home when ill. There was an emphasis on hand hygiene in public places with high human traffic, such as shopping malls, schools, and places of worship (Mudenda et al., 2022). These establishments were mandated to provide adequate and accessible facilities for hand hygiene and sanitation (Ministry of Health, 2020). However, unlike the cholera outbreak response, there was less focus on personalised outreach or ensuring household-level access to water in the peri-urban (Ministry of Health, 2020). This may have limited the adoption of handwashing at home.

Overall, the cholera outbreak had a more pronounced effect on household hand hygiene practices compared to the COVID-19 pandemic. The cholera interventions were characterised by direct, community-tailored measures that not only informed but also facilitated the practice of handwashing by ensuring the necessary resources were readily available. In contrast, the COVID-19 response, though effective in raising public awareness, did not translate as effectively into household behaviour change. Future public health responses may benefit from a dual approach combining immediate mass awareness with sustained community and household level support for more effective and sustained behaviour change.

2.4.2 *Hand hygiene practice and associated sociodemographic factors*

Studies indicate that higher education can provide better knowledge and resources for disease prevention and hygiene practices (Odo & Mekonnen, 2021; Wana & Mengesha, 2023). Also, education increases access to resources, including employment opportunities and income,

which enables greater access to hand hygiene materials and better practices. This corroborates this study's finding that those in employment were more likely to engage in hand hygiene. With infrastructural challenges, those with a stable income and higher education may face challenges in practicing hand hygiene yet are more likely to invest in household-based solutions to sustain hygiene behaviours. Literature indicates that larger households in the slums are more susceptible to experiencing diarrhoea than smaller households (Adane et al., 2018; Nyambe et al., 2020b). Consequently, larger households may be more motivated to engage in hand hygiene practices as a preventive measure against diarrheal diseases, as observed in the present study.

Recent research shows different views regarding hand hygiene practices between genders, with data suggesting that men exhibit significantly less consistent adherence to hand hygiene (Aunger et al., 2016; Haston et al., 2019; Olapeju et al., 2021). This discrepancy may be partly attributed to societal norms, culture, and differences in perception of personal hygiene (Amon-Tanoh et al., 2021; Jumaa, 2005; Wana & Mengesha, 2023; Whitby et al., 2007). Women perceive health risks more seriously than men, making them more likely to comply with preventive measures, such as handwashing (Dwipayanti et al. 2021a).This tendency is further reinforced by societal norms, which are stricter regarding hygiene among women, thereby increasing their handwashing practices (Eriksson et al., 2022). In many cultures, women often assume household caregiving roles, thereby positively influencing their handwashing habits (Lanfer & Reifegerste, 2021). A study in South Africa found that men's engagement in improving maternal, child health and nutrition was limited by culture-specified gender roles, which are more focused on providing for and advising their families (Watson et al., 2023). The social stigma associated with these traditional gender specific roles may impact men's prioritisation of hand hygiene (Ezezika et al. 2023; Watson et al. 2023). Public health interventions could target men by leveraging their perceived roles as providers and advisers to enhance household hand hygiene information and materials.

Studies have shown that hand hygiene practices tend to increase with age, with older individuals being more likely to engage in such behaviour than younger individuals (Aunger et al., 2016; Ilesanmi & Afolabi, 2020; Olapeju et al., 2021). However, this study found that hand hygiene practice was lower among older individuals, particularly after a respiratory event. On one hand, greater awareness and understanding of the importance of hand hygiene practices among older age groups or an increased perception of vulnerability to illness and infection may positively influence practice. On the other hand, a lack of health literacy may limit their hand hygiene practice, compounding their reluctance to change due to deeply engrained cultural traditions and beliefs (Lanfer & Reifegerste, 2021; Or et al., 2020) (Lanfer & Reifegerste, 2021; Or et al., 2020). A study in Sierra Leone found that due to a tendency by the elderly to uphold traditions, they were likely to oppose new behaviours if they diverge from the status quo (Lanfer & Reifegerste, 2021)**.** Considering the respect, status and influence of the elderly in their households and communities, public health interventions should target this population group to promote healthier practices.

Interestingly, most participants in the present study washed their hands with only water before eating. In Zambia, it is customary to use hands when eating (especially the staple food, nshima). It is common practice for people to wash their hands with water only and use soap after meals. This is anecdotally done to prevent the soap scent from interfering with the taste of the food and to eliminate any food odours on the hands after eating. While this is a common hygiene practice, it may not effectively remove pathogens compared to washing with soap and water (Burton et al., 2011). This highlights a potential disconnect between cultural hygiene habits and public health recommendations. It also presents an opportunity for health education and provision of culturally hygiene-friendly options to prevent disease transmission in this critical situation. Behaviour change strategies could emphasise how soap augments the existing handwashing cultural practices to improve acceptance and adoption. This could be further

enhanced by research to explore community perceptions of handwashing agents and identify culturally sensitive and appropriate strategies for increasing soap use before eating.

2.4.3 *Strengths and limitations*

We acknowledge that surveying different households across time points introduces a limitation, as some variations may be attributable to differences in the sampled populations. This challenge is inherent in repeated cross-sectional designs and is counterbalanced by the advantage of capturing broader trends in a population. By focusing on the same location and using standardised tools and methods for both surveys, we aimed to minimise the influence of sampling differences. Although our study had consistent methods and population, there were variations in sociodemographic characteristics between the two surveys, which may have affected comparability. However, considering the differences in the prevailing conditions during the surveys, our findings may help show variations during different social, physical and environmental disruptions in the communities. Additionally, self-reported hand hygiene practices may have been influenced by social desirability bias, meaning participants may have reported behaviours they believed were expected rather than their actual practices. Thus**,** we evaluated handwashing facilities as a reliable proxy in addition to self-reports. Direct observations were not included due to logistical constraints and concerns about the Hawthorne effect, where individuals may modify their behaviour when they are aware of being observed, potentially leading to biased results. Furthermore, our surveys were conducted after a cholera outbreak and during the COVID-19 pandemic; these events could have influenced handwashing behaviour but are important in giving insights into population behaviour during periods of societal disruption. Despite these limitations, our study still provides valuable insight into handwashing practices and infrastructure.

2.4.4 *Conclusion*

This study highlights a decline in the available hand hygiene facilities and a deterioration in good hand hygiene practices in critical situations for infection prevention. Disparities in hand hygiene practice were observed across different genders, ages, levels of education, and employment status. These findings underscore the urgent need for hand hygiene facilities in households and behavioural change interventions to make hand hygiene practice part of daily routines while carefully considering the unique characteristics of the peri-urban. There remains a need for context-specific research to identify the drivers and constraints of hygiene behaviour change to develop targeted interventions that can lead to sustained behaviour.

Chapter 3

Facilitators and barriers to household handwashing practice in peri-urban Zambia

3.1 Chapter summary

This chapter presents the second study, which aimed to explore the intricate landscape of handwashing barriers and facilitators, with a particular focus on peri-urban areas of Kafue, Zambia. This was a qualitative case study that used the Behaviour Centred Design framework to identify behavioural determinants, which were subsequently categorised as facilitators and barriers to handwashing in three peri-urban communities. Data were collected using focus group discussions from adult residents. A framework approach to thematic analysis was used to analyse the data in MAXQDA. The study revealed that the facilitators included knowledge of handwashing, availability of handwashing facilities with soap and water, higher education and income levels and early handwashing education. Among the barriers were the unavailability of functional handwashing facilities, a lack of essential supplies, limited household income, and environmental factors such as droughts and flooding. Cognitive and behavioural characteristics, including limited knowledge, perceived invulnerability, and personal habits, also hindered proper handwashing practices. The study highlights the need to address both behavioural factors and physical resources to achieve a more comprehensive and effective strategy, essential for sustainable improvements in hand hygiene practices.

3.2 Methods and participants

3.2.1 Study design

This study adopted a qualitative case study approach, which is well-suited for an in-depth exploration of handwashing in peri-urban communities in a real-world context (Creswell & Poth, 2018; Yin, 2018). Given the focus on understanding the intricacies of handwashing practices in households, this design allowed for a rich, detailed examination of the barriers and facilitators of handwashing in peri-urban community settings.

Theoretical consideration

The investigation was guided by an adaptation of the Behaviour-Centred Design (BCD) model (Aunger & Curtis, 2015), as refined by White et al. (2022) for handwashing in domestic contexts. The Behaviour-Centred Design (BCD) is an applied science of behaviour change that provides a systematic, evidence-based framework to guide the design, implementation, and assessment of interventions such as handwashing promotion programmes. The framework provides a behavioural-determinant taxonomy that classifies influences into five domains. The domains include the brain (factors such as knowledge, risk, motives, reactions, and psychological trade-offs), the body (individual characteristic traits), the behaviour setting (infrastructure, props, roles, routine and norms), the environment (the physical and social environment) and the broader external context. This model provided a structured approach to identify key determinants of handwashing behaviour, distinguish between facilitators and barriers within the community, and assess how these determinants operated in the study setting. A summary of the behavioural determinants and their definitions, as they apply to handwashing, is provided in Table 3.1. By applying this model, we ensured a systematic yet contextually grounded analysis of the factors influencing handwashing practices, aligning with established WASH research and allowing for a nuanced interpretation of local dynamics.

Table 3.1: Definitions of behavioural determinants

Behavioural determinants defined by the BCD framework		Definitions of each determinant adapted to handwashing
Brain	Executive Brain	The extent to which knowledge of handwashing behaviour and its benefits affects handwashing intentions and plans, and eventually performance of the behaviour.
	Motivated Brain	The goal-related drivers of behaviour. Motives for handwashing can include (but is not limited to) disgust (the desire to avoid cues to sources of infection), affiliation (the desire to fit in with others) and nurture (the desire to care for your child).
	Reactive Brain	The extent to which handwashing can be automatically triggered based on past experience and repetition.
	Discounts	The perceived time, effort and costs of washing hands with soap as compared to other courses of action.
Body	Characteristics	Socio-demographic characteristics that may affect handwashing, including gender, wealth, age, education and employment.
	Senses	The sensory perceptions that may cue handwashing behaviour or be experienced during or after handwashing.
	Capabilities	Whether an individual has the skills required to wash their hands with soap. Whether an individual perceives themselves to be able and willing to actually wash their hands at the times required.
Behaviour settings	Stage	The design and set up of the specific physical spaces where handwashing behaviour takes place.
	Infrastructure	Durable infrastructure associated with handwashing such as water supply systems, sanitation, kitchen facilities and handwashing facilities.
	Props	The value, characteristics, usability, ownership and accessibility of soap and other objects used for handwashing.
	Roles	The ways in which an individual's role, identity or responsibilities influence their handwashing practices.
	Routine	The sequence of behaviours regularly performed in association with handwashing.
	Norms	The extent to which an individual's handwashing practice is influenced by their perception of normative setting-specific rules. This includes an individual's perception of whether handwashing is commonly practiced in their community (descriptive norm); whether handwashing is part of their role and their normal behaviour (personal norm); whether handwashing is socially approved of (injunctive norm); and whether handwashing is practiced by their 'valued others' (subjective norm).
Environment	Physical environment	Factors in the physical or built environment including climate and geography.
	Biological Environment	Factors associated with an individual's interaction within their biological environment.

Behavioural determinants defined by the BCD framework		Definitions of each determinant adapted to handwashing
	Social Environment	The structure of an individual's social environment, including how they interact with it and perceive themselves within it.
External context	Political and historical context	The historical and cultural events that have shaped current perceptions and practices of handwashing. The extent to which handwashing-related policies or local and national leadership on handwashing issues, shape handwashing perceptions and practices at the individual level.

3.2.2 Study area

This study was conducted in three peri-urban locations in Kafue Town. Kafue town is located 45 km south of Zambia's capital city, Lusaka (Figure 3.1). The three communities were purposively selected following consultations with the local municipal council to identify the peri-urban communities and the water, sanitation, and hygiene challenges within them. Two of the communities are among the four main informal settlements of Kafue (GRZ, 2025). The two communities had household populations of approximately 3020 and 1600, respectively. The riverside location of the third community served as a critical criterion for inclusion in the study, providing richer insights into handwashing in diverse community settings. The household population of this community was approximately 390. The communities are located in largely informal and unplanned settlements of unregulated tenure, characterised by a lack of infrastructure services, including water and sanitation (Ibid). In Kafue Town, 38% of the population is connected to a sewer system (off-site sanitation), 61% use pit latrines and septic tanks (on-site sanitation), and 1% practice open defaecation (Bwalya et al., 2023). The most common type of sanitation in the peri-urban areas of Kafue is pit latrines, which are often shared by multiple households (Ibid, Zgambo J et al., 2023). The primary sources of water in Kafue Town include piped water, boreholes, shallow wells, kiosks, and rivers (GRZ, 2025). Piped water was only available in two of the communities included in the study, which also had a mix of access to boreholes and shallow wells. The riverside community had access only

to boreholes (mainly communal) and to river water. A preliminary study in a peri-urban area of Kafue revealed a low prevalence of hand hygiene facilities and inadequate hand hygiene practices during critical times for disease prevention, such as before eating food, after using the toilet, and when hands are visibly dirty (Zgambo et al., 2023).

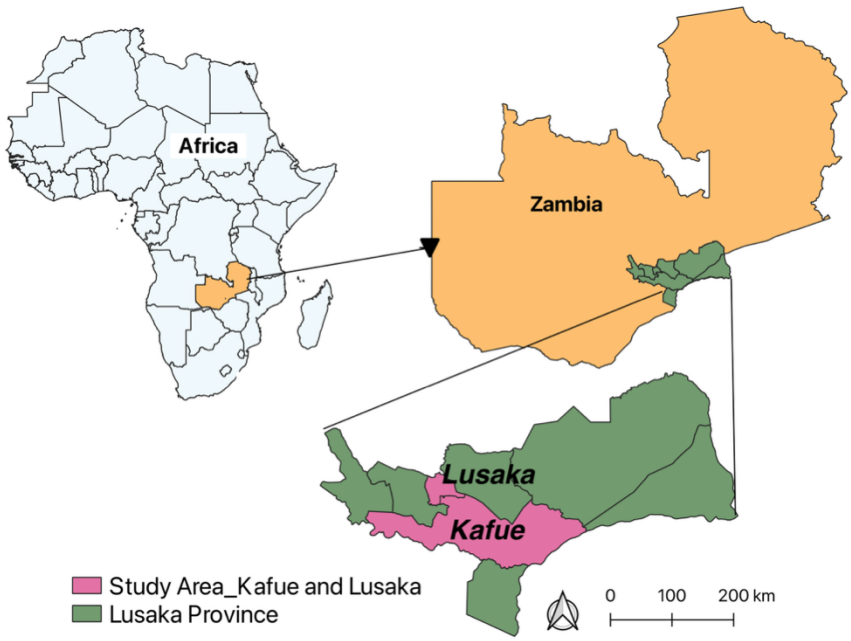

Figure 3.1: Map of study area

3.2.3 Sample size and sampling procedure

Fifty participants, residents of three peri-urban communities who could provide relevant and diverse data to meet the research objectives, were included. Their ages ranged from 18 to 77 years. Gender balance and a diverse age range were considered in the composition of the groups to ensure the completeness and saturation of the data. Persons with disabilities were included, where available, to gain a deeper understanding of their experiences. Participants were purposively recruited by community health workers and research assistants who were also community residents. To ensure representativeness, participants were selected from different locations within the community.

3.2.4 Data collection tools and procedures

Focus Group Discussions (FGDs) were conducted in the local languages Bemba, Nyanja, Tonga, and English using a focus group discussion guide. The researcher, fluent in Bemba and English, collected the data with the help of three local research assistants fluent in all the local languages. The research assistants who were residents of the communities assisted in contextualising the questions where necessary to ensure the questions were accurate and that the responses represented the views of the participants. In the month of September 2024, two focus group discussions were conducted in each community, with eight to nine participants in each discussion. The FGDs were conducted in the communities at a location identified by the research assistants that was convenient for all the participants and allowed them to express themselves freely. The FDGs lasted for 60–100 min. Digital voice recorders recorded the discussions, and a research assistant with relevant experience took notes. The FDGs included topics on knowledge and awareness, intentions and motivations, habit formation and behavioural triggers, socio-demographic influences, environmental and infrastructural context, historical and political influences, and social and community engagement. Figure 3.2 illustrates the focus groups during data collection.

Figure 3.2: Focus group discussions held with the community members

3.2.5 Data analysis

Audio recordings were transcribed verbatim, and personal identifiers were removed from the transcripts. A framework approach to thematic analysis was used to analyse the data. First, the transcripts were read several times to familiarise the researchers with the data. The Behaviour Centred Design (BCD) provided a framework for the thematic analysis. Additional supporting codes and themes were identified and included. Two independent investigators cross-checked the codes with the transcripts and derived their codes and themes. Comparisons were made, and any discrepancies were discussed until a consensus was reached. The final codes were rearranged, and the final themes were derived. Meaningful quotes which were representative were drawn and assigned to support the themes. A reflexive approach was used to ensure consistency while maintaining rigour and validity. The data were coded and analysed using MAXQDA 24.

Rigour and trustworthiness

In this study, credibility was ensured through triangulation, in which the codes and themes were cross-checked during data analysis. To minimise bias and ensure confirmability, the researcher, an outsider to the communities with a public health background, maintained reflective journals to document personal assumptions and their influence on data interpretation. As a public health researcher external to the study communities, the researcher's professional training and outsider status shaped this study in several ways. The researcher considered how a public health background could predispose them to prioritise disease prevention narratives when interpreting handwashing behaviours, potentially overlooking culturally embedded practices not tied to health outcomes. The 'outsider' status of the researcher may have affected the participants' responses. On one hand, some participants might have perceived the interviewer as an 'expert' and emphasised socially desirable answers, while others could have been hesitant to share critiques of WASH programs with an outsider. Conversely, this outsider

status may have given participants room to speak more freely about sensitive topics (such as their distrust of local health authorities) than they would have with a community insider. To bridge this gap, research assistants from the community provided contextual nuances during data collection and analysis.

Detailed records of the raw data, coding decisions, and analytical processes were maintained in MAXQDA 24 for transparency. To enable applicability to similar contexts, we provided rich details on the study setting (context), participants, and data, as well as all other research procedures, including data collection and analysis. The use of the Behaviour-Centred Design framework enabled direct comparison with other WASH studies, while data saturation across FGDs suggested stable findings. We note that Kafue's proximity to Lusaka may limit the generalisability of the findings to more remote peri-urban areas of Lusaka.

3.2.6 Ethical considerations

Permission to conduct the study was obtained from the Kafue Town Council, and consent to participate was obtained from all participants. Ethical clearance was obtained from ERES Converge Research Ethics Committee in Zambia (Ref. No. 2024-Sep-011).

3.3 Results

The identified determinants, based on the Behaviour-Centred Design (BCD) model, were categorised into two overarching themes: facilitators and barriers to handwashing behaviour (Table 3.2).

Table 3.2: Handwashing with Soap and Water Behavioural Determinants

BCD Component	BCD Determinant	Facilitators	Barriers
Brain	Executive	Knowledge of handwashing for disease prevention after toilet use Knowledge of handwashing as a protective measure against disease Disease specific risk avoidance	Limited knowledge of handwashing Perceived invulnerability to disease Personal laziness attribution to non-compliance
	Motivated	Fear of disease during outbreaks Desire to avoid germs and contamination Feeling of disgust when hands are dirty Desire to protect children from diseases Cleanliness viewed as a religious instruction that must be followed	
	Reactive	Early teaching of handwashing in one's upbringing Having a handwashing facility close to the toilet serving as reminder	Upbringing shaping handwashing neglect
Body	Socio-demographic characteristics	Gender roles and expectations Children of a young age Having high education Having high income	Being male and older Young adolescents rebellious of handwashing teachings
Behavioural setting	Infrastructure	Presence of handwashing facility Toilet design improvements with handwashing facilities Presence of soap and water for handwashing	Insufficient and inconsistent water supply Poor water quality High cost of handwashing stations Vandalism and theft of handwashing facilities
	Props	Distribution of soap and chlorine during outbreaks	Limited soap availability
	Norms	Positive social influence from neighbours driving handwashing	Community fragmentation hindering collective hygiene efforts Cultural resistance to soap use due to sensory preferences before eating food
Environment	Physical environment		Contamination of water during the rainy season Seasonal water scarcity during the dry season
External context		Outbreak driven hygiene education fostering temporary compliance	Short term behaviour change linked to outbreak fear

Executive brain determinants

The participants were aware that they encountered a lot of dirt and various objects throughout the day, and that washing their hands helped remove germs and dirt and protected them from diseases. Participants mentioned the importance of handwashing after using the toilet and before eating food. Some also mentioned washing their hands before cooking and after changing a baby's diaper. The main sources of information were education and sensitisation campaigns by healthcare workers, clinics, schools, churches, and community health workers, which increased awareness of the importance of handwashing. Non-Governmental Organisations working with neighbourhood sensitisers and youth groups (through peer educators) were also sources of information on handwashing.

> *The things we touch have germs. Just where we're sitting, if we touch anywhere, there are germs, so we need to wash our hands each time, not only after using the toilet to avoid falling sick. (Male, 35 years)*

> *Washing hands is important because if you do not wash, you can get sick of diseases like cholera. Same as us with babies, when we finish changing the baby's diaper, are supposed to wash our hands. (Female, 25 years)*

Sensitisation campaigns were acknowledged as helpful in changing handwashing practices. They stated a desire for more frequent sensitisation, noting that some community members did not know what to do, specifically regarding handwashing. Participants mentioned that some community members believed they were immune to illness, even without practising good hygiene. In contrast, others admitted their negligence as the reason for not washing their hands.

Motivated brain determinants

Participants widely stated that their primary motivation for washing their hands was the desire to avoid disease for themselves and their families. They also indicated that fear of sickness due to germs they encounter and the desire to remain clean were motivators for

practising hand hygiene. For those with children, a significant motivation was to prevent their babies from getting sick, particularly from diarrhoea, by washing their hands after changing their diapers.

> *If you come from the toilet and touch food without washing your hands, you will become sick. (Female, 45 years)*

> *If we do not wash our hands, the baby gets sick and develops diarrhoea. (Female, 25years)*

Some were motivated by physical discomfort or a feeling of disgust if they did not wash their hands after using the toilet, and felt unable to eat until they had done so.

> *I have friends who always say that if I come from the toilet and do not wash my hands, my body feels heavy, and for sure even me I feel it. I cannot eat anything if I do not wash my hands after using the toilet. (Male, 56 years)*

The discussants also pointed out that hygiene is a divine command from God:

> *From the beginning of the earth, God commands us to be clean, and we must keep our hands clean. (Male, 18 years)*

Reactive brain determinants

Participants mentioned being taught handwashing from a young age and having a handwashing station near the toilet as a reminder to wash hands.

> *This depends on how they are raised. Some people, whether the clinic staff go around to educate us, remain untidy and never change. (Female 48 years)*

Sociodemographic factors

Differences in hand hygiene practices were observed based on sex, age, education, and economic status. A common perception was that women are generally cleaner than men; therefore, they wash their hands more than men do. Men were described as ‘difficult’ and often refused to wash their hands, claiming they never got sick or grew up like that. Men were also mentioned as influencing children not to wash their hands.

Mostly, men are a problem because whether a man has been to school or not or whether there is a handwashing facility at home, they are difficult. They refuse, saying they have grown up and have not been sick or died from not washing their hands, so what difference will it make? (Female, 25 years)

These same men are the ones who influence the children not to wash their hands as well. Children will say, My father does not wash his hands, so why should I wash mine? (Female, 22 years)

However, some female participants admitted that women could also be unhygienic, citing examples such as not washing their hands while cooking, tasting food, or using wrappers (chitenge) to wipe urine and then using them as a kitchen towel.

It is not just the men, but also the women. A woman can cook and not wash her hands. She can even taste food without washing her hands. Others sniff insunko (sniffing tobacco) while cooking and do not wash their hands. (Female, 28, years)

Older people were said to find it difficult to wash their hands regularly, citing ignorance as the main reason. Similarly, the youths were described as difficult to sensitise and get to practice hand hygiene. However, the children reminded others about handwashing.

Older people find it difficult to wash their hands regularly because of ignorance. (Male, 52 years)

The main challenge we have is that even if we sensitise the youth, they still do not follow. (Female, 35 years)

…. My grandchildren always wash their hands and remind others to do the same, even those who are older than they are. (Female, 77 years)

Education was also noted as a potential factor influencing hygiene practice. Some participants believed that those who were educated knew how to practice hand hygiene, while it was more difficult for the uneducated. However, this was contradicted by those who mentioned that some educated individuals were also ‘very dirty’.

The educated know how to practice hygiene, while someone who is not educated will find it difficult to practice hygiene. (Female, 59 years)

Economic status was also mentioned as influencing access to hygiene products, noting that people with money have nice and expensive cleaning products, making it easier for them to practice hygiene.

Yes, people with money have better things (referring to hygiene materials) so its easier for them to practice hygiene (Male, 72 years)

However, some participants believed that hygiene was more about mindset than economic status. A strong belief was articulated that 'hygiene is hygiene, whether you are rich or poor.

I believe that the difference lies in the mindset of the individual. Therefore, cleanliness or untidiness does not depend on the money that someone has. (Male, 20 years)

The theft of handwashing containers for sale reflects the underlying economic pressure impacting hygiene infrastructure.

Hmm, no, most people do not have them (referring to handwashing containers and stands). The people who get scrap metals have stolen them……. they steal to go and resell. (Female, 50 years)

Infrastructure

Regarding infrastructure, lack of access to clean and sufficient water was a major impediment to handwashing in this study. Some also noted that although they were connected to the municipal water supply, it was intermittent.

The water we fetch is not very clean, which does not encourage people to wash their hands (Male, 55 years)

We have water challenges from the water company. Sometimes we stay two days without water (Male, 50 years)

Although participants noted that containers for handwashing were easily accessible, they mentioned that purchasing handwashing buckets was expensive.

It is much easier to find a container than a bucket. Buckets are expensive. (Female, 35 years)

Additionally, the presence and functionality of toilets were closely linked to hygiene practices in this study.

They dug a few free toilets in the community with slabs, and they also put handwashing facilities outside the toilets, including soap. (Female, 35 years)

However, others pointed out that the location of the handwashing facility mattered in terms of the convenience of practising handwashing.

You find that the house is next to the toilet, so instead of going to wash your hands, you just enter the house. (Male, 22 years)

Props

Participants noted that although handwashing was practised, it was often done without soap. In some cases, soap use was reserved only for specific situations, such as after using the toilet or after eating.

We wash just like that without soap. (Female, 29 years)
We only use soap when we come from using the toilet. (Male, 65 years)

There were indications of gaps in hygiene material supply and distribution, with some respondents highlighting that essential items, such as soap and chlorine, were not provided in certain interventions.

Social norms

There was a strong indication of positive competitive social norms around hygiene, as it was reported that observing clean neighbours was inspiring.

Our neighbours also inspire us to do the same. When we see others being clean and hygienic, we practice it in our homes. (Male, 56 years)

However, some participants felt that a lack of community cohesion hindered collective hygiene action.

People in this community are difficult because we do not work together. (Female, 36 years)

Some individuals also held norms against using soap. Participants unanimously expressed their sensory preferences regarding soap use, indicating that the smell of soap deterred them from using soap for handwashing before eating meals.

We're used. That is just our way of living because soap has a smell. How can you wash with soap when you are about to eat? It'll smell. (Male, 50 years)

Physical environment

Physical environmental factors related to the rainy season were noted as challenging for hygiene due to flooding and potential mixing of water with toilet waste. Others mentioned dry spells, which resulted in the drying up of the boreholes in their community.

This is a problem during the rainy season. We do not have proper drainage, and it floods. Sometimes the water mixes with toilet water and causes diseases (Male, 61 years)

"The boreholes dry up during the dry season here and we have to fetch water from the river" (Female, 45 years)

External context

Participants mentioned an increase in motivation, especially during outbreaks such as cholera and the COVID-19 pandemic. This was driven by increased health education and handwashing demonstrations, which were pointed to cease after the outbreak was over, and handwashing also followed suit.

Well, washing hands was mandatory, especially during COVID-19. (Male 72 years)

People are very dedicated to washing their hands during cholera. They clean even the drainage in the streets.(Male 26 years)

However, participants noted that health workers often only came to provide sensitisation when there was an outbreak, such as cholera or COVID-19. and that they returned to their old behaviour after sensitisation or disease outbreak.

…Clinic staff should sensitise people more often, not only during a pandemic. (Male, 56 years)

Once that period is done, they stop (referring to people stopping the practice of handwashing after the sensitisation campaigns). (Male, 18 years)

3.4 Discussion

3.4.1 Facilitators of household handwashing

In this study, knowledge of handwashing and its importance were facilitators of handwashing practice. Studies examining handwashing highlight the vital role of knowledge in promoting handwashing within community and household settings (MacLeod et al., 2025; Siddiqua et al., 2023). However, gaps in practice and knowledge persist across various populations and settings. In rural Bangladesh, a study found that while a significant portion of caregivers reported understanding the importance of handwashing with soap, their observed practices did not align with their self-reports. Only a minority effectively used soap and water after key activities such as defaecation (Halder et al., 2010). Similarly, despite being knowledgeable, only a fraction of Ethiopian mothers consistently practised good handwashing (Taddese et al., 2020) The gap between understanding and implementation indicates that even when knowledge is available, it does not automatically lead to action. Therefore, while knowledge is a facilitator of handwashing practices, actual behaviour is often influenced by other factors, such as the availability of handwashing resources.

In our study, the availability of a handwashing facility with soap and water was a key facilitator of handwashing. Beyond providing the basic tools for effective hygiene, such infrastructure also acted as a visual reminder to wash hands regularly (Brauer et al., 2020; Hulland et al., 2013; Seimetz et al., 2016). Participants further noted that when the handwashing station was placed close to the toilet, where hand hygiene is most critical, its accessibility strengthened these cues and made handwashing more convenient and more

habitual. This strategic placement aligns with previous research showing that environmental cues and proximity can significantly promote consistent handwashing, even outside outbreak periods (Aunger & Curtis, 2016; Hulland et al., 2013; Seimetz et al., 2016; Simiyu et al., 2025; White et al., 2020).

Similar to studies in settings such as the current study, higher education and income levels facilitated handwashing (Zgambo et al., 2025). Education and income levels interact by reinforcing each other in influencing handwashing behaviour, in that higher education typically facilitates higher income, which in turn provides better means for maintaining hand hygiene, such as access to handwashing facilities with soap and water. In the present study, being female was identified as a facilitator of handwashing linked to two drivers: the innate protective instinct towards family health and the visceral reaction of disgust to visibly soiled hands. This protective behaviour aligns with evolutionary tendencies to nurture and preserve family well-being, whereas the disgust response plays a significant role in avoiding contamination (Inbar & Pizarro, 2022; Murendo et al., 2024). Furthermore, being young and receiving handwashing education early in life were identified as enablers of handwashing in the present study. This suggests that early intervention and education play key roles in making handwashing habitual.

In outbreak situations, particularly in resource-limited settings, there is often a temporary increase in health education campaigns and awareness efforts (Kapata et al., 2018; Kateule et al., 2024). These campaigns typically lead to improvements in handwashing practices, as people become more conscious of immediate health risks. However, once the perceived threat diminishes, individuals tend to revert to their previous habits. This was observed in previous studies, where a decline in the practice and availability of handwashing facilities was evident in households after outbreak periods (Zgambo et al., 2025). In resource-limited settings, where access to information and healthcare may be restricted, this cyclical

pattern of behavioural change can be particularly pronounced. As such, normalising proper handwashing practices and making them a habitual part of daily life, rather than a temporary response to perceived threats, must be the goal of hand hygiene interventions.

3.4.2 Barriers to household handwashing

The unavailability of a functional handwashing facility is a significant barrier to handwashing in households, as it removes the primary means for individuals to wash their hands effectively and regularly. Even when a facility is present, the absence of essential supplies, such as clean water and soap, further impedes the ability to practice proper hand hygiene (Endalew et al., 2022). The absence of soap significantly reduces the effectiveness of handwashing in removing pathogens, even when water is available (Ross et al., 2023; Wolf et al., 2019). These physical barriers directly impact the feasibility of handwashing, regardless of an individual's knowledge or intention to maintain good hygiene practices. Additionally, the scarcity of these basic resources can lead to inconsistent handwashing habits, as individuals may be forced to prioritise limited water supplies for other essential needs or soap use at selected critical times for handwashing, such as only after using the toilet.

The scarcity of handwashing facilities and materials is intrinsically linked to limited household income, as some families lack the financial means to procure these essential items (Kisaakye et al., 2021). Furthermore, environmental factors such as prolonged droughts and water contamination resulting from flooding events exacerbate this scarcity, creating additional barriers to maintaining proper hand hygiene. The inadequacy of handwashing facilities and materials is further compounded by incidents of theft and vandalism, which disproportionately affect households in resource-limited settings, particularly in peri-urban areas (Simiyu et al., 2025). Certain handwashing station designs, such as buckets, are more susceptible to such criminal activities, highlighting the need for secure and theft-resistant designs in affected homes (Mwila-Kazimbaya et al., 2025a). Additionally, the formulation of soap products, often

containing high concentrations of fragrances, presents a cultural barrier in communities where food is traditionally consumed with the hands. This incompatibility between soap composition and local eating practices serves as an impediment to handwashing before meals, highlighting the complex interplay between product design, cultural norms, and hygiene practices in resource-constrained environments.

The barriers to household handwashing extend beyond physical constraints to include cognitive and behavioural factors. Limited knowledge of handwashing techniques and their importance in disease prevention can significantly hinder the adoption of proper hygiene practices. This knowledge gap often intersects with a perceived invulnerability to disease, particularly among certain demographic groups. Males and older individuals, for instance, may exhibit lower compliance with handwashing recommendations, potentially due to ingrained habits or misplaced confidence in their health status (Ezezika et al., 2023; Watson et al., 2023). Personal factors, such as laziness and upbringing, play crucial roles in shaping handwashing behaviour. Individuals may neglect handwashing due to perceived inconvenience or a lack of motivation, especially when the immediate consequences are not apparent (Curtis et al., 2009; Seimetz et al., 2016a). One's upbringing significantly influences hygiene habits, as practices learned in childhood often persist into adulthood. This underscores the importance of early education and consistent reinforcement of proper handwashing techniques in households.

3.4.3 Implications for handwashing interventions

The specific facilitators and barriers identified in this study have implications that may enable public health planners to develop targeted, context-specific interventions that go beyond generic handwashing campaigns. Particularly addressing knowledge on handwashing, gender-sensitive health education that involves men, youths and supports women's protective instincts can help overcome cultural barriers (Biran et al., 2014; Caruso et al., 2022; Rajaraman et al., 2014; Seimetz et al., 2016a). Also, ongoing community awareness, early education in schools

or community groups, and encouraging positive neighbour influence can sustain knowledge and habits beyond outbreaks (Crosby et al., 2023; Lanfer et al., 2023). Beyond knowledge acquisition, ensuring access to clean water and durable, theft- and vandalism-resistant handwashing stations near key areas such as toilets and kitchens is important for facilitating behaviour (K. R. S. Hulland et al., 2013; Mwila-Kazimbaya et al., 2025b). Local, low-cost, unscented soap or alternative cleaning materials directly address material shortages and cultural aversions to soap scents, especially for handwashing before eating. The use of self-made handwashing stations could enable access for low-income households (Chingatichifwe Mbakaya et al., 2020; Mwila-Kazimbaya et al., 2025b; Sultana et al., 2018; Wichaidit et al., 2019). Financial constraints on accessing these handwashing resources could be further eased through subsidies or cash transfer programs, which may boost the household capacity to acquire and maintain handwashing facilities. Community-led programmes could enhance community cohesion through peer educators, monitoring, clean-up campaigns, and sensitisation. Overall, addressing both behavioural aspects and physical resources is a more comprehensive and effective strategy, essential for sustainable improvements in hand hygiene practices.

3.4.4 Strengths and limitations

This qualitative case study offers an in-depth exploration of the facilitators and barriers to household handwashing in peri-urban Kafue, guided by the Behaviour-Centred Design (BCD) model. The BCD model provided a systematic lens for analysis while situating findings within the broader body of WASH research. The study was conducted in three peri-urban communities of Kafue, which may limit the generalizability of findings to other peri-urban contexts. Data collection relied solely on focus group discussions, which may be subject to social desirability bias and may not necessarily reflect actual behaviour. Despite these limitations, the study offers rich, contextually grounded insights into the behavioural and

structural determinants of hand hygiene in peri-urban Zambia, highlighting practical implications for future interventions.

3.4.5 Conclusion

This study used the Behaviour Centred Design framework to examine household handwashing in peri-urban Kafue and showed that handwashing behaviour is shaped by several interacting determinants. The findings demonstrate that improving hand hygiene in such settings requires more than increasing knowledge, since behaviour is strongly influenced by access to handwashing resources such as soap and water, cultural norms, environmental conditions, and the cues available within the household, such as a functional handwashing facility. These insights reinforce the value of using a behavioural framework to understand how physical and social contexts shape daily hygiene practices. The implications of these findings point to the need for integrated interventions that address both behaviour and the environment. Ensuring reliable access to water, affordable soap, and durable handwashing facilities, together with strategies that support habit formation and community engagement, can create conditions that make regular handwashing more achievable.

Chapter 4

Water, sanitation and hygiene access and diarrhoea prevalence in peri-urban Zambia

4.1 Chapter summary

This chapter presents the third study, which assessed access to WASH and diarrhoea prevalence in peri-urban communities of Kafue, Zambia. A household survey was conducted among 374 adults in four peri-urban communities. Data on WASH facilities, practices, and recent diarrhoea episodes were collected using a questionnaire and checklist. Logistic regression was used to determine factors associated with diarrhoea, with significance set at $p \leq 0.05$. Most households (96%) had improved water sources, primarily municipal water supplied to the yard/plot (40%); 78% reported experiencing insufficient drinking water at least once in the previous month. While 83% had improved sanitation, 74% shared toilets with multiple households. Only 32% had a handwashing station, and 12% had both water and soap. The two-week diarrhoea prevalence was 15.5%. Households with unimproved sanitation (AOR = 2.34; 95% CI: 1.04–5.15; $p \leq 0.05$) and those with inconsistent handwashing after toilet use (AOR = 5.32; 95% CI: 2.55–11.26; $p \leq 0.05$) had higher odds of experiencing diarrhoea. Findings reinforce that diarrhoeal risk reduction requires addressing functional WASH deficits, ensuring a reliable water supply and promoting consistent handwashing behaviour tailored to peri-urban contexts.

4.2 Methods and participants

4.2.1 Study design

The study utilised a quantitative cross-sectional design to evaluate access to Water, Sanitation, and Hygiene (WASH) facilities and diarrhoea prevalence in peri-urban areas. This methodological approach enabled a comprehensive assessment of WASH infrastructure availability and its potential association with diarrhoeal disease outcomes. By capturing data at a specific point in time, the cross-sectional design provided a snapshot of the current WASH situation and health status, facilitating the identification of potential relationships between WASH access and the occurrence of diarrhoea.

4.2.2 Study area

The study was conducted in peri-urban locations in Kafue Town. Kafue Town is located 45 km south of Zambia's capital city, Lusaka. The town was chosen due to its strategic location near the capital city. It is a rapidly growing urban area that offers housing for city inhabitants as well as a diverse community of rural residents. Four communities were purposively selected following consultations with the local municipal council to identify communities with characteristics relevant to the study, specifically in peri-urban locations. These communities included Zambia Compound, Kalundu View, Soloboni and the Bridge Community (Figure 4.1). The peri-urban communities included in the study are primarily located in informal and unplanned settlements with unregulated tenure, and they are characterised by a lack of infrastructure services, including water and sanitation (GRZ, 2025).

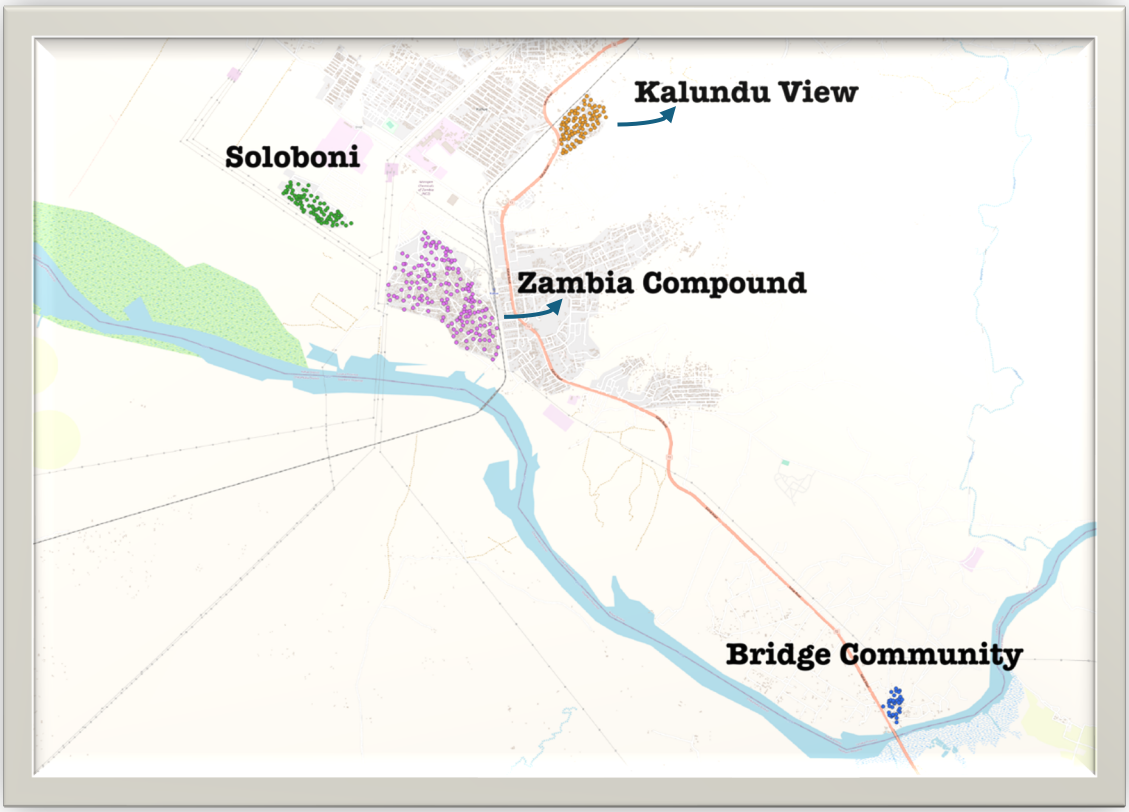

Figure 4.1: Map of the study area showing the four study sites in Kafue Town

4.2.3 Sample size and sampling procedure

The study population included consenting resident adults aged 18 years or older who were either household heads or individuals capable of providing information on behalf of the household head. For the survey, the sample size was determined using the single population proportion formula, with a 95% confidence level, a 5% expected margin of error, a proportion of 31 (households with access to basic water service based on statistics from the district health office), and a 20% non-response contingency. This calculation yielded a sample size of 350, although the final sample was 374. The sample was proportionally divided among the four peri-urban communities based on household size. The community household size data was collected from the health centre serving the community.

Systematic random sampling was employed to select households in the study area (Mostafa & Ahmad, 2018). The area had a mix of structured and semi-structured housing

layouts. This made completely random sampling logistically challenging without a complete list of households beforehand. Systematic sampling allowed for even coverage, reducing the risk of clustering or omitting a population segment. The systematic approach used in this study had been used in a similar setting described separately (Zgambo et al., 2025).

4.2.4 Data collection tools and procedures

A household demographic and WASH questionnaire and a household WASH checklist were used to collect data. The WHO-UNICEF (2018) JMP guidelines were utilised to provide standardised core questions for assessing household WASH and practices (WHO/UNICEF, 2018). The Demographic and Health Survey (DHS) provided demographic survey questions. A checklist was used to gather detailed information about the WASH facilities used by the respondents. Pictures and geographic locations of the facilities were collected. Data were collected by data collectors who were residents of Kafue and received specialised training to identify potential WASH facilities within the communities, enabling them to classify them accurately. A pilot was conducted to check the tools for consistency and further orient the research assistants. The research assistants' classifications were subsequently verified through photographs taken during the assessment. Tablets were used to collect data, with the questionnaire and checklist loaded onto the Kobo Toolbox platform.

4.2.5 Data analysis

Descriptive statistics were used to describe participants and WASH characteristics. Pearson's Chi-square and Fisher's exact tests were used to examine associations between diarrhoea and WASH and participants' demographic and household characteristics for bivariate analyses. This non-parametric test is appropriate for categorical data and helps identify significant relationships between variables without assuming a specific distribution (Kirkwood & Sterne, 2010). Logistic regression was used to assess the strength of the associations and predict outcomes. The primary outcome variable for the logistic regression was diarrhoea,

defined as having experienced diarrhoea by a household member within two weeks prior to the interview.

A machine-led stepwise forward logistic regression approach was utilised. This method systematically adds variables to the model based on their statistical significance, allowing for efficient model building when dealing with multiple potential predictors. The regression models included a priori variables, even though many associations were not statistically significant in the bivariate analysis. This approach acknowledges that some variables may have theoretical importance or potential confounding effects, despite not showing strong individual associations. The entry threshold of $p \leq 0.25$ for variables was considered in the model. The Akaike Information Criterion (AIC) was used to select the best-fit model, balancing model complexity and goodness of fit. Statistical significance was set at a 95% confidence level ($p \leq 0.05$) for final interpretations. JMP Pro version 16.1.0 was used for all statistical analyses, providing a robust platform for both descriptive and inferential statistics (SAS Institute Inc., Cary, NY, 2016).

4.2.6 Ethical considerations

Permission to conduct the study was obtained from the Kafue Town Council, and consent to participate, as well as to take pictures of the WASH facilities, was obtained from all participants. Ethical clearance was obtained from ERES Converge Research Ethics Committee in Zambia (Ref. No. 2024-Sep-011).

4.3 Results

Participants' sociodemographic and household characteristics

A total of 374 participants responded to the study, with a median age of 34 (IQR: 25, 45). Most respondents were female (n = 293, 78.3%), and more than half (n = 200, 53.5 %) had attained secondary education or higher. Two-thirds of respondents were married or living with

a partner (n = 250, 66.8%), with half of them employed (n = 190, 50.8%). Household monthly income varied, with most households (40.9 %) earning approximately USD 45 or less. Slightly more than half of the households (n = 195, 52.1%) resided in yards shared with multiple housing units, and a similar proportion owned the house they lived in (n = 191, 51.1%). Most households consisted of six or fewer members (n = 267, 71.4%), and 272 (72.7%) had at least one child under 12 years old (Table 4.1).

Table 4.1: Bivariate analysis of participant sociodemographic and household characteristics with diarrhoea

Participant and Household Characteristics		Total (n = 374)	Diarrhoea			
			Yes	No		
		n (%)	n (%)	n (%)	COR (95% CI)	p-value
Sex	Female	293 (78.3)	48 (16.4)	245 (83.6)	1	
	Male	81 (21.6)	10 (12.4)	71 (87.7)	0.71 (0.34 - 1.49)	0.376
Age	18-25 years	97 (25.9)	17 (17.5)	80 (82.5)	1	
	26-35 years	104 (27.8)	18 (17.3)	86 (82.7)	0.98 (0.47 - 2.04)	0.968
	36-45 years	81 (21.6)	14 (17.3)	67 (82.7)	0.98 (0.45 - 2.14)	0.966
	46 and older	92 (24.6)	9 (9.8)	83 (90.2)	0.51 (0.21 - 1.21)	0.127
Education	Primary & lower	174 (46.5)	24 (13.8)	150 (86.2)	1	
	Secondary & higher	200 (53.5)	34 (17)	166 (83)	1.28 (0.72 - 2.25)	0.394
Marital Status	Married/Living with partner	250 (66.8)	38 (15.2)	212 (84.8)	1	
	Divorced/Separated/Widowed/ Never married	124 (33.2)	20 (16.1)	104 (83.9)	1.07 (0.59 - 1.93)	0.815
Employment Status	Employed	190 (50.8)	29 (15.3)	161 (84.7)	1	
	Unemployed	184 (49.2)	29 (15.8)	155 (84.2)	1.03 (0.59 - 1.81)	0.894
Household Income*	K1000 and below	112 (40.9)	25 (22.3)	87 (77.7)	1	
	K1001 - K2000	75 (27.4)	15 (20.0)	60 (80.0)	0.87 (0.42 - 1.78)	0.704
	K2000 - K3000	50 (18.2)	9 (18.0)	41 (82.0)	0.76 (0.32 - 1.78)	0.533
	More than K3000	37 (13.5)	0	37 (100)	1	
Peri-urban community	Soloboni	83 (22.2)	4 (4.8)	79 (95.2)	1	
	Zambia compound	169 (45.2)	26 (15.4)	143 (84.6)	3.59 (1.34 - 12.49)	0.009
	Kalundu view	86 (23.0)	18 (20.9)	68 (79.1)	5.23 (1.85 - 18.76)	0.001
	Bridge community	36 (9.6)	10 (27.8)	26 (72.2)	7.59 (2.33 - 29.62)	0.001
Households in a yard	Multiple houses	195 (52.1)	32 (16.4)	163 (83.6)	1	
	Single house	179 (47.9)	26 (14.5)	153 (85.5)	0.86 (0.49 - 1.51)	0.615
House ownership	Resident	191 (51.1)	27 (14.1)	164 (85.9)	1	
	Rented	140 (37.4)	24 (17.1)	116 (82.9)	1.25 (0.69 - 2.28)	0.455
	Family	43 (11.5)	7 (16.3)	36 (83.7)	1.18 (0.47 - 2.92)	0.719
Number of people in the households	≤ 6	267 (71.4)	39 (14.6)	228 (85.4)	1	
	> 6	107 (28.6)	19 (17.8)	88 (82.2)	0.79 (0.43 - 1.44)	0.448
Children <12 years	Yes	272 (72.7)	47 (17.3)	225 (82.7)	1.72 (0.85 - 3.48)	0.126
	No	102 (27.3)	11 (10.8)	91 (89.2)	1	

*Excludes those who wished not to disclose (Minimum wage for domestic work was ZMW 1100 in 2022), COR: Crude Odds Ratio, CI: Confidence Interval

Water-related characteristics

Most households (n = 357, 96%) had access to an improved water source. According to the WHO-UNICEF Joint Monitoring Programme (JMP) criteria, an improved water source is defined as one that, by nature of its construction and design, is protected from outside contamination, particularly faecal matter. This includes sources such as piped water into dwellings, yards or plots; public taps or standpipes; boreholes or tube wells; protected dug wells; protected springs; and rainwater collection (WHO-UNICEF, 2018). In this study, municipal water supplied directly to the yard or plot was the main drinking and cooking water source for 148 households (39.6%), followed by municipal water supplied to a neighbour's yard for 132 households (35.3%). Most households (n = 214, 57%) did not treat their drinking water at home, and slightly more than half (n = 201, 57%) expressed satisfaction with the water quality. Drinking water was stored by most households (n = 351, 94%), predominantly in buckets with lids (n = 332, 96%). These storage containers were washed at the time of refill by the majority (n = 323, 92%), typically using water, soap, and a scrub (n = 298, 87%) (Table 4.2). Figure 4.2 shows the water facilities used in the communities.

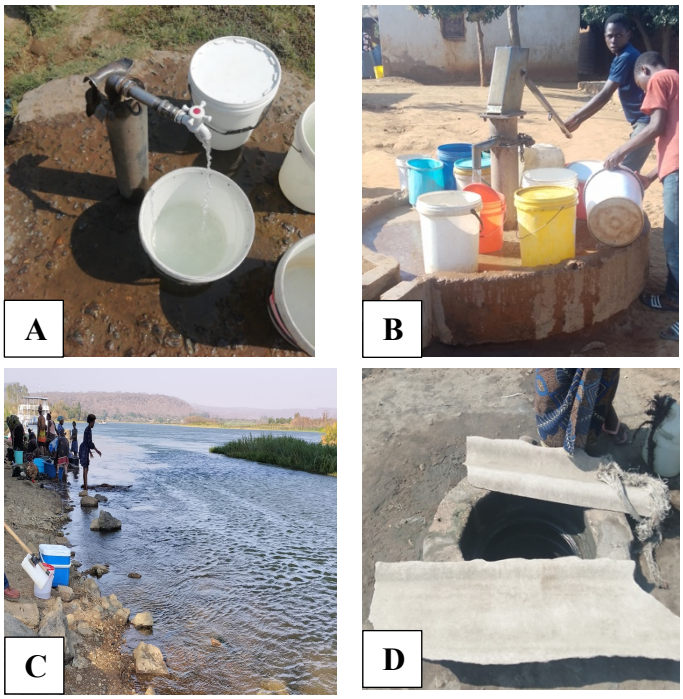

Figure 4.2: Water facilities used in the communities
A) Municipal water tap
B) Communal borehole with a manual hand pump
C) Surface (River) water
D) Unprotected shallow well

Table 4.2: Bivariate analysis of household water characteristics and practices with diarrhoea

Water, sanitation and hygiene characteristics		Total (n = 374)	Diarrhoea		COR (95% CI)	p-value
			Yes [n (%)]	No [n (%)]		
Drinking and cooking water source	Municipal supplied to yard/plot	148 (39.6)	16 (10.8)	132 (89.2)	1	
	Municipal supplied to neighbour	132 (35.3)	19 (14.4)	113 (85.6)	1.38 (0.68 - 2.82)	0.367
	Borehole	77 (20.6)	16 (20.8)	16 (79.2)	2.16 (1.01 - 4.61)	0.046
	Surface water (river)	16 (4.3)	7 (43.8)	9 (56.3)	6.41 (2.10 - 19.58)	0.001
	Shallow well	1 (0.3)	0	1 (100)	1	
Drinking water source by JMP classification	Unimproved water source	17 (4.3)	7 (41.2)	10 (58.8)	1	
	Improved water source	357 (95.7)	51 (14.3)	306 (85.7)	0.23 (0.08 - 0.65)	0.005
Frequency of water treatment	Almost always	60 (16.0)	4 (6.7)	56 (93.3)	1	
	Sometimes	100 (26.7)	18 (18)	82 (82)	2.83 (1.07 - 9.77)	0.034
	Never	214 (57.2)	36 (16.8)	178 (83.2)	3.07 (1.07 - 11.07)	0.034
Satisfied with quality of drinking water	Yes	201 (53.7)	24 (11.9)	177 (88.1)	0.55 (0.31 - 0.98)	0.039
	No	173 (46.3)	43 (19.7)	139 (80.3)	1	
Drinking water sufficiency (In previous month)	Yes, always sufficient	83 (22.2)	7 (8.4)	76 (91.6)	1	
	No, at least once	291 (77.8)	51 (17.5)	240 (82.5)	2.31 (1.00 - 5.30)	0.044
Store drinking water	Yes	351 (93.9)	52 (14.8)	299 (85.2)	0.49 (0.19 - 1.31)	0.148)
	No	23 (6.1)	6 (26.1)	17 (73.9)	1	
Type of storage container*	Bucket with a lid	332 (96.2)	49 (14.8)	283 (85.2)	1	
	Container	13 (3.8)	3 (23.1)	10 (76.9)	1.73 (0.46 - 6.52)	0.411
Frequency of cleaning storage container*	At refill	323 (92.3)	48 (14.9)	275 (85.1)	1	
	More than twice a week	27 (7.7)	4 (14.8)	23 (85.2)	0.99 (0.33 - 3.00)	0.994
Method of washing storage container*	With water only	15 (4.4)	1 (6.7)	14 (93.3)	1	
	With water, soap and sand	31 (9.0)	7 (22.6)	24 (77.4)	4.08 (0.63 - 80.44)	0.153
	With water soap and scrub	298 (86.6)	44 (14.8)	254 (85.2)	2.42 (0.47 - 44.48)	0.339

*excludes those who did not store water
COR: Crude Odds Ratio, CI: Confidence Interval

Sanitation and hygiene-related characteristics

Most households (n = 348, 93.1%) reported having access to a toilet, with most (n = 284, 81.8%) owning only one facility. Toilet sharing was widespread (n = 258, 74.4%), and nearly half of the households sharing (n = 156, 45.0%) shared facilities with four or more other households. Pit latrines with slabs were the most common toilet type (n = 187, 53.9%), while flush or pour-flush toilets connected to septic tanks accounted for a smaller proportion (n = 86, 24.8%). According to the WHO/UNICEF Joint Monitoring Programme (JMP) classification, sanitation facilities are categorised as improved—those that hygienically separate human excreta from human contact (e.g., flush or pour-flush toilets to septic tanks, ventilated improved pit latrines, or pit latrines with slabs) and unimproved, those that do not ensure such separation (e.g., pit latrines without slabs or open pits) (WHO-UNICEF, 2018). Based on this classification, most households (n = 289, 83.3%) had improved sanitation facilities, while 58 (16.7%) relied on unimproved options. Regarding hygiene, only about one-third of households (n = 119, 31.8%) had a designated handwashing station, and very few (n = 11, 9.2%) had both water and soap available. In terms of hygiene practices, two-thirds of respondents (n = 227, 66.8%) reported washing their hands almost always before eating, although most (n = 273, 80.3%) used water only. Handwashing after using the toilet was more consistent (n = 242, 79.9%); however, fewer than half (n = 148, 48.8%) reported using both water and soap (Table 4.3). Figures 4.3 and 4.4 illustrate the sanitation and handwashing facilities used in the communities, respectively.

Table 4.3: Bivariate analysis of sanitation and hygiene characteristics and practices with diarrhoea

Sanitation and hygiene characteristics		Total (n = 374)	Diarrhoea			
			Yes	No		
		n (%)	n (%)	n (%)	COR (95% CI)	p-value
Toilet present	Yes	348 (93.1)	54 (15.5)	294 (84.5)	1.01(0.33 - 3.04)	0.986
	No	26 (6.9)	4 (15.4)	22 (84.6)	1	
Number of toilets*	1 toilet	284 (81.8)	47 (16.5)	237 (83.5)	1	
	2-3 toilets	63 (18.2)	7 (11.1)	56 (88.9)	0.63 (0.27-1.46)	0.285
Toilet sharing*	Yes	258 (74.4)	43 (16.7)	215 (83.3)	1.41 (0.69 - 2.88)	0.336
	No	89 (25.6)	11 (12.4)	78 (87.6)	1	
Households using the toilet**	1 household (Not sharing)	89 (25.6)	11 (12.4)	78 (87.6)	1	
	2 - 3 households	102 (29.4)	14 (13.7)	88 (86.3)	1.13 (0.45 - 2.68)	0.78
	≥ 4 households	156 (45.0)	29 (18.6)	127 (81.4)	1.62 (0.78 - 3.56)	0.197
Toilet type*	Pit latrine without slab	58 (16.7)	15 (25.9)	43 (74.1)	1.79 (0.78 - 4.07)	0.163
	Pit latrine with slab	187 (53.9)	22 (11.8)	165 (88.2)	0.68 (0.33 -1.41)	0.308
	VIP	16 (4.6)	4 (25)	12 (75.0)	1.71 (0.48 - 6.09)	0.405
	Flush/pour to septic tank	86 (24.8)	14 (16.3)	72 (83.7)	1	
Sanitation facility by JMP classification	Unimproved sanitation facility	58 (16.7)	15 (25.9)	43 (74.1)	1	
	Improved sanitation facility	289 (83.3)	40 (13.8)	249 (86.2)	0.46 (0.23 - 0.91)	0.025
Designated handwashing station	Present	119 (31.8)	13 (10.9)	106 (89.1)	0.57 (0.29 - 1.11)	0.097
	Absent	255 (68.2)	45 (17.6)	210 (82.4)	1	
Hand washing facility***	Water and soap present	11 (9.2)	2 (18.2)	9 (81.8)	1	
	Water only present	86 (72.3)	8 (9.3)	78 (90.7)	0.46 (0.08 - 2.51)	0.372
	No water or soap present	22 (18.5)	3 (13.6)	19 (86.4)	0.71(0.10 - 5.02)	0.732
Handwashing before eating food****	Almost always	227 (66.8)	27 (11.9)	200 (88.1)	1	
	Sometimes	113 (33.2)	29 (25.7)	84 (74.3)	2.55 (1.42 - 4.58)	0.002
	Water and soap	67 (19.7)	10 (14.9)	57 (85.1)	1	
	Water only	273 (80.3)	16.8)	227 (83.2)	1.15 (0.54 - 2.42)	0.704
Handwashing after using the toilet****	Almost always	242 (79.9)	30 (12.4)	212 (87.6)	1	
	Sometimes	61 (20.1)	21 (34.4)	40 (65.6)	3.71(1.93 - 7.12)	<0.0001
	Water and soap	148 (48.8)	25 (16.9)	123 (83.1)	1	
	Water only	155 (51.2)	26 (16.8)	129 (83.2)	0.99 (0.54 - 1.81)	0.978

*excludes no toilet **Excludes no toilet and not sharing ***Excludes households that did not have handwashing facilities ****Excludes those who did not wash hands

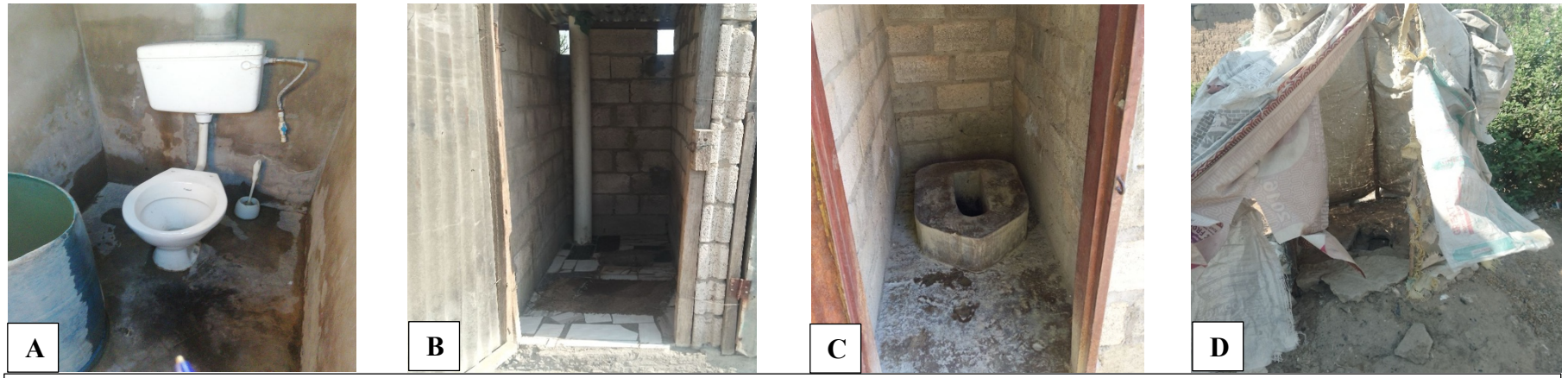

Figure 4.3: Sanitation facilities used in the communities

A) Flushing toilet connected to septic tank
B) Ventilated improved pit latrine
C) Pit latrine with a slab
D) Pit latrine without a slab with temporal super structure materials

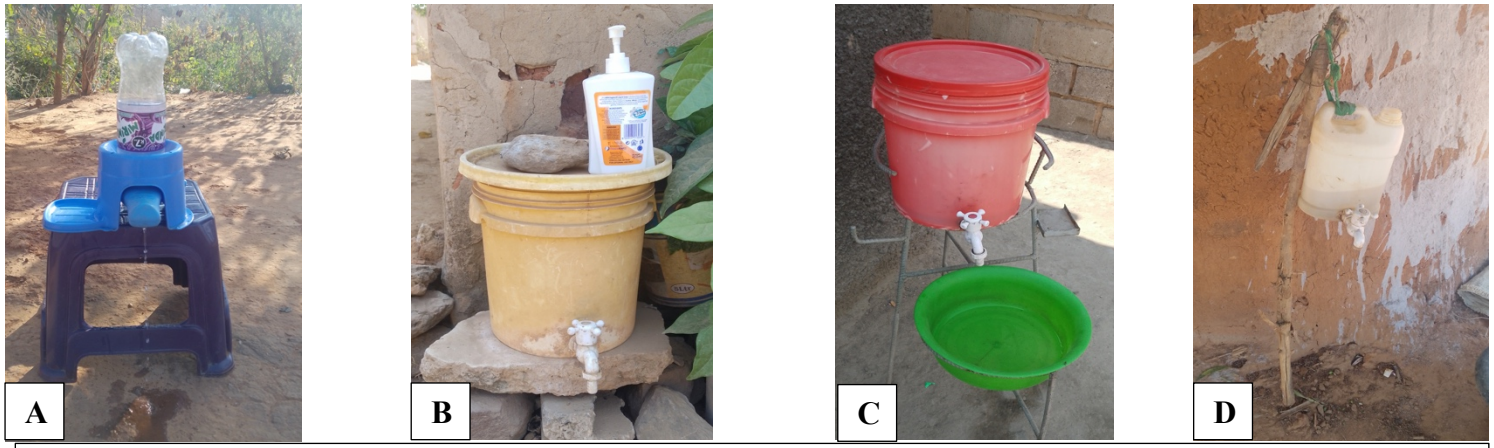

Figure 4.4: Handwashing facilities used in the communities

A) SATO tap
B) Handwash bucket and liquid soap
C) Handwash bucket and basin on a metal stand
D) Container on a wooden support post

Diarrhoea occurrence with WASH characteristics and practices

In the two weeks preceding the survey, the household prevalence of diarrhoea for all age groups was 15.5% (95% CI: 12.2% – 19.5%). At bivariable analysis, significant differences in diarrhoea prevalence were observed across peri-urban communities. Households in Bridge Community (COR = 7.59; 95% CI: 2.33–29.62; $p = 0.001$) and Kalundu View (COR = 5.23; 95% CI: 1.85–18.76; $p = 0.001$) had markedly higher odds of diarrhoea compared with those in Soloboni (Table 4.1). The use of surface water (COR = 6.41; 95% CI: 2.10–19.58; $p = 0.001$) and borehole water (COR = 2.16; 95% CI: 1.01–4.61; $p = 0.046$) was linked to a significantly higher chances of diarrhoea, whereas households relying on improved water sources had reduced probability (COR = 0.23; 95% CI: 0.08–0.65; $p = 0.005$). Irregular household level water treatment, either sometimes (COR = 2.83; 95% CI: 1.07–9.77; $p = 0.034$) or no treatment (COR = 3.07; 95% CI: 1.07–11.07; $p = 0.034$) and inadequate water availability in the preceding month (COR = 2.31; 95% CI: 1.00–5.30; $p = 0.044$) were also significantly associated with diarrhoea occurrence (Table 4.2).

In terms of sanitation and hygiene, households with improved sanitation facilities were less likely to report diarrhoea compared to those with unimproved sanitation (COR = 0.46; 95% CI: 0.23–0.91; $p = 0.025$). Hygiene practices further influenced risk: individuals who sometimes washed hands before eating (COR = 2.55; 95% CI: 1.42–4.58; $p = 0.002$) or after using the toilet (COR = 3.71; 95% CI: 1.93–7.12; $p < 0.0001$) were significantly more likely to report diarrhoea than those who did so almost always (Table 4.3).

Factors associated with diarrhoea occurrence

Multivariable logistic regression analysis identified significant associations between diarrhoea prevalence and sanitation and hygiene factors across peri-urban communities of Kafue. Compared with Soloboni, the likelihood of diarrhoea was significantly higher among residents of Kalundu View (AOR = 5.04; 95% CI: 1.42–24.03; p = 0.004) and Bridge Community (AOR = 7.13; 95% CI: 1.81–36.12; p = 0.011). Although Zambia Compound also showed elevated chances (AOR = 2.73; 95% CI: 0.85–12.25), the association did not reach statistical significance (p = 0.095) (Figure 4.5). Households with unimproved sanitation facilities were twice as likely to report diarrhoea compared with those with improved sanitation (AOR = 2.34; 95% CI: 1.04–5.15; p = 0.039). Participants who reported washing hands only sometimes after using the toilet had a substantially higher likelihood of experiencing diarrhoea (AOR = 5.32; 95% CI: 2.55–11.26; p < 0.0001) compared with those who reported almost always washing hands (Table 4.4).

Table 4.4: Factors associated with diarrhoea in peri-urban communities of Kafue, Zambia

Variable		A0R (95% CI)	P - value
Peri-urban community	Soloboni	1	
	Zambia compound	2.73 (0.85 - 12.25)	0.095
	Kalundu view	5.04 (1.42 - 24.03)	0.004
	Bridge community	7.13 (1.81 - 36.12)	0.011
Sanitation	Improved	1	
	Unimproved	2.34 (1.04 - 5.15)	0.039
Frequency of handwashing after using the toilet	Almost always	1	
	Sometimes	5.32 (2.55 - 11.26)	< 0.0001

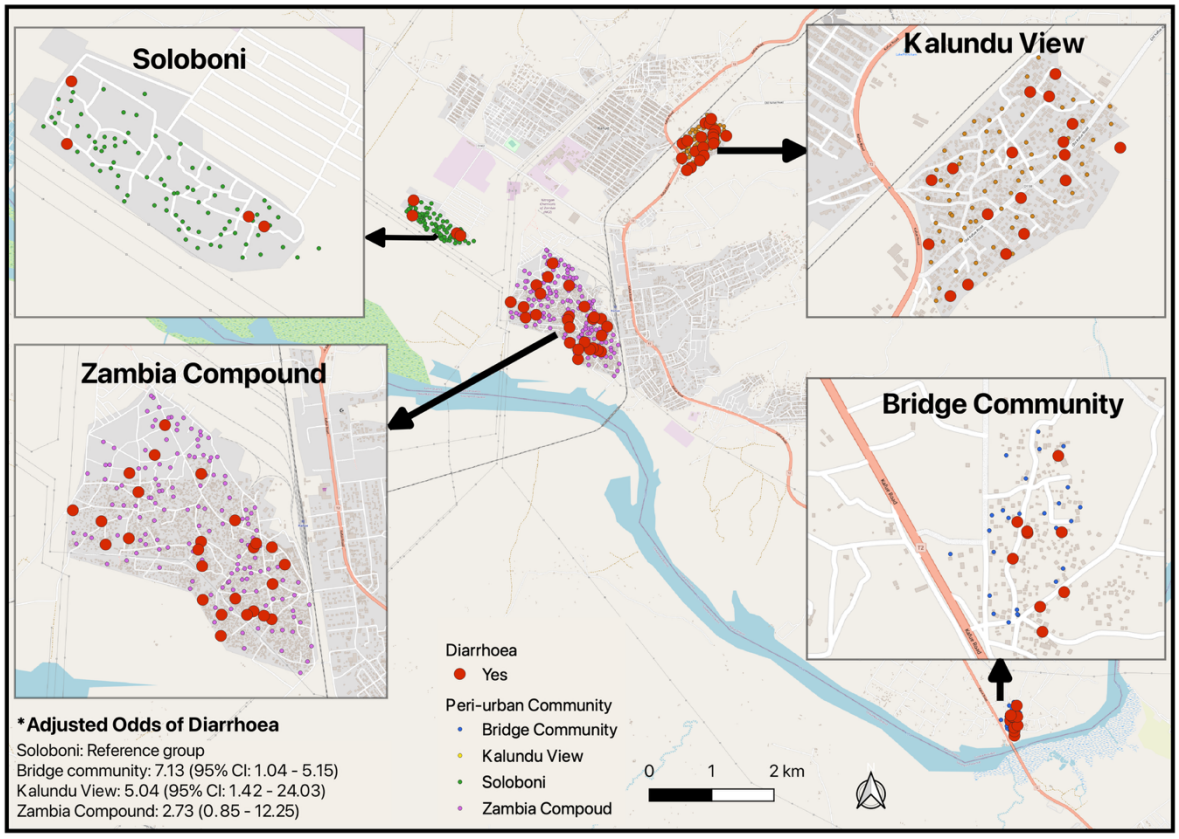

Figure 4.5: Spatial distribution of households with diarrhoea in the four peri-urban communities in Kafue Town, Zambia

Community-level variation in household and WASH characteristics

Table 4.5 presents household and selected WASH characteristics across the four study communities. Regarding household characteristics, households differed significantly by type of residency across communities ($p < 0.0001$). Overall, 52% of households were located in yards with multiple houses; however, this was most common in Zambia Compound (60%) and Kalundu View (58%), while Bridge Community was characterised predominantly by single-house households (81%). Household ownership patterns did not differ significantly between communities. Marked differences were observed in drinking and cooking water sources across communities ($p < 0.0001$). Municipal water supplied to the yard or plot was the most common source overall (40%), largely driven by Zambia Compound, where 61% of households reported this source. In Soloboni, the majority of households relied on municipal water supplied to a

neighbour (70%). In contrast, boreholes were the dominant source in Kalundu View (63%) and Bridge Community (56%). Surface water use was reported exclusively in Bridge Community, where 44% of households relied on river water. Consistent with this pattern, unimproved drinking water sources were concentrated in Bridge Community (44%), while nearly all households in Zambia Compound, Soloboni, and Kalundu View reported improved water sources.

Sanitation access and toilet characteristics also varied significantly by community. While most households reported having a toilet (93% overall), the absence of a toilet was highest in Soloboni (14%) ($p = 0.0375$). Single-toilet households predominated across all communities (82% overall), with all households in Bridge Community reporting only one toilet ($p = 0.0037$). Toilet sharing was common overall (67%) but varied substantially by site ($p \leq 0.0001$), ranging from 85% in Soloboni to 21% in Bridge Community. Pit latrines with slabs were the most frequently reported toilet type across all communities (54%), particularly in Bridge Community (76%) and Kalundu View (62%). Flush or pour-flush toilets connected to septic tanks were most commonly reported in Zambia Compound (33%) and Kalundu View (27%), but were rare in Bridge Community (3%).

Substantial variation was observed in handwashing infrastructure across communities ($p < 0.0001$). Overall, only 32% of households had a designated handwashing station. Availability was highest in Bridge Community (58%) and lowest in Kalundu View (15%). Among households with a handwashing facility, the presence of both water and soap was uncommon across all communities. Water-only handwashing facilities predominated overall (72%), particularly in Zambia Compound (92%). Soloboni reported the highest proportion of households with handwashing facilities lacking both water and soap (50%), followed by Bridge Community (33%) and Kalundu View (23%).

Household and selected WASH Characteristics	Overall (n = 374)	Zambia Compound (n = 169)	Soloboni (n = 83)	Kalundu View (n = 86)	Bridge Community (n = 36)	P-value (Chi-square)
Households in a yard						
Multiple houses	195 (52)	102 (60)	36 (43)	50 (58)	7 (19)	< 0.0001
Single house	179 (48)	67 (40)	47 (57)	36 (42)	29 (81)	
House ownership						
Resident	191 (51)	82 (48)	47 (57)	44 (51)	18 (50)	
Rented	140 (37)	69 (41)	22 (27)	35 (41)	14 (39)	0.303
Family	43 (12)	18 (11)	14 (16)	7 (8)	4 (11)	
Number of people in the households						
≤ 6	267 (71)	127 (75)	54 (65)	61 (71)	25 (69)	0.412
> 6	107 (29)	42 (25)	29 (35)	25 (29)	11 (31)	
Children under 12 years						
Yes	272 (73)	131 (78)	56 (67)	66 (77)	19 (53)	0.012
No	102 (27)	38 (22)	27 (33)	20 (23)	17 (47)	
Drinking and cooking water source						
Municipal supplied to neighbour	132 (35)	64 (37)	58 (70)	10 (12)	0	
Municipal supplied to yard/plot	148 (40)	103 (61)	23 (28)	22 (25)	0	< 0.0001
Borehole	77 (21)	1 (1)	2 (2)	54 (63)	20 (56)	
Surface water (river)	16 (4)	0	0	0	16 (44)	
Shallow well	1 (0)	1 (1)	0	0	0	
Drinking water source by JMP classification						
Unimproved water source	17 (5)	1 (1)	0	0	16 (44)	< 0.0001
Improved water source	357 (95)	168 (99)	83 (100)	86 (100)	20 (56)	
Toilet present						
Yes	347 (93)	161 (95)	71 (86)	81 (94)	34 (94)	0.0375
No	27 (7)	8 (5)	12 (14)	5 (6)	2 (6)	
Number of toilets*						
1 toilet	284 (82)	123 (76)	63 (89)	64 (79)	34 (100)	0.0037
2-3 toilets	63 (18)	38 (24)	8 (11)	17 (21)	0	
Toilet sharing*						
Yes	231 (67)	117 (73)	60 (85)	47 (58)	7 (21)	≤0.0001
No	116 (33)	44 (27)	11 (15)	34 (42)	27 (79)	
Toilet type*						
Pit latrine with slab	187 (54)	65 (40)	46 (66)	50 (62)	26 (76)	
Pit latrine without slab	58 (17)	40 (25)	8 (11)	5 (6)	5 (15)	≤0.0001
Flush/pour to septic tank	86 (25)	53 (33)	10 (14)	22 (27)	1 (3)	
VIP	16 (4)	4 (2)	6 (9)	4 (5)	2 (6)	
Designated handwashing station						
Present	119 (32)	65 (38)	20 (24)	13 (15)	21 (58)	< 0.0001
Absent	255 (68)	104 (62)	63 (76)	73 (85)	15 (42)	
Hand washing facilty***						
Water and soap present	11 (10)	3 (5)	2 (10)	3 (23)	3 (14)	
Water only present	86 (72)	60 (92)	8 (40)	7 (54)	11 (52)	< 0.0001
No water or soap present	22 (18)	2 (3)	10 (50)	3 (23)	7 (33)	

**excludes no toilet **Excludes no toilet and not sharing*
****Excludes households that did not have handwashing facilities*

4.4 Discussion

This study assessed household WASH conditions and their relationship with diarrhoeal disease in the peri-urban communities of Kafue Town, Zambia. The findings reveal important disparities in access to safe water, sanitation, and hygiene facilities, and demonstrate how these factors jointly influence diarrhoeal outcomes.

4.4.1 *Water access and satisfaction with quality*

The present study shows that while access to improved water sources (as defined by the WHO/UNICEF JMP) is relatively high among households, moderate satisfaction suggests concerns about the water quality, quantity or perceived inadequacies in the appearance or safety of the water. Despite these concerns, over half of households do not treat their drinking water before consumption, suggesting a significant gap between desired water quality and the safety practices used to achieve it. At the national level, only 37% of households treat their drinking water appropriately, and those who do use chlorine or boil it (Zambia Statistics Agency et al., 2024). Unsafe water practices increase the potential for exposure to waterborne contaminants, leading to diseases such as diarrhoea. The association between irregular or no household water treatment and diarrhoea further supports the critical role of point-of-use treatment in preventing enteric infections. Studies indicate that the mere use of an improved water source is insufficient for sustained protection against waterborne diseases; rather, the risk of exposure to waterborne contamination depends on reliable service continuity, safe storage, and hygiene practices at the point of use (Clasen et al., 2007; Hubbard et al., 2020; Ng'andwe et al., 2025).

Inadequate water availability in the preceding month doubled the likelihood of experiencing diarrhoea, underscoring the indirect effects of water scarcity on hygiene and sanitation practices. This scarcity may compel households to use unimproved water sources, such as rivers, which carry a higher risk of contamination (Asgedom et al., 2023; Cairncross et al., 2010). Consistent with this, households relying on surface water and boreholes exhibited a

significantly increased chance of diarrhoea, emphasising the health risks associated with unimproved water sources.

4.4.2 *Sanitation coverage and shared facilities*

Although most households in the peri-urban areas have access to improved sanitation facilities, sharing toilets, often among four or more households, is a common practice, as observed in this study and others (Nyambe et al., 2020b). Only 37% of the Zambian population has access to an improved sanitation facility that is not shared with other households (basic service level) (Zambia Statistics Agency et al., 2024). The primary concern regarding shared sanitation is that it is difficult to minimise exposure to faecal contamination because of poor maintenance and uncleanliness (Tidwell et al., 2021). There are also concerns of privacy and safety for those using shared facilities, especially women, as well as the ability to access them at any time when needed. However, in low-resource peri-urban communities, sharing sanitation facilities is frequently the only viable option for many households (Lebu, Sprouse, Akudago, Twinomucunguzi, et al., 2024).

Existing literature suggests that when shared sanitation is appropriately maintained, the associated risk of contamination can be significantly reduced (Lebu, Sprouse, Akudago, Baldwin-SoRelle, et al., 2024). Researchers have suggested the inclusion of shared sanitation in the WHO-UNICEF JMP classification, along with guidelines on how it can be assessed in national and global surveys (Lebu, Sprouse, Akudago, Baldwin-SoRelle, et al., 2024). Households with unimproved sanitation (pit latrines without a slab or platform) had higher chances of diarrhoea compared to households with improved sanitation (pit latrine with a slab, flushing toilets connected to a septic tank, ventilated improved pit latrines), a finding consistent with regional evidence linking unimproved latrines and faecal contamination pathways (Asgedom et al., 2023; Nyambe et al., 2020b).

4.4.3 *Hand hygiene behaviour*

In this study, the frequency of handwashing practice was relatively high based on self-reports with most participants indicating to always wash hands before eating after using the toilet. However, literature indicates that self-reported hand-washing frequency often overestimates actual practice due to missing infrastructure (Berendes et al., 2022). This limitation is addressed by assessing observed handwashing facilities as a proxy for handwashing (WHO-UNICEF, 2018). This study revealed that handwashing practices were suboptimal, with only one-third of households having a designated handwashing station, and even fewer with both soap and water readily available. The findings of this study are consistent with the broader literature in resource-limited settings, which indicates low access to handwashing facilities with soap and water (Berendes et al., 2022; Ezezika et al., 2023a, 2023b; Zgambo et al., 2025).

Notably, the present study observed that inconsistent handwashing after using the toilet was strongly associated with the occurrence of diarrhoea, even after adjusting for other factors. This reinforces the idea that behaviour change and sustained access to soap are critical components of WASH interventions (Aydamo et al., 2023; White et al., 2020; Wolf et al., 2019). The greater consistency in handwashing after using the toilet than before eating may reflect a stronger perceived risk from faecal exposure as well as gaps in habitual practice.

4.4.4 *Community-level variation in diarrhoea prevalence*

Marked differences in diarrhoea prevalence were observed among the peri-urban communities. The Bridge Community (located near the river, with no municipal water supply) and Kalundu View (situated on a rocky terrain with communal boreholes as the main water source) exhibited significantly higher adjusted odds of diarrhoea compared with Soloboni and Zambia Compound (with relatively better connectivity to the municipal water network). Such

spatial heterogeneity suggests that community-specific interventions are necessary rather than uniform WASH approaches across peri-urban settings.

4.4.5 *Implications for policy and practice*

The findings reveal a dual challenge in achieving lasting improvements in WASH, including gaps in infrastructure and behavioural barriers. Although many households have access to improved facilities, their benefits are limited by factors such as shared use, irregular water supply, and inconsistent hygiene habits. Effective interventions must therefore address both physical infrastructure and behavioural aspects. The physical aspects could be addressed through low-cost and reliable sanitation options, convenient handwashing stations, and expansion of improved water infrastructure. This could be coupled with support of a steady supply of soap and water treatment products through existing social support networks in the communities. The behavioural aspects could emphasise community involvement in the development and implementation of WASH interventions to increase adoption and sustainability. Strategies to improve the cleanliness of shared sanitation, such as clear communication of maintenance responsibilities, regular cleaning schedules, provision of cleaning supplies, and community engagement, can enhance toilet hygiene standards and reduce the risk of faecal contamination. Finally, targeted behaviour change communication regarding WASH practices would help alleviate behavioural barriers, complementing the provision of affordable, user-friendly WASH facility options/solutions suited to peri-urban contexts.

4.4.6 *Strengths and limitations*

This study contributes empirical evidence from under-researched peri-urban Zambia, using household-level data to link WASH characteristics with recent diarrhoeal episodes. However, self-reported measures may have introduced recall or desirability bias, and the cross-sectional design limits the ability to make causal inferences. Despite these limitations, the

consistency of associations across multiple WASH domains strengthens confidence in the observed relationships.

4.4.7 Conclusion

Overall, this study highlights the continuing public health burden of inadequate WASH infrastructure in rapidly growing peri-urban settlements. Diarrhoeal disease in peri-urban Kafue remains closely associated with unimproved sanitation, irregular water supply and treatment, and inconsistent handwashing behaviour. Addressing these factors requires integrated WASH strategies that are context-specific, behaviourally informed, and supported by innovations that improve accessibility and usability of sanitation and hygiene infrastructure.

Chapter 5

General Conclusion and Recommendations

5.1 Conclusion

This research set out to investigate hand hygiene practices, the barriers and facilitators that shape these behaviours, and the broader WASH conditions influencing diarrhoeal disease in peri-urban Zambia. Using a mixed-methods approach across three complementary studies, the research provides comprehensive insight into how structural, environmental, socio-behavioural, and cultural factors jointly influence hygiene practices and diarrhoeal disease in low-income peri-urban settings. The collective findings highlight persistent gaps in WASH infrastructure and behaviour, as well as the influence of public health emergency contexts.

This research reveals that hand hygiene practices in peri-urban Zambia are not simply a matter of individual choice or awareness, but rather as behaviours carried out within unstable environmental, infrastructural, and social contexts. The observed fluctuations in handwashing practices and facility availability between survey periods, particularly the regression following periods of heightened public health attention, demonstrate the fragility of behaviour that relies heavily on the presence of supportive external conditions. Furthermore, the persistence of culturally rooted habits, such as washing hands with water only before eating, underscores that hygiene practices are embedded in meanings that extend beyond biomedical logic.

By highlighting the layered determinants, the study advances the argument that variability in hygiene behaviour reflects broader social and infrastructural inequalities that shape what is feasible, acceptable, and meaningful to households. In doing so, it contributes to a broadened understanding of why handwashing behaviours persist, shift, or regress, and underscores the importance of interpreting hygiene practices within the lived realities of peri-urban communities rather than through purely behavioural or resource-based lenses.

Lastly, this research confirms that diarrhoea in peri-urban areas is closely linked to gaps in household WASH access and practices, which supports the need for WASH improvements in these resource-constrained areas. Furthermore, community-level variations indicate that diarrhoeal risk exposure is unevenly distributed across peri-urban communities, reflecting broader spatial and socioeconomic inequalities within these settings. By situating diarrhoeal disease within these socio-ecological dynamics, this study challenges linear models of WASH–health relationships. It underscores the importance of understanding how structural conditions, behavioural adaptations, and environmental contingencies converge to influence health in rapidly growing urban settlements.

5.2 Recommendations

This research underscores that achieving hand hygiene for all in peri-urban Zambia will require integrated WASH approaches that bridge the gap between knowledge and practice, infrastructure and behaviour, and community needs and policy responses. By recognising the interconnected drivers of hygiene behaviour and diarrhoeal disease, policymakers, practitioners, and researchers can design more effective, locally relevant strategies that improve household health and build resilience. The study makes the following recommendations to the various WASH stakeholders:

National Government and Policymakers

1. **Consider the stability of water supply in peri-urban areas**

   The findings suggest that unreliable water supply undermines the maintenance of household handwashing facilities. National efforts may therefore benefit from greater attention to water supply stability in peri-urban communities, particularly where reliance on unsafe sources such as surface water was observed.

2. **Acknowledge shared sanitation as a common peri-urban condition**

   Given the high prevalence of shared sanitation identified in this study, national

guidelines could better reflect the realities of shared toilet use, with attention to hygiene and maintenance challenges documented at the household level.

3. **Sustain hygiene promotion beyond outbreak periods**

   The study showed that handwashing practices improved during cholera outbreaks but declined once public health attention decreased. This suggests a need for more consistent hygiene messaging that extends beyond emergency response periods and takes cultural practices, such as preferences around soap use before eating, into account.

4. **Address material barriers faced by low-income households**

   In communities where soap scarcity, water insecurity, and facility costs were reported, targeted material support, such as subsidies or vouchers, may help reduce barriers to effective hygiene practices.

Local Government and Line Ministries

1. **Support sanitation options suited to high-density living conditions**

   Local authorities may consider supporting sanitation improvements that are appropriate for densely populated peri-urban settings, where toilet sharing and unimproved facilities were common in communities with higher diarrhoeal prevalence.

2. **Strengthen household-level engagement mechanisms**

   The effectiveness of community-based volunteers during cholera outbreaks highlights the value of personalised, household-level engagement. Continued support for such approaches may help address persistent hygiene challenges outside outbreak contexts.

3. **Encourage local coordination around shared sanitation**

   Where shared toilets are common, local government structures could facilitate simple,

community-led arrangements for cleaning and maintenance, reflecting practices observed during the study.

Non-Governmental Organisations, Product Designers, and Private Sector Actors

1. **Align hygiene products with local practices and constraints**

   The findings indicate that handwashing facilities are often simple, temporary, and vulnerable to theft or damage. Interventions may therefore benefit from promoting low-cost, durable, and locally appropriate handwashing solutions.

2. **Improve access to culturally acceptable hygiene materials**

   Low use of soap before eating suggests that product design and distribution could better account for cultural preferences, including the use of mild or unscented soaps.

Households, Individuals, and Community-Level Actors

1. **Encourage the practical placement of handwashing facilities**

   The study identified proximity to toilets and visibility as facilitators of handwashing. Communities may benefit from encouraging the placement of handwashing stations in locations that support routine use.

2. **Strengthen household water management practices**

   Where diarrhoea was associated with reliance on unimproved water sources or inconsistent treatment, reinforcing safe water storage and treatment practices may help reduce exposure risks.

3. **Promote shared responsibility for hygiene within households**

   Differences in hygiene practices by gender and age suggest value in encouraging open household discussions about roles and responsibilities related to handwashing.

Academic and Research Institutions

1. **Examine the sustain/ability of hygiene behaviours over time**

   The temporary improvements observed during outbreak periods highlight the need for

longitudinal research to better understand how hygiene practices change once emergency conditions subside.

2. **Co-develop context-sensitive WASH innovations**

   Collaboration with communities to design hygiene products and interventions, such as culturally acceptable soap options or secure handwashing facilities, may improve acceptability and sustained use.

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Achievements

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Conference proceedings

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International and Local Oral Conference Presentations

Zgambo, J., Nyambe, S., & Yamauchi, T. (2025, June 4). Assessment of Household Water, Sanitation, and Hygiene and Diarrhoea Prevalence in a Peri-Urban Community of Zambia. *Sustainability Research & Innovation Congress* - Africa Satellite Event, Nairobi, Kenya (Online).

Zgambo, J., Nyambe, S., & Yamauchi, T. (2025, September 30). Assessing Community Readiness for Hand Hygiene Interventions in Peri-Urban Kafue, Zambia: A Qualitative Exploration. *The International Society for Sanitation Studies (ISSS)* Annual Conference, Hokkaido University, Japan (Online).

Zgambo, J., Nyambe, S., & Yamauchi, T. (2025, October 12). Case Study of Enablers and Challenges of Hand Hygiene in Peri-Urban Communities of Kafue, Lusaka- Zambia. The *Japanese Society of Health and Human Ecology* (JSHHE) - 90th Annual Meeting, Hokkaido, Japan (In-person).

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Zgambo, J., Nyambe, S., & Yamauchi, T. (2024, June 13-14). Assessment of hand hygiene and access to hygiene facilities in peri-urban Lusaka, Zambia. *Zambia Water Forum and Exhibition*, Lusaka, Zambia (In-Person).

Zgambo, J., Nyambe, S., & Yamauchi, T. (2024, October 12–13). Peri-urban Assessment of Water, Sanitation, and Hygiene in Kafue, Zambia. *Japanese Society of Health and Human Ecology (JSHHE)* - 89th Annual Meeting, Tokyo, Japan (Online).

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Poster Presentations

Zgambo, J., Nyambe, S., & Yamauchi, T. (2025, October 24). Sociodemographic disparities in water, sanitation and hygiene access and diarrhoea prevalence in peri-urban communities of Kafue, Lusaka, Zambia. *7th FHS International Symposium*, Hokkaido University, Sapporo, Japan (**Best Poster Award,** In-person).

Zgambo, J., Nyambe, S., & Yamauchi, T. (2023, October 20). Water-Environment-Health Nexus: Assessing the interplay of Water, Sanitation, and Hygiene with Environmental Factors and Health Risks in Peri-urban Zambia. *6th Faculty of Health Sciences (FHS) International Conference,* Hokkaido University, Sapporo, Japan (In-person).

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