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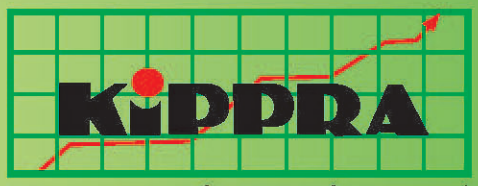

The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

The Role of Water, Sanitation, and Hygiene in Diarrhoea Prevention Among Children Under the Age of Five Years in Kenya

Violet Nyabaro, Boaz Munga, Miriam Mwiti, and Rosemary Murebu

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Abstract

This study examined the effect of access to improved sources of water, sanitation, and hygiene (WASH) on the probability of reducing diarrhoeal among children under the age of five years (under-five children) in Kenya. Differential effects were estimated for urban and rural areas. Diarrhoea is one of the causes of morbidity and mortality among children under-five years globally. In 2018, Kenya reported nearly 1.5 million diarrhoeal cases among under-five children. The study estimated probit models using the Kenya Integrated Household Budget Survey (KIHBS) 2015/16 data to assess diarrhoea prevalence controlling for other contributing factors. Access to improved sources of water and sanitation plays a preventive role in diarrhoea prevalence among under-five children. Access to improved water sources and sanitation significantly reduces the probability of households with under-five children reporting a prevalence of diarrhoea compared to those with access to unimproved water sources. Other factors such as large households, high monetary poverty levels, and low levels of maternal education significantly contribute to an increased probability of diarrhoea prevalence in under-five children. The findings indicate that enhancing access to improved water and sanitation is a key factor in reducing the probability of diarrhoea prevalence among under-five children. Education for all is a key strategy, and expanding the ongoing efforts to readmit teenage mothers to school is commendable. It is also important for the government with support from stakeholders to enhance targeted WASH investments in rural areas and urban informal settlements with high poverty rates in piped water systems; scale up small-scale/pilot WASH interventions and innovations that have had good outcomes; and support an enabling environment for more market-based innovations such as water and sanitation lending by financial institutions for the development of water and sanitation infrastructure. From the review of overarching institutional issues, the national and county governments need to improve coordination of WASH interventions through collaborative planning, prioritize funding for sanitation and hygiene services to reduce reliance on donor support, and develop robust maintenance plans to facilitate timely repair/rehabilitation of WASH infrastructure.

Abbreviations and Acronyms

CEREB	Central Region Economic Bloc
CSO	Civil Society Organizations
CLTS	Community-Led Total Sanitation
FCDC	Frontier Counties Development Council
GoK	Government of Kenya
HSBC	Hong Kong and Shanghai Banking Corporation
IWRM	Integrated Water Resources Management
JKP	Jumuiya ya Kaunti za Pwani
KIHBS	Kenya Integrated Household Budget Survey
LREB	Lake Region Economic Bloc
MDA	Ministry Department and Agency
MDG	Millennium Development Goals
NAKAEB	Narok-Kajiado Economic Bloc
NOREB	North Rift Economic Bloc
RoK	Republic of Kenya
SDG	Sustainable Development Goals
SEKEB	Southeastern Kenya Economic Bloc
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHabitat	United Nations Human Settlements Programme
UNICEF	United Nations Children's Fund
UNWWAP	United Nations World Water Assessment Programme
WHO	World Health Organization
WASH	Water, Sanitation, and Hygiene

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1. Introduction

Diarrhoea, defined as the passage of three or more loose stools per day, is a critical public health problem globally and is the second leading cause of death among children under the age of five years (under-five children) (WHO, 2017). Though diarrhoea is preventable and treatable, it is estimated that there are 1.7 billion cases and about half a million diarrhoea-related deaths in the globe among under-five years children annually (WHO, 2017; Troeger, et al. 2018; CDC, 2019).

About 90 per cent of the annual global diarrhoea-related deaths among under-five children occur in Sub-Saharan Africa (SSA) and South Asia. The high burden of diarrhoeal diseases in SSA can be linked to challenges related to access to water, sanitation, and hygiene (WASH) and access to essential medical services. Diarrhoeal diseases, including cholera, typhoid, paratyphoid, salmonella, giardiasis, and cryptosporidiosis, are mainly spread through lack of safe, reliable, affordable, and easily accessible water supply and/or poor sanitation and hygiene practices. Thus, interventions to prevent diarrhoea usually focus on enhancing access to safe drinking water, use of improved sanitation, handwashing, and treatment including the use of the oral rehydration solution (ORS). While progress has been reported in the reduction of under-five years mortality caused by diarrhoeal diseases, it remains a major cause of childhood mortality more so in Sub-Saharan Africa (SSA).

Although Kenya has a relatively high mortality rate resulting from diarrhoeal diseases, investments made by the government have reduced the mortality rate due to diarrhoea among children under-five years from 261 per 100,000 children in 2009 to 122 per 100,000 children in 2019. These investments include integrated management of newborn and childhood illnesses (IMNCI); national diarrhoea and pneumonia scale-up plan; introduction of the Rotavirus vaccine into the national routine immunization schedule; and early administration of ORS and zinc among children. Even so, diarrhoea remains a leading cause of death for under-five children in Kenya, and an estimated 31 per cent of the under-five children mortality rate was attributed to diarrhoea (WHO, 2005; 2017). This suggests that there is a need to put more effort into preventing diarrhoea in Kenya.

Diarrhoea also contributes to other adverse effects, including burdening the health system as it contributes to nearly 10 per cent of the total outpatient department (OPD) visits in Kenya in 2019/20 (Wangia and Wanjala, 2022). The diseases also contribute to malnutrition and stunted growth. Frequent diarrhoea can reduce children's growth and cognitive development, and increase their susceptibility to other diseases (WHO, 2017; UNICEF, 2016). It is documented that most diarrhoea-associated deaths are due to unsafe water, inadequate sanitation, and insufficient hygiene (Karambu et al., 2014; Wangia and Wanjala, 2022).

WASH is a human right (Constitution of Kenya, 2010), but a lot of work needs to be done to ensure universal access. With respect to access to safe water, Kenya's status remains a critical policy issue as, according to the WHO/UNICEF Joint Monitoring Project, only 71.2 per cent of Kenyans had access to improved drinking

water sources in 2020 while the rest depended on unimproved water sources such as rivers, shallow wells, and ponds. Moreover, rural areas still experience lower access to water, with 61.8 per cent of rural areas having access to water compared to 86.7 per cent of households in urban areas (Development Initiatives, 2018).

The low access to water in marginalized and rural counties has been attributed to a high prevalence of poverty and the cost of accessing water. Many households continue to spend substantial time, energy, and resources in search of water, often accessing contaminated water whose source is sometimes shared with domestic animals, or even wild animals. In other cases, in urban areas, water is contaminated through sewerage spews and industrial waste, while in other cases, water is fetched by unconcerned vendors in unclean containers getting contaminated in the process (Development Initiatives, 2018).

Besides the challenges associated with access to safe water, access to improved sanitation and hygiene remains a major development challenge in Kenya. Nearly one-third of the population depend on unimproved sanitation services (Shiras et al., 2018). It is estimated that five (5) million Kenyans practice open defecation and only 14 per cent have hand washing facilities with soap and water at home (UNICEF, 2020). Lack of access to clean water, sanitation, and hygiene has a substantial negative impact on health outcomes, with children under the age of five years being the most affected.

The high mortality rate associated with diarrhoea, despite public sector investments and interventions, suggests that a better understanding of the disease and its associated drivers is fundamental to its improved control. Although several studies have been conducted to explore the effect of access to reliable water, sanitation, and hygiene on diarrhoea among children under-five years, most of the studies have mainly focused on point-of-use water treatment (Simiyu, 2010; Mulatya and Mutuku, 2020; Maina, 2018).

There is, therefore, a need to map sources of water, the status of sanitation and hygiene with a prevalence of waterborne and sanitation and hygiene-related diseases, considering regional variations. This study, therefore, examines the role of water, sanitation, and hygiene and associated intervening factors on diarrhoea prevalence among children under the age of five years in Kenya.

The general objective of this study is to explore the role of water, sanitation, and hygiene in health outcomes among children under the age of five years in Kenya. The specific objectives are:

(i) to determine the effect of access to improved sources of water, improved sanitation, and hygiene on diarrhoea prevalence among under-five children;

(ii) to estimate the differential effects of improved sources of water, improved sanitation, and hygiene on diarrhoea prevalence among under-five children in rural and urban regions; and

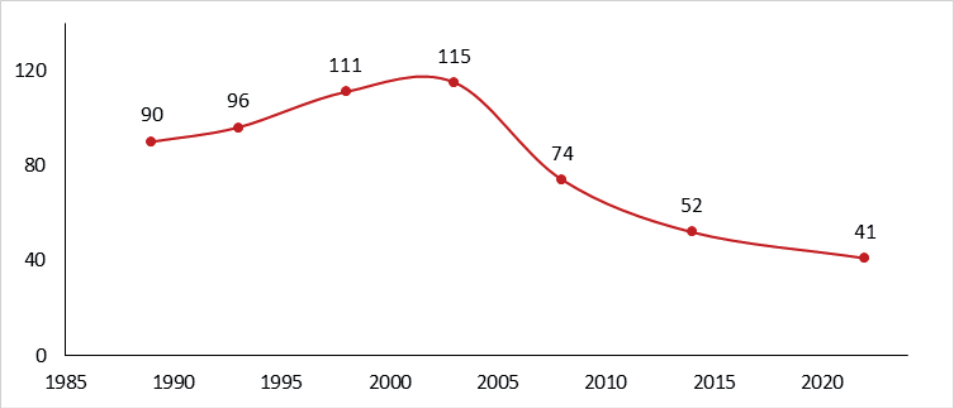
(iii) to draw policy implications.

2. Status, Trends, Institutional and Organizational Arrangements

2.1 Status and Trends of WASH and Under-five Children Mortality

This section presents a trend analysis on under-five years mortality per 1,000 live births and the status of WASH in the country using national-level datasets including the KDHS of 2022 and KIHBS 2015/16. Trends in under-five years mortality in Kenya have fluctuated over the years (Figure 2.1). There was an increase in under-five child mortality between 1989 and 2003 from 90 to 115 deaths per 1,000 live births, respectively. This was followed by a decline from 115 to 41 deaths between 2003 and 2022, a 64 per cent decline. This decline is attributed to various initiatives at the national and sub-national levels, such as the Beyond Zero Campaign and Malezi Bora, which led to an expansion in access to primary healthcare and decentralization of health services to devolved units of government (Macharia et al., 2019).

Figure 2.1: Under-five children mortality per 1,000 live births between 1989-2022

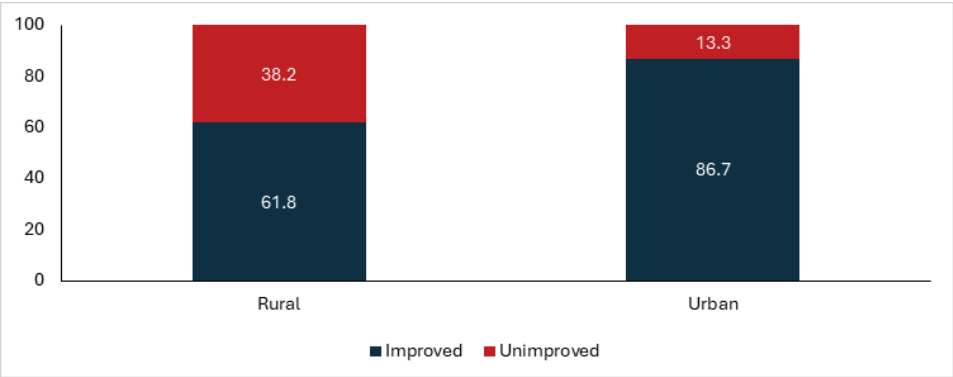


Data source: KNBS (2022), Kenya Demographic and Health Survey - KDHS

In 2022, 57 per cent of children who sought medical treatment were ailing from diarrhoea and about 14 per cent of those who were treated with diarrhoea had prior symptoms (KNBS, 2022). The findings collaborate with those of KDHS (2014), an indication of minimal improvement in diarrhoea prevalence among under-five children in households between the two time periods. Further, findings show that of those that sought treatment, 48 per cent of children received oral rehydration salts (ORS), 40 per cent received zinc supplements, 32 per cent received ORS and zinc supplements, and 26 per cent were given ORS, zinc supplements, and continued feeding.

An estimated 69 per cent of the households in Kenya have access to improved sources of water while 31 per cent do not have access to improved sources of water. Figure 2.2 indicates that in rural areas, 61.8 per cent of the households have access to improved sources of drinking water compared to 86.7 per cent of the households in urban areas.

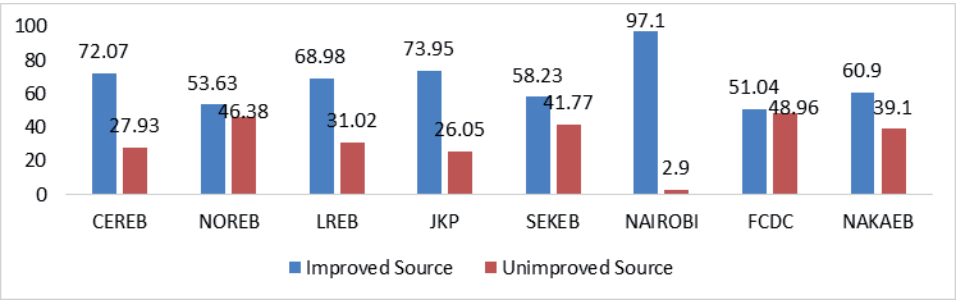
Figure 2.2: Access to improved water sources by place of residence



Data source: KNBS (2016), Kenya Integrated Budget Household Survey - KIBHS 2015/16

Further, only Jumuiya ya Kaunti za Pwani Regional Bloc and Nairobi County have more households with access to improved water sources compared to other regional blocs that have many households accessing unimproved water sources (Figure 2.3). This could be attributed to the fact that the two regions are mainly urbanized. On the other hand, counties in the Frontier Counties Development Bloc (FCDC) have the highest (49%) proportion of households with unimproved sources of water, followed by the North Rift Regional Bloc (NOREB) and South Eastern Kenya Economic Bloc (SEKEB) at 46 per cent and 42 per cent, respectively.

Figure 2.3: Access to water by regional blocs (%)

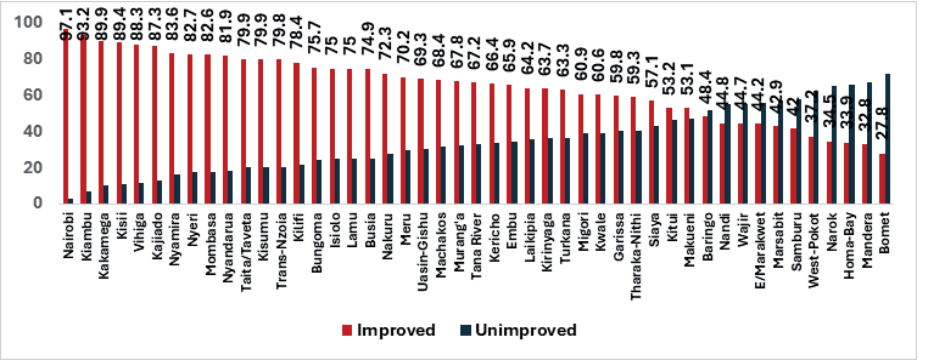


Data source: KNBS (2016), Kenya Integrated Budget Household Survey - KIBHS 2015/16

Key: CEREB – Central Region Economic Bloc; NOREB – the North Rift Economic Bloc: LREB – Lake Region Economic Bloc; JKP – Jumuiya ya Kaunti za Pwani; SEKEB – South Eastern Kenya Economic Bloc: FCDC – Frontier Counties Development Council; NAKAEB – Narok Kajiado Economic Bloc.

The majority of households in Bomet, Mandera, Homa Bay, and Narok counties had a high proportion of households with access to unimproved water sources at 72 per cent, 67 per cent, 66 per cent, and 66 per cent, respectively. On the other hand, the highest access to improved sources of water was observed in Nairobi County (97 %), Kiambu County (93%), and Kakamega County (90%) as shown in Figure 2.4.

Figure 2.4: Access to water by counties

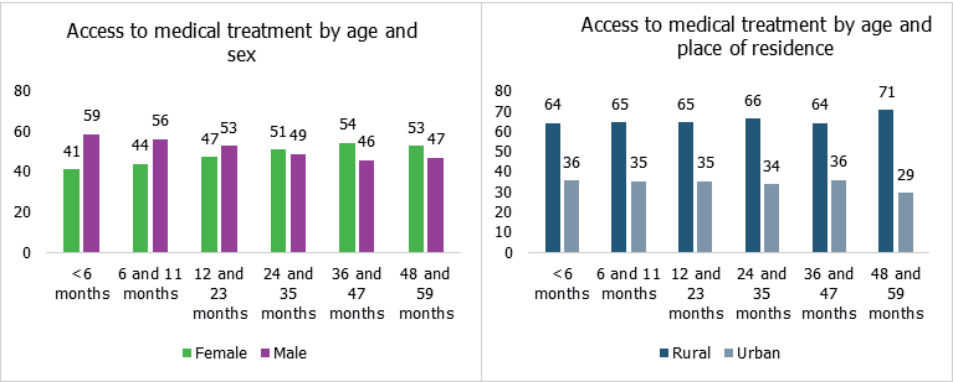


Data source: KNBS (2016), Kenya Integrated Budget Household Survey - KIBHS 2015/16

Diarrhoea is a common problem in Kenya, particularly among under-five children (WHO, 2017). In 2017, diarrhoeal diseases were responsible for 9.0 per cent of deaths among under-five children in Kenya. The prevalence of diarrhoea is influenced by various factors, including poor sanitation, lack of access to clean water, and inadequate hygiene practices. More recent data from the Kenya Demographic Health Survey of 2022 shows that two (2) weeks before the survey, 14 per cent of children exhibited diarrhoea-related symptoms, and 52 per cent of this proportion sought medical treatment.

According to the Kenya Demographic and Health Survey (2022), the proportion of children who were taken for treatment after exhibiting diarrhoea-related symptoms was highest in the age group between 12 and 23 months. When disaggregated by gender, more male children between 0 and 23 months were taken for treatment compared to female children. Access to treatment for female children was least observed in children below six months where 41 per cent of females were taken to the hospital for treatment compared to 59 per cent of their male counterparts (Figure 2.5). Regional disparities exist in the treatment of diarrhoea. Across the age groups, more children in rural areas were taken to the hospital for treatment compared to urban regions. This could be attributed to a higher diarrhoea prevalence in rural areas compared to urban regions, thus necessitating the need for medical treatment.

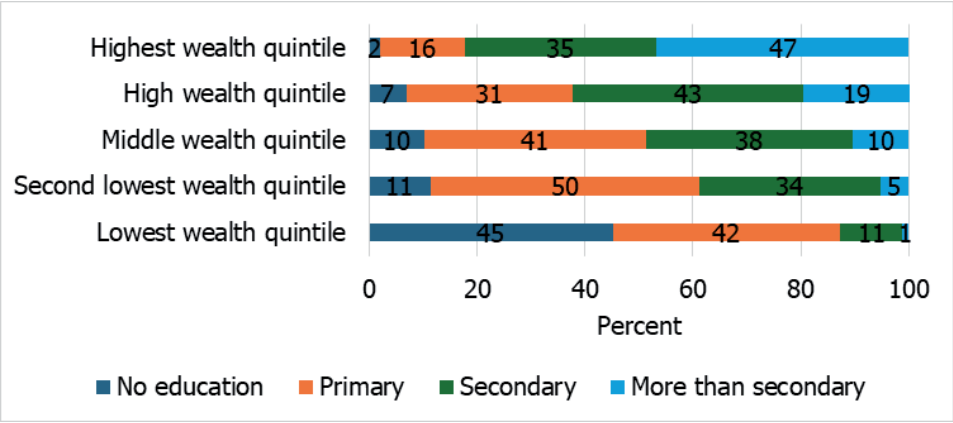
Figure 2.5: Proportion of children for whom treatment was sought by age and gender



Data source: KNBS (2022), Kenya Demographic and Health Survey - KDHS

Socio-economic characteristics play a key role in access to diarrhoea treatment, and consequently, under-five children morbidity outcomes. Key statistics show that 67 per cent of children with diarrhoea and who received medical treatment had mothers with more than secondary education. The largest proportion of mothers who sought medical advice were in the highest wealth quintile and had more than secondary education at 47 per cent (Figure 2.6). This signifies the importance of education and income in accessing medical services for diarrhoea treatment. Interestingly, about 45 per cent of mothers with no education and in the lowest wealth quintile also sought medical advice if their child exhibited diarrhoea symptoms.

Figure 2.6: Percentage of mothers who sought medical advice or treatment (by education and income level)



Data source: KNBS (2022), Kenya Demographic and Health Survey - KDHS

The government has implemented initiatives and made investments to prevent diarrhoea. However, there is more that needs to be done. The investments include

Integrated Management of Newborns and Childhood Illnesses (IMNCI) and Integrated Community Case Management of Childhood Illness (ICCM). There has also been an increase in the proportion of households with improved sanitation facilities from 52.0 per cent to 82.3 per cent between 2018 and 2020 (KPHC, 2019).

Based on the National Health Accounts (2018/19), the government spends less than 3.0 per cent of the total health expenditure on prevention and treatment of diarrhoea. This is approximately Ksh 122 million annually. In making a case for further investments, Wangia and Wanjala (2022) note that every US$ 1.0 invested in the prevention of diarrhoea yields an average return of US$ 25.50 as estimated in the Handbook on Paediatric AIDS in Africa (2006). Even so, in 2018/19, most expenditure on diarrhoea was on outpatient and inpatient curative services – at 39 per cent and 31 per cent, respectively, and only 10 per cent was on preventive care. The rest of the spending was used for governance, health system, and financing administration (13%), medical goods (5%), and others (1%). Going forward, there may be a need for not only additional investments in infrastructure but also improvements in the reallocation of resources towards preventive interventions – to improve access to clean water, proper sanitation, and hygiene.

2.2 Institutional and Governance Arrangements Impacting the Performance of WASH

The outcomes envisaged in WASH for the population and under-five children hinge on institutional and governance arrangements in the sector. Owing to the importance of institutions, this subsection reviews recent developments and identifies gaps that may be addressed to enhance ongoing interventions and outcomes.

The WASH sector in Kenya has experienced tremendous transformation in service delivery since the early 2000s. A key transformation was the separation of policy making, regulation, and service provision following the enactment of the Water Act of 2002. The promulgation of the Constitution in 2010 transitioned WASH into a shared obligation between the National and County governments. This led to the enactment of the Water Act of 2016 and the redefinition of roles and responsibilities for the management, development, and regulation of water resources and water services.

The delivery of WASH services involves the participation of national and county-level ministries, departments, and agencies. The national-level MDAs are mainly responsible for policy formulation, coordination, resource mobilization, and regulation while the counties lead in service delivery. There are outstanding observations that deserve a relook at the institutional and organizational arrangements.

Although WASH coordination structures have been established at the national and county levels through recent reforms, significant coordination challenges continue to plague the sector. National-level structures include the overarching

Environmental Sanitation and Hygiene Interagency Coordination Committee (ESHICC) established by the Ministry of Health; and the Water and Environmental Sanitation Coordination Mechanism (WESCOORD) established by the Ministry of Water and Irrigation. County-level coordination structures are diverse and include WASH Stakeholder Forums (such as in West Pokot). The main challenges include weak links among the coordination structures in WASH policies and laws; inadequate funding to support operations such as regular meetings; and overreliance on donor support. There are also gaps in the framework for stakeholder collaboration. The consequences are weak coordination of investment plans, duplication of effort, wastage, and weak WASH outcomes for the population including the under-five children.

Despite the existence of diverse sources of funding for WASH, from governments, the private sector, and donors, the sector is significantly underfunded at both the national and county level. The Department of Health for Nakuru County, for instance, required Ksh 74.2 million in 2020/21 for sanitation/hygiene interventions but only 4.2 per cent of the budget (about Ksh 3.2 million) was allocated (Nakuru Annual Development Plan, 2021/22 and Nakuru County Approved Budget Estimates, 2021). In the subsequent year, the Department required Ksh 224.2 million for sanitation interventions but less than 1.0 per cent (Ksh two million) was allocated (Nakuru Annual Development Plan, 2022/23 and Nakuru County Approved Budget Estimates, 2021). The inadequate funding is evident in nearly all counties in Kenya and may be reflective of the low prioritization of sanitation and hygiene interventions in the annual budgets.

In addition to the funding issues, utilization of funds or absorption is a major challenge. In Nakuru County, for instance, less than 50 per cent (or Ksh 559.9 million) of the Ksh 1.2 billion allocated to water and sewerage was absorbed. The common explanations are the delays in disbursement of funds and lengthy procurement processes. In the end, some counties do not include funding for sanitation services in their budgets – an example being West Pokot in 2022/23.

Planning and budgeting are key challenges. One aspect of the challenge is that the counties are faced with a technical skills gap in the development and assessment of not only the Annual Development Plans but also the County Budget Review and Outlook Paper, and the Executive Budget Proposal. These compromises costing and budgeting at the departmental level and technical oversight at the County Assemblies. Another aspect facing effective planning and budgeting is a weak capacity for data collection and analysis at the county level. In addition, monitoring and evaluation is weak, owing to insufficient staff, budget gaps, and limited technical capacity.

While significant effort has been made to establish an enabling policy framework, greater progress is needed to improve the implementation of existing policies. Existing policies and laws – including the Water Act, 2016; Environmental Sanitation and Hygiene Policy (KESHP) 2016-2030; and the Urban Sanitation Guidelines – are slowed by challenges such as inadequate funding, weak coordination, and limited technical capacity.

There are various innovative interventions put in place to enhance access to WASH by both the public sector and other actors. As an example, the public sector has put in place more effective organizational frameworks. An example is the Community-Led Total Sanitation (CLTS), which is an innovative community-driven approach aimed at eliminating open defecation. The CLTS was adopted by the Ministry of Health in 2007 as a sustainable behaviour change approach that leverages social capital to trigger households to construct their pit latrines without subsidies. Good results have come out of the initiative with numerous villages declared open defecation free.

Besides the interventions and investments by the public sector, the non-State actors are implementing numerous WASH interventions and innovations that have had good outcomes with respect to enhancing access to improved water, sanitation, and hygiene in Kenya. The actors include civil society organizations (CSOs), United Nations agencies, global movements, and communities. An assessment of some of the programmes reveals that interventions that combine the use of diverse stakeholders, community support, and promotional activities – including social marketing – are more impactful. Broad examples of these interventions encompass promotional activities and awareness campaigns to promote behaviour change; and support an enabling environment for more market-based innovations, especially in urban informal settlements and rural areas.

Promising results have been observed for innovative pilot programmes. These include water and sanitation lending by financial institutions and the use of digital financial services and microloans. Some of these projects indicate that besides investments in physical infrastructure, there is immense potential in improving the procedures, policies, laws, and regulations through deeper partnerships among the public and private sectors, and other non-State actors such as CSOs, and communities.

3. Literature Review

This section presents a comprehensive review of both theoretical and empirical literature.

3.1 Theoretical Literature

Personal, behavioural, and environmental factors have a major impact on the quality of human health and associated outcomes (Fuchs, 1974; Lindsay, 1980). Various theories form the foundation of how cognitive and social factors contribute to human health and diseases. Some of these theories include the ecological model (Bronfenbrenner, 1979), the health belief model (Becker, 1974; Rosenstock, 1974), the social cognitive theory (Bandura, 1986; 1997), and the theories of reasoned action (Ajzen and Fishbein, 1980), and planned behaviour (Ajzen, 1985).

3.1.1 The Ecological Model

Proposed by Bronfenbrenner (1979), the ecological model is a framework used in the field of public health and social sciences to understand and address health issues and behaviours. Health and well-being are the result of complex interactions between an individual and their environment. The model is based on the idea that health is influenced by multiple levels of factors, including the individual, their relationships, the community, and the larger society and culture. These factors interact and influence one another, creating a dynamic and complex system. The ecological model looks at both the positive and negative influences on health and well-being, including access to resources, social support, and opportunities for physical activity, and exposure to stressors and risk factors. The model forms a foundation to guide the development of interventions and policies that address health issues at multiple levels, including individual, community, and societal levels. It is also applied to studies seeking to evaluate the effectiveness of existing interventions and policies.

3.1.2 The Health Belief Model

Existing evidence on preventive and promotive health behaviour relies on the principles of the Health Belief Model (HBM). The HBM plays a significant role in explaining and predicting individual changes in health behaviours, which can lead to promotive and preventive health practices (Rosenstock, 1974). The HBM comprises of six constructs: perceived sensitivity, perceived benefits, perceived barriers, perceived severity, cues to action, and self-efficacy. The HBM assumes that, for an individual to take health action to avoid an illness he would: perceive that they were personally susceptible to the illness; the occurrence of the illness would have at least moderate severity on some component of their life; taking health action would be beneficial by reducing their susceptibility to the illness

or, if the illness occurred, by reducing its severity; and taking action would not require overcoming psychological barriers, such as embarrassment and cultural taboos (Rosentock, 1974).

In Uganda, Kankya et al. (2022) applied the HBM to assess diarrhoeal diseases dynamics. The authors found that lack of knowledge among individuals immensely affects the management of the diseases. In Kenya, Graf et al. (2008) used the Health Belief Model of Rosenstock (1974) and the Theory of Planned Behaviour of Ajzen (1988, 1991) to assess the effect of water disinfection and hygiene behaviour on child diarrhoea in Kibera slums. The study found that the consumption of safe drinks and the hygiene behaviour of the household has a significant effect on child diarrhoea. Kwakye et al. (2018) used the Health Belief Model to investigate the determinants of handwashing behaviour among school-going children in Ghana. The results showed that perceived susceptibility, perceived benefits, and perceived barriers were significant predictors of handwashing behaviour.

Teshome et al. (2015) employed the Health Belief Model to understand the factors that affect water and sanitation behaviours in rural Ethiopia. The results showed that perceived susceptibility, perceived benefits, and perceived barriers were significant predictors of water and sanitation practices. Similar findings were reported in India where Kumar et al. (2016) relied on the Health Belief Model to estimate the factors that influence the adoption of improved sanitation facilities. The results indicate that the adoption of enhanced sanitation facilities was significantly predicted by perceived susceptibility, perceived benefits, and perceived barriers.

3.1.3 Theory of Planned Behaviour

The theory of planned behaviour (TPB) describes the process by which a person's attitudes, subjective norms, and perceived behavioural control influence their intentions to engage in a behaviour, and ultimately, the behaviour itself (Ajzen, 1991). The theory posits that an individual's intention to engage in a behaviour is the best predictor of that behaviour, and that intentions are influenced by attitudes toward the behaviour (whether the behaviour is seen as good or bad), subjective norms (the perceived social pressure to engage in or avoid the behaviour), and perceived behavioural control (the extent to which an individual believes they have the resources and ability to perform the behaviour). The theory of planned behaviour can be used to predict and explain a wide range of behaviours, including health-related behaviour.

The theory of planned behaviour (TPB) is applied in public health to understand and forecast behaviours associated with health issues. It is used to identify factors that influence people's intentions to engage in healthy behaviours and to predict how likely they are to engage in those behaviours. In public health, researchers apply the TPB to identify these factors and develop interventions to change them to promote healthy behaviours. In addition to behaviours associated with substance abuse and mental health, the TPB is also used to comprehend and predict health

behaviours linked to chronic illnesses such as diabetes and heart disease. With respect to WASH, TPB can aid in the promotion of water sanitation and hygiene outcomes by identifying the principal factors that affect an individual's intentions and behaviours regarding these issues. By understanding these factors, health promotion campaigns and interventions can be tailored to target the specific beliefs and attitudes that are most likely to influence an individual's behaviour.

There is a growing body of empirical evidence that supports the use of the theory of planned behaviour (TPB) in promoting water sanitation and hygiene (WASH) behaviours. In rural India, Patel et al. (2020) found that the TPB was effective in predicting and explaining WASH behaviours such as handwashing with soap and using latrines. Agyeman et al. (2016) use TPB to assess sanitation behaviour in Ghana. Attitudes, subjective norms, and perceived behavioural control were identified as significant predictors of WASH behaviours in the study. Similar findings were reported by Getnet and Gebregergs (2015), who relied on TPB to understand handwashing behaviour among rural school-going children in Ethiopia.

3.1.4 Social Cognitive Theory

The Social Cognitive Theory (SCT) describes mutual interactions between the individual, the behaviour, and the environment in which the behaviour is practiced (Bandura, 1987). In public health, the SCT explains how a child's or caregiver's behaviour is influenced by their environment, such as availability and accessibility to resources that promote the health behaviour, behavioural capability such as knowledge and skills to perform the health behaviour by the caregivers and moral disengagement, which involves ways of thinking to accept harmful behaviours. The key foundations of the SCT include self-efficacy, which is the ability of people to undertake certain actions towards improved outcomes both at a personal, household, and community level.

Thus, the theory is critical to communities especially in solving challenges related to poor sanitation, causing diarrhoeal diseases among children under the age of five (5) years. Based on self-efficacy theory, health-promoting behaviours, which include hygiene practices related to water cleanliness, cleanliness of the surroundings of public standpipes, and storage tanks private household vendors, handling food, sanitation, and healthy breastfeeding practices require behaviour changes within a community (Maddux and Stanley, 1986). Self-efficacy is crucial in both stages of the self-regulation of health behaviour.

To understand water, sanitation, and hygiene (WASH) behaviours, various studies have employed social cognitive theory (SCT) to identify the factors that influence them. Application of the SCT in Kenya found that perceived childhood diarrhoea is caused by inadequate personal hygiene, inadequate knowledge of the causes and prevention methods by parents and poor environmental sanitation (Kipngeno and Aseta, 2020). Simmons et al. (2014) conducted a review on the role of social cognitive theory in understanding WASH behaviour where social cognitive theory provided a valuable framework for comprehending the determinants of WASH

behaviour, and interventions targeting these determinants can effectively promote WASH behaviour change.

3.2 Empirical Literature Review

There are several factors identified in the literature to have an association with the occurrence of childhood diarrhoea. The factors may broadly be classified to encompass environmental, behavioural, and socio-economic aspects. Some of the environmental factors include the source of drinking water, water treatment, and sanitation facilities. The behavioural factors include handwashing with soap and feeding using a bottle while the socio-economic factors encompass the age of the child, household size, and the age, education, and occupation of the mother.

3.2.1 Environmental factors

Several studies have found an association between environmental factors – such as source of drinking water, water treatment, and sanitation facilities – and childhood diarrhoea. As an example, non-protected sources of drinking water have been significantly associated with an increased risk of diarrhoea. These sources of water, such as shallow wells and uncovered boreholes, get easily contaminated by runoff rendering the water unsafe (Getu et al., 2014; Mamboleo et al., 2016; Id et al. 2018; Jacket et al., 2020; Mulatya and Ochieng, 2020; Getachew et al., 2021). Moreover, households with water in their homes and with nearly all the members using improved sanitation were found to have improved maternal and child health (Geere and Hunter, 2020). Studies also find that treating water is significantly associated with the prevention of diarrhoea, and residing in rural areas lowers the risk of diarrhoea relative to urban residents (Kawakatsu, 2017). The rural-urban divide is usually linked to the higher levels of congestion and pollution in some urban environments, and more so within urban informal settlements.

Other studies have found an association between water quality and diarrhoea prevalence among under-five children. For example, a study by Tumwine et al. (2002) in Kenya, Gambia, Mali, and Zambia found that households with piped water connections had significantly lower diarrhoea likelihood compared to households that lacked piped water (Tumwine et al., 2002).

Besides the nature of sources of water, the availability of sanitation facilities and sanitation practices are also significant. The availability of latrines among households has been found to reduce childhood diarrhoea (Getu et al., 2014; Id et al., 2018; Asfaha et al., 2018). In related findings, children residing in houses with in-built toilets were 50 per cent less likely to contract diarrhoea than those who used outside toilets (Hung, 2006). An assessment in India shows that improved sanitation facilities have an impact on the reduction of diarrhoea among under-five children. However, water access did not have any impact on diarrhoea prevalence and was mainly attributed to the maximum improved water coverage in India. This is indicative of the fact that apart from access to improved water, improved sanitation also plays an important role in reducing cases of diarrhoea in children

under the age of five (Mallick Rahul et al., 2020). These findings were similar to a study in Ethiopia, which indicated that households that practiced Community-led Total Sanitation (CLTS), had access to water that was less contaminated than households that did not practice CLTS (Negasa et al., 2019).

Fink et al. (2011) used a logistic model to establish the relationship between access to water and sanitation on child health. Improved sanitation was found to be associated with lower mortality, a lower risk of child diarrhoea, and a lower risk of mild or severe stunting. The study also found that access to improved water was associated with a lower risk of diarrhoea and a lower risk of mild or severe stunting, but there was no association with non-infant child mortality.

House floor material has been found to significantly affect the occurrence of childhood diarrhoea. In Ethiopia's Dale district, Melese et al. (2019), employing a community-based study, found that developing diarrhoeal diseases among children under the age of five were 3.22 times higher among children dwelling in mud floor households compared with children whose household dwellings had a cement floor. This was interpreted to suggest that housing with cement floors was a cleaner environment.

3.2.2 Socio-economic factors

Socio-economic variables including education and occupational status play a significant role in explaining the prevalence of childhood diarrhoea. An important variable is education. Children with more educated mothers or caregivers tend to have lower diarrhoea prevalence, irrespective of water and sanitation conditions. In numerous studies, it has been found that childhood diarrhoea occurrence is significantly lower where mothers have secondary education or formal education, compared to mothers with no education or informal education. The explanations for these observations are linked to the fact that more educated mothers/caregivers have a better understanding of proper hygiene practices (Mohammed et al., 2013; Mbugua et al., 2014; Connell et al., 2017; Fartum et al., 2017; Afzal, 2017; Habtu, 2017; Asfaha ety al., 2018).

Using KDHS data, Mbugua et al. (2014) examined the effect of household, demographic, and maternal characteristics on diarrhoea prevalence among under-five children in Kenya. The findings showed that besides the education of the mother, the age of the child and the residence of the mother was more likely to influence childhood diarrhoea. Other significant household characteristics included household size or number of children. In a study done in Kenya, it was reported that children from households with more than three under-five children were four times at risk of diarrhoea compared to two or fewer under-five children in the households. This is linked to quality of care or less difficulty associated with taking care of two or fewer children relative to more than three children (Asfaha, 2018). The findings are consistent with those of Kawakatsu (2017) who uses multilevel logistic regressions to examine factors associated with the prevalence of diarrhoea among under-five children in Nyanza Province, Kenya, and finds

that a child receiving more attention was less likely to develop diarrhoea-related diseases.

Another valuable socio-economic factor that has been found to influence childhood diarrhoea is the occupational status of the mother or caregiver. Some studies find that housewives tend to have better outcomes than working mothers who may find it difficult to manage their time for caregiving and work (Afzal, 2017). This may impact negatively nutrition and predispose children of working mothers to a higher incidence of diarrhoea.

Other socio-demographic characteristics that significantly predict a lower incidence of diarrhoea among under-five children include higher household income and the age of the child. Higher household income is associated with better environmental factors such as better sanitation facilities. With respect to the age of the child, older children are better able to practice better sanitation than younger ones (Danquash et al., 2007; Mamboleo et al., 2016; Connell et al., 2017).

3.2.3 Behavioural factors

On the behavioural front, an association between maternal hygiene and behavioural variables and rates of childhood diarrhoea has been demonstrated through various studies. A study conducted in Kenya found that hand washing using soap after using a toilet facility reduced diarrhoeal diseases (Mamboleo, Njoroge, and Okaru, 2016). In another study, Mulatya and Ochieng' (2020) examined the environmental and behavioural determinants of diarrhoea in under-five children in Kenya by analysing the secondary data using the Kenya Demographic and Health Survey of 2014. They observe that households practicing unsafe disposal of children's faeces had a higher prevalence (18.1%) compared to households with safe disposal (14.4%). In addition, households practicing open defecation were five percentage points more likely to report diarrhoea in under-five children compared to the ones with improved sanitation.

Similar findings have been found in other countries, for example, in Ethiopia, Getu, Gedefaw, and Abebe (2014) found that children from mothers who washed their hands with water only were nearly twice more likely to develop diarrhoeal diseases when compared to children whose mothers had hand washing practice with water and soap/ash. In addition, Mohammed, Tilahun, and Tamiru (2013) using a systematic review of the literature, found that mothers with poor handwashing practices were significantly associated with childhood diarrhoeal diseases. Both studies used community-based cross-sectional studies employing multistage sampling techniques.

Child immunization has also been found to be a significant factor in explaining childhood diarrhoea incidence. Habtu (2017) found that children who had not been vaccinated for Rotavirus in Nyarugenge District in Rwanda were eight (8) times more likely to develop diarrhoeal diseases than those who were vaccinated. The study employed a descriptive cross-sectional design using a multistage sampling technique.

Child feeding practices have also been found to be significantly associated with childhood diarrhoea – with children who did not exclusively breastfeed found to be at a higher risk. Further, Quigley et al. (2016) report that breastfeeding was associated with significantly less diarrhoeal disease and formula-fed infants were more prone to diarrhoea if their bottles and teats were not sterilized.

Mwashumbe (2019) assessed the effect of water, sanitation, and hand hygiene practices on diarrhoea-related diseases among community members in Nyeri County, Kenya, by adopting cross-sectional study design. The study used data from 200 households sampled proportionately from two wards in Kieni East Sub-county selected through simple random sampling. The findings revealed that predictors of diarrhoea in the community included low level of education, households with four or more members, unimproved water source, water inadequacy, unavailability of toilets, and unavailability of hand washing facilities. The study also pointed out that the community was not consistently practicing adequate handwashing practices, and that the occurrence of diarrhoea could be decreased by interventions aimed at improving water availability, sanitation, and hygiene.

4. Methodology

4.1 Analytical Framework

From the household production function, child health production function is produced (Akin, 1992). The child health production function is a theoretical model that describes the relationship between inputs (such as access to improved sources of water, improved sanitation access to handwashing facilities, distance travelled to fetch water, household size, poverty levels, place of residence, and parental education) and outputs such as child health in early childhood. The model suggests that investing in certain inputs can lead to improved outcomes for children and is often used to inform policies and programmes aimed at improving child health and development. Mosley and Chen (1984) argue that investment in WASH (described as environmental contamination) and other socio-economic attributes, including maternal factors, are important inputs into health outcomes. However, the authors also note that the use of these inputs is dependent on other socio-economic factors such as level of education and income. DaVanzo and Gertler (1990) on the other hand, argue that apart from the economic factors that influence health at the household level, other 'non-economic' factors such as sociocultural set-up, institutional settings, and psychological aspects influence health outcomes within households.

The general child health production function is as presented below.

$$Ch = Ch\,(H, W, 0) \qquad 4.1$$

Where Ch = child health is a function of

H = Household characteristics, which included household size and overall poverty

W = WASH-specific attributes, which included access to improved sources of water, access to improved sanitation, access to handwashing facility, and distance travelled to water sources.

O = Other control variables including maternal education and place of residence.

This study uses the probit model to compute the probabilities of diarrhoea prevalence given the status of access to water, sanitation, and hygiene in two stages. In the first stage, the study estimates a first regression on the effect of WASH-only attributes on under-five children diarrhoea prevalence. The second regression was used to estimate a probit regression using WASH attributes and other control variables. In the second stage of the analysis, the study aims to bring out differences in diarrhoea prevalence among under-five children between rural and urban regions using probit regression.

The dependent variable represents households that had experienced diarrhoea prevalence two weeks before the day the survey was carried out in 2015/16. The variable takes the value one if the household had a prevalence of diarrhoea and zero if there was no diarrhoea prevalence. Since the outcome variable is dichotomous, unordered probit is the appropriate model to apply.

In this probit model, we assume the probability of having diarrhoea is determined by the underlying response variable of household characteristics, whose disturbance term is normally distributed with mean zero and constant variance one (1). The model that we estimate is of the form:

$$y = \beta' x + \varepsilon \quad 4.2$$

$$y = 1 \quad if\ y^* > 0 \quad 4.3$$

$$y = 0 \quad if y^* \leq 0 \quad 4.4$$

Where y is a dependent dichotomous variable taking one (1) if there is diarrhoea and zero (0) if there is no diarrhoea. β is a vector of unknown parameters, x is a vector of observed independent variables and ε are the unobserved factors that cause diarrhoea. The independent variables used in the application of this model include access to water, access to handwashing facilities at home and access to improved sanitation, household size, overall poverty, maternal education, and place of residence. In this estimation, our objective is to capture the effect of WASH on diarrhoea and its role in child health. Consequently, we control for all the other listed variables to avoid their effects being captured in the error term.

Therefore, the binary response model can be denoted as:

$$\text{Prob}\ (y = 1|x) = f(x'\beta) \quad 4.5$$

To obtain the marginal effects of the regressors x, on the probabilities, we take the derivative of the function at the probability of the occurrence of diarrhoea.

$$\frac{\partial\ Prob\ (y=1)}{\partial\ x} = \partial\ f(x'\ \beta) \quad 4.6$$

Since the occurrence of diarrhoea is a dummy variable, we compute the difference in probability of the dummy taking values 1 and 0.

$$P(y = 1|x) = P\big(y = 1\big|x, x_j = 1\big) - Pr\big(y = 1\big|x, x_j = 0\big) \quad 4.7$$

4.2 Definition and Measurement of Variables

The dependent variable in this study was the prevalence of diarrhoea. The main explanatory variables of interest for this study were access to water, access to handwashing facilities at home, access to improved sanitation, distance to water sources, household size, overall poverty, maternal education, and place of residence. Table 4.1 presents the variables included in the models and how they were measured.

4.2.1 Dependent variables

Diarrhoea prevalence

The outcome variable in this study was a dummy variable, which measures diarrhoea prevalence among children who were under five (5) years, two weeks before the survey was conducted. To measure diarrhoea prevalence in under-five children, the respondents were asked the following question "Has [Child's name] had diarrhoea in the last two weeks?" The response was binary either Yes (1) or No (0). The variable was used without undertaking any further construction.

4.2.2 Variables of interest

WASH attributes

(a) Access to improved water sources

A household is considered to have access to safe water if its main source of water is an improved source (O'Hara et al., 2008). Improved sources are those deemed to be relatively protected from contamination and, therefore, likely to provide water that is safe for human consumption and household use, such as piped, boreholes with pumps, protected springs, protected wells, and rainwater. In this study, access to improved sources of water is a dummy variable measured as "What is the main source of water for your household over the past one (1) month?" The responses included pipe water – piped into dwelling; piped water – piped into plot/yard; piped water – public tap/standpipe; tubewell/borehole with pump; dug well-protected well; dug well- unprotected well; water from spring – protected spring; water from spring – unprotected spring; rainwater collection; vendors – tankers/trucks; vendors – cart with small tank/drum/bucket; vendors – bicycles with buckets; surface water – river, stream, pond, dam, lakes; and others. Construction of variables involved categorization of improved sources of water (1), which includes a household that has piped water into a dwelling; piped water – piped into plot/yard; piped water – public tap/standpipe; tubewell/borehole with pump; dug well-protected well; water from spring – protected spring; rainwater collection and unimproved sources of water were zero (0).

(b) Access to improved sanitation

Without a facility that safely separates human waste from human contact, people have no choice but to use inadequate communal latrines or to practise open defecation. In this study, to measure access to improved sanitation, respondents were asked the following question, "What kind of toilet facility does your household use?" The responses included flush to piped sewer system; flush to septic tank; flush to pit latrine; flush to somewhere else; flush to an unknown place; ventilated improved pit latrine (VIP); pit latrine with a slab; pit latrine without slab/open pit; composting pit; bucket toilet; hanging toilet/hanging latrine; no facility/ bush/field; other. Therefore, a household was considered to have improved sanitation if their human waste disposal facilities were connected to the main sewer, septic tanks, ventilated improved pit latrine, pit latrine with a slab, and

composting toilets. Households that had access to improved sources of sanitation were categorized as 1(Yes) and those without at 0 (No).

(c) Access to handwashing facilities

Good hygiene practices such as washing hands after defecation, play a role in reducing the spread of diseases. The question asked in the survey was, "Is there a place for hand washing in or near the toilet facility?" The response was either Yes (1) or No (0). A household was considered to have access to hygiene if it had a hand washing facility near the toilet.

(c) Distance travelled to water sources

Fetching water for drinking and other household uses is a substantial burden that affects water quantity and quality in a household. Households that travel for more than 30 minutes to access water have been shown to collect progressively less water. Limited water availability may also reduce the amount of water that is used for hygiene in the household, thus increasing the prevalence of waterborne diseases including diarrhoea. Distance to water sources was measured by asking respondents the following question, "What is the average distance to the source of drinking water in metres?" This is a binary variable measured using the World Health Organization (WHO) definition that "Access to drinking water means that the source is less than one (1) kilometre away from its place of use." The variable was constructed into a binary variable a categorical variable where 1=WHO recommended distance to source of water; 0= Otherwise.

(e) Household characteristics

Household size

Family size has been found to influence diarrhoea in various studies. When many people live together, the chance of contact with pathogens increases, and hygiene may deteriorate (Woldemicaei, 2001; Manun'ebo et al., 1994). Having many children in a household increases the likelihood of having diarrhoea because of crowding and competition for the mother's time and attention and other resources (Woldemicaei, 2001). In this study, the respondents were asked the following question to measure household size, "What is the total number of people living in the household?" The response was continuous. Construction of the variable resulted in a categorical variable where 1=Small household (has 1-5 members); 2=Medium households (has 6-10 members); 3= Large households (has 11-15 members); 4 = Overly large households (has more than 15 members).

Overall poverty

Poverty has a significant impact on the prevalence and severity of diarrhoea among under-five children. Diarrhoea is one of the leading causes of morbidity and mortality among young children, particularly in developing countries where poverty is widespread. In rural Bangladesh, Kosek et al. (2003) found that poverty was a significant risk factor for childhood diarrhoea, with children from the poorest households being more than twice as likely to experience diarrhoea as children from the wealthiest households. A study conducted in Sub-Saharan Africa found that poverty was associated with an increased risk of diarrhoea among young

children, but that this association was partially mediated by access to clean water and sanitation facilities (Wagenaar et al., 2016). In this study, overall poverty was measured as the proportion of the population in rural and urban areas whose monthly adult equivalent total consumption per person was less than Ksh 3,252 and Ksh 5,995 in rural and urban areas, respectively. Construction of the variables resulted in a dummy variable where 1=Yes if a household is living below the poverty line and 0=No If a household is living above the poverty line.

4.2.3 Other control variables

(a) Maternal education

The level of education of the mother has been found to reduce diarrhoea prevalence within the household. Women education may enhance knowledge, attitude, and the practice of basic preventive measures such as proper breastfeeding, child feeding, water treatment, and healthier childcare. In SSA, Demissie et al. (2021) found that the prevalence of diarrhoea was higher among children whose mothers had secondary education and below. Access to education was measured "What is the highest educational level and grade has [Name] completed?" The responses were as follows pre-primary; primary; post primary, vocational; secondary; college (middle level); university undergraduate; university postgraduate; Madrasa/ Duksi; Other. Construction of the variables was done to a dummy variable where access to pre-primary, primary, post-primary, vocational; Madrasa/Duksi and other was categorized as primary education and below (1) and otherwise (0).

(b) Place of residence

Differentials in mortality by urban/rural residence have commonly been observed, with urban areas having more advantages and therefore better child survival prospects. The place of residence is one of the predictors of child health in general and diarrhoeal disease in particular. In developing countries, socio-economic status, access to health services, and environmental conditions all affect the health of children in rural areas (Timaeus and Lush, 1995). Children in urban areas where proper sanitation and water are available, and where modem treatment is more frequent, will have a lower prevalence of diarrhoea. The variable was measured as, "What is your place of residence?" The responses were binary where one (1) was rural and zero (0) urban areas.

Table 4.1: Measurement of the variables included in the models

Dependent variable	**Measurement**
Diarrhoea prevalence	Dummy (0=No; 1=Yes)
Explanatory variables of interest	**Measurement**
WASH attributes	
Access to improved water	Dummy (0=No; 1=Yes)
Access to improved sanitation	Dummy (0=No; 1=Yes)

Access to handwashing facility	Dummy (0=No; 1=Yes)
Distance to water sources (Dummy)	Dummy (0=Otherwise; 1=Meets WHO recommended distance)
Distance to water sources (Kilometres)	Continuous variable measured in metres travelled to fetch water for household use
Household characteristics	**Measurement**
Household size (category)	Categorical (1=Small household (has 1-5 members); 2= Medium households (has 6-10 members); 3= Large households (has 11-15 members); 4 = Overly large households (has more than 15 members)
Household size (number)	Continuous variables measured as number of people living in the household.
Overall poverty	Dummy (0=Non-poor; 1=Poor)
Other control variables	**Measurement**
Mother's level of education	Dummy (0= Otherwise; 1=Primary and below)
Place of residence	Dummy (0=Urban; 1=Rural)

Source: Authors' conceptualization

4.3 Research Design and Data Sources

The main data source for this investigation was the Kenya Integrated Household Budget Survey (KIHBS) 2015/16 data produced by the Kenya National Bureau of Statistics (KNBS). The sample was stratified and selected in two stages from the master sample frame. Data was collected from 47 counties using individual, household, and community questionnaires. Stratification was achieved by separating each county into urban and rural areas; in total, 92 sampling strata were created. Samples were selected independently, in each sampling stratum by a two-stage selection. In this regard, 2,400 clusters were sampled where the clusters served as primary sampling units for the selection of ten households per cluster, translating to 24,000 households. Following data cleaning, our study sample mainly constituted households with children under the age of five (5) years and their characteristics. Following this classification, the sample size consisted of 12,455 observations.

4.4 Descriptive Statistics

This section presents summary statistics on the variables included in the regression model. Table 4.2 presents the summary statistics from the study

sample. Information on access to water, sanitation, hygiene, and the basic child characteristics and health information for 12,455 households with children under the age of five (5) years was available.

Findings from the summary statistics show that only 8.0 per cent of children had experienced diarrhoea in the two weeks preceding the survey. Further, statistics indicate that 41 per cent of children under the age of five live in households experiencing overall poverty, and an estimated 80 per cent of these households are in rural areas. While the average household size as per the survey is six people, about 49 per cent of these households are categorized as small, with members between one (1) to five (5). Medium households are categorized as those with members between six (6) to 10 and they account for 47 per cent of the households. An analysis of mother's highest level of education in households with under-five children shows that only 9.0 per cent of the households had mothers whose educational level is primary and below. This implies that in about 90 per cent of the households with under-five children, mothers have secondary education and above.

Table 4.2: Descriptive statistics of variables included in the analysis

Variable	Observations	Mean	Std. Dev	Min	Max
Child diarrhoea	12,455	0.082	0.274	0	1
Improved water sources	12,455	0.624	0.484	0	1
Improved sanitation	12,455	0.765	0.424	0	1
Handwashing facility	12,016	0.115	0.319	0	1
Distance travelled (Continuous)	8,738	1.301	10.512	0.1	600
Distance travelled (Dummy)	8,738	0.786	0.409	0	1
Household size (Continuous)	9,407	6.079	2.346	2	28
Small households	12,455	0.487	0.5	0	1
Medium households	12,455	0.466	0.499	0	1
Large households	12,455	0.045	0.208	0	1
Overly large households	12,455	0.001	0.037	0	1
Place of residence	12,455	0.802	0.399	0	1
Mother's education (primary and below)	12,455	0.099	0.299	0	1
Overall poverty	12,455	0.410	0.492	0	1

Data source: KNBS (2016), KIHBS 2015/16

In assessing access to WASH, findings show that over two-thirds of households with under-five children have access to improved water sources whereas about 75 per cent have access to improved sanitation. Interestingly, the findings point towards a low level of hygiene in these households. Only 12 per cent of households have a hand washing facility outside the toilet, an indication of low hygiene standards. Distance travelled to fetch water is an indicator of improved access to water. In this study, about a quarter of the households do not cover any distance to fetch water for both household use and drinking. On the other hand, most of the households (74%) travel short distances to fetch water. A negligible proportion of households travel medium distances (between 201 and 600 metres) to fetch water.

5. Results and Discussion on the Effects of WASH on Diarrhoea Prevalence among Under-Five Children

This section presents findings from the probit regression analysis. Multicollinearity tests were run and an acceptable variance inflation factor (VIF) value of below 2.5 was attained for each explanatory variable revealing a low correlation among the variables being tested. In the first stage, analysis was undertaken to establish the effect of our variables of interest, namely access to improved sources of water, access to improved sanitation, access to improved sanitation, and distance travelled to fetch water for use in the household. In the WASH regression, only access to improved sources of water was significant. Table 5.1 presents marginal effects from the probit regression. Findings show that access to improved sources of water increases the probability of diarrhoea prevalence among under-five children by 3.1 percentage points. Although not statistically significant, improved sanitation and distance to the water source are likely to lower diarrhoea prevalence.

Table 5.1: Marginal effects after probit of diarrhoea prevalence on the determinants of under-five children

Variable	Marginal effects (WASH only regression)	Marginal effects (All variables re-gression)
Improved water	-0.0312***	-0.0273**
Improved sanitation	-0.0070	-0.0021
Improved hygiene	0.0013	0.0033
Distance to water source	-0.0039	-0.0077
Place of residence	-	0.0186*
Medium households	-	0.0218***
Large households	-	0.0295**
Overly large households	-	-0.0175
Mother's education	-	0.0778***
Overall poverty	-	0.0141**

Source: Author's construct based on KNBS (2016), KIHBS) 2015/16 data

In the next step, we estimate the effect of WASH variables on diarrhoea prevalence among under-five children while controlling for other variables. The marginal effect of access to improved water sources is negative and significant. Access to improved sources of water reduces the probability of diarrhoea prevalence by 2.7 percentage points for under-five children. Various studies have documented the effect of access to improved sources of water on diarrhoea and the findings are varying. For instance, Wolf et al. (2014) found a modest effect of piped water on diarrhoea morbidity in under-five children compared to water from an unimproved source. When controlling for the quality of improved sources of water, the authors found larger effects implying that access to improved sources of water alone is not the sole determinant of diarrhoea in under-five children. Other

factors such as quality and frequency of water supply, especially piped water, also play a significant role.

Residing in rural areas significantly increases the probability of diarrhoea prevalence among children under the age of five by 1.9 percentage points. Environmental attributes, including place of residence, are key predictors of household access to WASH and subsequent diarrhoea prevalence within households. Empirical evidence shows that children living in non-rural regions have better health outcomes compared to those living in rural areas. The urban residence is characterized by shorter distances to health facilities and improved access to WASH, thus childhood diarrhoea varies considerably depending on the region/neighbourhood (Aziz et al., 2018). In this study, descriptive statistics show that households living in rural areas have a high (77%) prevalence of diarrhoea in under-five children.

Household size was found to be associated with a higher prevalence of diarrhoea in children. Relative to small households (with one to five members), being in medium and large households led to increases in the probability of diarrhoea prevalence among under-five children by 2.2 percentage points and 3.0 percentage points, respectively. Empirical evidence has shown that in households with more members, the prevalence of diarrhoea is high due to poor household sanitation, hygiene practices, and poor food handling practices. Moreover, larger households are an indication of overcrowding in the household, which increases the likelihood of disease transmission through contamination of water and food and poor personal hygiene and environmental sanitation. Compared to children living in smaller households, these children are vulnerable and prone to diarrhoea. Similar findings have been reported in Ethiopia by Bekele et al. (2021) who found that in large households without health extension, diarrhoea prevalence was higher compared to large households with health extension.

Mother's education is a dummy variable taking a value of one if a mother has primary education or less. The findings suggest that in a household where the mother's education is primary level or less, the probability of diarrhoea prevalence is higher by 7.8 percentage points. This finding corroborates those of a wide body of literature, which states that higher education level is associated with increased WASH knowledge and, thus, reduces diarrhoea prevalence within the household (Acharya, 2018; Ferrer, 2008; Nassir, 2015; Dhingra, 2018). For instance, Mihrete et al. (2014) found that maternal education has a strong association with under-five children diarrhoea prevalence in Ethiopia. Compared to mothers who have primary education and above, diarrhoea prevalence is two times more likely to occur in households where the mother has no education.

The effect of overall poverty on diarrhoea prevalence in under-five children is positive and significant. Specifically, an under-five child in a poor household is associated with an increase in the probability of diarrhoea prevalence by 1.4 percentage points. Poor households have fewer resources to fulfill their necessities, have poorer living conditions, and have a lower health status, all factors that increase diarrhoea risk.

In the second stage, we undertook analysis in rural and urban regions to assess differential factors that influence diarrhoea prevalence among under-five children. Table 5.2 presents the marginal effects of the probit regression. In rural areas, access to improved sources of water reduces the probability of diarrhoea prevalence by 2.9 percentage points.

High poverty levels in rural areas often translate into limited access to clean water sources and proper sanitation facilities. Most rural communities lack the financial resources to invest in safe water storage or construct improved latrines. Consequently, rural communities rely on unimproved water sources and engage in open defecation practices, which significantly increase the risk of diarrhoeal diseases. Thus, the larger the household size, the higher the probability of diarrhoea prevalence in rural areas. The other variables, including improved sanitation, handwashing facility, and distance to water sources were not statistically significant for the rural sample but had the expected signs.

Table 5.2: Marginal effects after probit of diarrhoea prevalence on influencing factors in rural and urban regions

Variable	Marginal effects (Rural regression)	Marginal effects (Urban regression
Improved water	-0.0290**	-0.0207
Improved sanitation	-0.0011	-0.0133
Handwashing facility	-0.0006	-0.0187
Distance to water sources (Continuous)	-0.0000	0.0030
Household size (Continuous)	0.0040**	0.0067
Mother's education	0.0696***	0.1219***
Overall poverty	0.0153**	0.0061

Source: Authors' construct based on KNBS (2026), KIHBS)2015/16 data

In urban areas, the only significant variable was the mother's highest educational level – in households where the mother had primary education or less, this was associated with a probability of 12.2 percentage points of diarrhoea prevalence. Although the other variables were not statistically significant, they had the expected signs.

6. Conclusion and Policy Recommendations

6.1 Conclusion

This study examined the role of water, sanitation, and hygiene in diarrhoea prevention among under-five children using KIHBS, 2015/16 microdata.). Access to WASH (water, sanitation, and hygiene) has a significant impact on reducing child diarrhoea, which is a major cause of childhood mortality, particularly in developing countries. Households' use of contaminated water is one of the main causes of diarrhoea, thus access to clean water can prevent diarrhoeal diseases. Similarly, poor sanitation and hygiene practices may lead to the spread of germs and bacteria that cause diarrhoea. Empirical evidence has shown that improving access to WASH can significantly reduce the prevalence of child diarrhoea, with high benefits derived in developing countries.

Compared to households without access to improved sources of water, the probability of diarrhoea prevalence is greatly reduced, which consequently leads to better health outcomes for under-five children. Access to improved sanitation also confers protective benefits to children in this age category. The effect of hygiene practices is found to be statistically insignificant. However, a wide body of empirical evidence shows that proper hygiene practices including access to handwashing facilities reduce diarrhoea in children (Luby et al., 2011; Ejemot-Nwadiaro et al., 2021). Distance travelled to fetch water for drinking and household use also matters. When households travel shorter distances, the probability of diarrhoea prevalence is significantly reduced, because the volume of water collected is higher and the water is less contaminated. A study conducted by Vyas et al. (2017) in India found that water quality deteriorated significantly as the distance travelled to fetch water increased. Similar findings have been reported in China by Bai et al. (2018); in Tanzania by Kihila et al. (2019); and by Tesfaye et al. (2019) in Ethiopia.

On household characteristics, results show that households living in poverty are associated with an increased probability of the prevalence of diarrhoea for under-five children. High poverty levels are associated with limited access to improved sources of water, sanitation, and hygiene. In addition, under-five children residing in large households are at a higher risk of diarrhoea compared to those residing in small and medium households. In large households, diarrhoea prevalence is more likely to occur because of overcrowding and poorer sanitation and hygiene practices (Moyer and Kirby, 2016).

Results from other variables show that residing in rural areas is linked to an increased probability of diarrhoea prevalence among children. This is because rural areas have low access to improved sources of water characterized by access to water from unprotected springs, rivers, and unprotected wells. In households where the mother's highest level of education is primary level, children experience a higher probability of diarrhoea prevalence compared to those with mothers having at least secondary education. This implies that education is an important tool in access to information and practicing and promoting good WASH practices.

Prevention of diarrhoea prevalence in under-five children can be achieved through continued access to WASH.

The review indicated that the government has implemented initiatives and made investments to prevent diarrhoea but the National Health Accounts (2018/19) indicates that despite policy efforts to focus on preventive interventions, the government spends only 10 per cent of the total expenditure on diarrhoea preventive care despite its potentially high returns.

6.2 Policy Recommendations

This study offers several recommendations, considering ongoing interventions. The governments in collaboration with non-State actors need to:

(i) Enhance access to basic education for all – focusing on disadvantaged individuals. The ongoing efforts such as the policy to readmit teenage mothers to school are commendable, since educated mothers are more likely to make informed decisions about their health and that of their children.

(ii) Boost investment in improved water sources, especially in rural areas. This can be through public-private partnerships that enhance and support community engagement.

(iii) Deliberately shift more resources towards preventive care for WASH interventions. This should include more sensitization among communities on the importance of practices such as hand washing.

(iv) Scale up small-scale/pilot WASH interventions and innovations that have had good outcomes with respect to enhancing access to improved water and sanitation. In Kenya, a common thread for more impactful interventions includes those that combine the use of diverse stakeholders, community support, and promotional activities, including social marketing.

(v) Support an enabling environment for more market-based innovations, especially in urban informal settlements and rural areas. These include water and sanitation lending and the use of digital financial services.

(vi) Improve targeting of poor households for all programmes and deepen alliances with non-State actors. Improved targeting implies the need to focus on rural areas, urban informal settlements, and specific areas with high poverty rates.

From the review of overarching institutional issues, the National and County governments need to:

(i) Improve coordination of WASH interventions through collaborative planning.

(ii) Prioritize funding for sanitation and hygiene services to reduce reliance on donor support.

(iii) Develop a maintenance plan to facilitate timely repair/rehabilitation of WASH infrastructure.

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Appendix

Appendix 1: Regression with distance to water source and household size as continuous variables

Variables	Marginal effects (WASH-only)	Marginal effects (All variables)
Improved water	-0.0313***	-0.0273**
Improved sanitation	-0.0072	-0.0021
Handwashing facility	-0.0014	-0.0028
Distance to water source	0.0000	0.000
Place of residence		0.0193*
Household size		0.0042**
Mother's education		0.0766***
Overall poverty		0.0145**

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