PREDICTORS OF THE RESURGENCE AND SUSTAINABILITY OF OPEN DEFECATION-FREE STATUS AMONG ADULT RESIDENTS IN KIBWEZI EAST SUB COUNTY, MAKUENI COUNTY, KENYA

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PUBLIC HEALTH DEGREE IN EPIDEMIOLOGY AND DISEASE CONTROL OF MOUNT KENYA UNIVERSITY.

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DECLARATION

STUDENTS DECLARATION

This research thesis is my original work and has never been presented for award of a degree in any other University or institution of higher education.

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DEDICATION

This work is dedicated to my wife Agnetta, Sons Abednego, Brian and daughter Faith for their support during my entire study period. God bless you.

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ABSTRACT

Worldwide, 2.4 billion persons lack improved sanitation and practice open defecation. In Kenya, about 14% of its population defecates in the open. Makueni County ranked 44th out of 47 counties defecating openly. Kibwezi East showed that, 48% of certified villages (235 out of 488) had resumed to OD, more than the Counties of Busia (10%), Siaya (12.5%), and Kitui (32%). The study objectives were socio-demographic characteristics, individual characteristics, infrastructural factors and interventions influencing the sustainability of ODF status. This study employed various approaches to achieve the required sample size of 423 respondents in Kibwezi East. Data was analyzed using SPSS version 27, and Chi2 assessed significant differences between categorical variables. The results were presented in tables, graphs, and pie charts. The study reported that approximately 17.1% to 20.9% practiced open defecation. Most respondents were Christians (98.8%), completed primary education (52.9%), females (68.6%) and married (89.1%). Regarding knowledge of ODF, majority identified community meetings (69.50%) as their primary source of information. Disposable diapers were the primary choice for child waste disposal (48.0%). Respondents who believed OD had not been eradicated were less likely to sustain ODF (uOR = 0.481, p = 0.004), those not attending community meetings had lower ODF sustainability odds (uOR = 0.551, p = 0.004). On socioeconomic characteristics, majority of participants were unemployed (91.5%), had outside toilets (89.6%), and pit latrines (95.1%). Lack of vent pipes was associated with a 1.701 times higher likelihood of not maintaining ODF sustainability (p = 0.019). Households with ODF sustainability had a slightly higher mean monthly income (Kshs. 3928.9). Most participants had handwashing (69.6%) and cleansing (60.8%) facilities in their toilets. Households lacking toilet cleansing facilities were 2.583 times more likely, those without handwashing facilities were 4.757 times more likely, individuals who did not frequently wash their hands were 3.007 times more likely to experience ODF unsustainability ($p < 0.05$).On further analysis, most sanitary facilities (59.5%) were located within 10-50 meters, with a median walking time of 3.0 minutes. ODF sustainability was less likely in households without user-friendly sanitary facilities (uOR = 2.47, $p < 0.001$) and roofless toilets (uOR = 0.355, $p < 0.001$). Longer walking times (>3 minutes) were associated with reduced ODF sustainability (uOR = 0.341, $p < 0.001$).Conversely, the absence of designated open defecation sites increased the odds of ODF sustainability by 1.669 times (UOR = 1.669, $p < 0.001$), and households with toilets emitting no unpleasant odors were more likely to sustain ODF (UOR = 1.287, p = 0.030). Approximately 57% of participants attended recent sanitation training, with the majority (71%) not receiving incentives. Statistically significant associations were found between ODF sustainability and awareness of sanitation campaigns (p = 0.006), sanitation marketing awareness (p = 0.009), and partner support for sanitation marketing (p = 0.013). In conclusion, this study achieved a high response rate. The findings indicate that education levels, knowledge, practices, access to user-friendly sanitary facilities and infrastructure play a significant role in ODF sustainability.

Key words; Resurgence, sustainability, Open Defecation, Open Defecation Free, Adult residents.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACTED	Agency for Technical Cooperation and Development
CLTS	Community-Led Total Sanitation
CPR	Centre for Policy Research
HH	Households
KHIS	Kenya Health Information System
MDG	Millenium Development Goal
MoH	Ministry of Health
MOWS	Ministry of Water Supply
OD	Open defecation
ODF	Open Defecation Free
SDGs	Sustainable Development Goals
TTM	Trans-Theoretical Model
UN	United Nations
UNICEF	United Child Education Fund
WCAR	Western & Central African Region.
WHO	World Health Organization
WTP	Willingness to Pay
CHV	Community Health Volunteer
GDP	Gross Domestic Product
SCT	Social Cognitive Theory
JMP	Joint Monitoring
NACOSTI	National Commission for Science Technology Innovation

OPERATIONAL DEFINITION OF TERMS

Certification - This is the official confirmation and recognition of ODF status.

CLTS This is a comprehensive approach to achieving and maintaining open defecation-free (ODF) status. This involves facilitating community analysis of their hygiene status, defecation habits, and consequences, leading to collective action as ODF.

Open defecation -According to this study, "open defecation" refers to defecation in the open air, which exposes feces to the outside world.

Open defecation-free -According to the study, open defecation-free means a household has a pit latrine providing privacy, no human feces in the compound, an aperture cover, and the presence of a hand washing facility with running water and soap.

Validation –The ability of the research tool to collect the desired data or information

Predictors -Circumstances that contribute to a result (oxford Dictionary).

Predictors influencing -Those variables that can affect some of a target object as control variables that determine key influencers.

Sustainability -Ability to maintain the non-negotiable indicators in the CLTS protocols, such as the presence of pit latrine, privacy, hand washing facility with running water and soap, squatting lid/aperture cover, and absence of open defecation sites in the households or village.

Resurgence – Variables increasing the process of sustaining ODF status after certification of villages,

Adult residents- This study defines adult resident as any person found in the household during the time of survey who is head of the household or any person above 18 years and has been in the household for the last two years and mandated to provide livelihood for the house hold.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter presents the background of the study, the problem statement, the study's justification, the study's objectives, the study's justification, the study's scope, and the study's constraints and exemptions.

1.1 Background of the study

This study defined open defecation as lack of sanitary facility, absence of squarting lid, in adequate privacy in provided sanitary facility, human faeces found in the compound and lack of hanwashing facility with running water and soap in a house hold. Reduced soil worms, cholera, diarrhea, trachoma, and malnutrition are some public health advantages associated with increased sanitation access (Pickering *et al.,* 2019). Other benefits include savings from reduced healthcare costs (Van and Nguyen-Viet, 2011) and non-health benefits of time savings (Geere and Hunter, 2020) that would otherwise be patients queue to use shared facilities or seek privacy. Despite its well-known advantages, effective excreta disposal remains a challenge, particularly in attaining universal coverage of the dispersed rural populations that characterize most people in middle- and low- income countries (Dickson *et al.,* 2016).

Worldwide, 2.4 billion inhabitants have limited access to better sanitation, thus posing a challenge to sustaining open defecation-free status in villages (WHO, 2019). Eliminating open defecation and providing safe, affordable, and accessible sanitation for everyone everywhere are central tenets of Sustainable Development goal 6 (SDG 6) (Assembly General of the United Nations, 2015).

Studies have indicated that open defecation fell by 9% globally, from 1.3 billion to 670 million, and open defecation fell by 55% in India, from 767 million to 344 million (WHO, UNICEF, 2017). Open defecation rates in sub-Saharan Africa have increased by 13% .8%, from 16 million to 220 million (UNICEF, 2019).

Despite decades of public investment in increasing toilet coverage, open defecation remains widespread in rural areas (Adhikari *et al.,* 2020). Research shows that adding latrines is not enough to reduce fecal-oral disease, but non-negotiable indicators such as toilet privacy, aperture covers, facilities where one can use soap and water to wash their hands, and the absence of defecation sites are paramount. (Abebe *et al.,* 2020).

In Kenya, the estimated open defecation rate is 14%. (Ministry of Health, 2017). Some counties, such as Turkana, Wajir, and Samburu, have open defecation rates exceeding 70% (Ministry of Health, 2017). Kenya's health policy expects the country to achieve and maintain ODF by 2030. According to WHO (2014) and Njuguna (2019), 49.6% of poor Kenyan households defecate in the open. Increasing the efficiency of health care programs in rural areas is crucial to meeting SDG 6 (Stuart *et al.,* 2021). The most comprehensive and effective intervention is community-led total sanitation. However, research shows that community-led total sanitation does not work equally and effectively everywhere, thus necessitating a study on the predictors of resurgence and sustainability of open defecation-free status (Ofumbi, 2020).

There are 3643 villages in Makueni County, and 860 out of 3643 villages in Makueni County are open-defecation-free. Most of the open-defecation-free villages (488) are located in Kibwezi East Sub-County; this makes it a prime location for a study on the predictors influencing resurgence and sustainability of open defecation free.

1.2 Statement of the Problem

Over 5.6 million people in Kenya defecate and urinate in the open (Njuguna & Muruka, 2017). Kenya loses over $324 million a year due to poor sanitation (WB-WSP, 2012). About 28% of villages (1025 out of 3643) in Makueni County have been triggered, while only 24% of villages (860 out of 3643) have been designated open defecation-free (CLTS Hub, 2022). Open defecation in Kibwezi East before 2015 was rampant and only and 45% of the house holds had sanitary facilities based on house hold mapping data carried out before initiation of community led total sanitation activities carried out by Department of Health. Child mortality from fecal-oral illnesses like diarrhea in Kenya is linked to open defecation (CLTS Hub, 2022). Millions of people still lack access to adequate sanitation, with only 29% of Kenyans having improved sanitation (CLTS Hub, 2022). Kibwezi East sub-county has the highest number of ODF-certified villages in Makueni County, with 488 villages. After applying the CLTS model in 2015, careful monitoring of open defecation-free villages in Makueni County showed a variance in fecal-oral disease prevalence, ranging from 18% in 2018 to 38% in 2021 (KHIS, 2021).

Table 1.1 Trend of diarrhea-related cases for under 5s and above 5s in Makueni County

	Year	Cases	Percentage
Diarrhoeal Related Disease Burden	2018	7040	18
	2019	9629	25
	2020	7460	19
	2021	14527	38

Source: KHIS, (2021)

The above prevalence of fecal-oral diseases has worried the health department, provoking a team of CHVs and public health officers to follow up on village sanitation in certified open defecation-

free villages. Routine village sanitation follow-up by CHVS and public health officers showed that 48% of certified villages (235 out of 488) had reverted to an open defecation state, necessitating research on the predictors influencing the resurgence and sustainability of Open Defecation Free Status among adult residents in Kibwezi East sub-county, Makueni County.

1.3 Study justification

A total of 15 counties (Garissa, Baringo, Isiolo, Kajiado, Kilifi, Kwale, Mandera, Samburu, Marsabit, Narok, Tana River, Homa Bay, Turkana, Wajir, and Pokot) account for about 85% of all cases of open defecation in Kenya (KPHC, 2019). Even though the Kenyan Constitution 2010 guarantees all Kenyans the right to a reasonable standard of a clean and sanitary environment, Preventable diarrhea is unacceptably high (KHIS, 2021). Since 2015, Kibwezi East Sub-County has been carrying out community-led total sanitation (CLTS) activities. Four hundred eighty-eight (488) villages out of 603 are certified open defecation-free.

The open defecation reverting rate in villages in the county is high (48%), which is higher than the ODF reverting rate in Busia (10%) and Siaya counties (12.5%) (UNICEF, 2015) and 32% in Kitui County (UNICEF, 2021). Conversely, the surge of fecal-oral diseases from 2018 to 2021 could be

attributed to high reversion rate of ODF villages to OD. Therefore, the high rate of reversion to OD status in the Kibwezi East sub-county, Makueni County, calls for a study on the predictors influencing the resurgence and sustainability of ODF status.

1.4 Research Objectives

The broad objective of the study was to establish predictors of the resurgence and sustainability of an open defecation-free status among the residents in the Kibwezi East sub county, Kenya.

1.4.1Specific objectives

1. To determine how Socio-demographic characteristics influencing resurgence and sustainability of ODF status in Kibwezi East, Makueni, Kenya.
2. To establish individual characteristics influencing the resurgence and sustainability of an open defecation-free status among residents in Kibwezi East Sub-County, Makueni, Kenya.
3. To ascertain how infrastructural factors influence the resurgence and sustainability of open defecation-free status among residents in the Kibwezi East sub-county, Makueni, Kenya.
4. To evaluate the available interventions influencing the resurgence and sustainability of open defecation-free status among residents in the Kibwezi East sub-county, Makueni, Kenya

1.5: Research Questions

1. What are the socio-demographic characteristics of respondents influencing the resurgence and sustainability of open defecation-free status in the Kibwezi East sub-county, Makueni, Kenya?
2. What individual characteristics influencing the resurgence and sustainability of an open defecation-free status among residents in Kibwezi East Sub-County, Makueni, Kenya?
3. What infrastructural factors influencing the resurgence and sustainability of open defecation-free status among residents in the Kibwezi East sub-county, Makueni, Kenya?
4. What are the available interventions influencing the resurgence and sustainability of an open defecation-free status among residents of Kibwezi East sub-county, Makueni, Kenya?

1.6 The importance of the research

1.6.1 To the Governments of Kenya

The policymakers would use these results at national and county levels to plan and implement CLTS programs through an informed point of view on the predictors contributing to the long-term success of eliminating open defecation. Based on the research findings, the Kenyan government could review and modify the strategy to sustain the country's ODF status and provide stakeholders with key information on the possible resurgence and sustainability measures for ODF status. The Ministry of Health would also use the research findings to develop actionable policies to help community members in rural areas maintain ODF status and continue climbing the health sanitation ladder.

1.6.2 To the Community

The community is likely to benefit from research findings by identifying gaps in current software (knowledge and practice) and hardware (pit latrines and hand washing facilities) that can be applied for sanitation facilitation and advocate for social behavior change communication training. The important information generated by this study would help improve household sanitation infrastructures in the Kibwezi East sub-county of Makueni County, Kenya. This research would set the stage for keeping the study region ODF, reducing the high reverting rate to OD, and reducing fecal-oral disease. Reduced fecal-oral diseases will save time wasted while seeking medical attention, money used for treatment, thus improving their economic status.

1.6.3 To the researchers

Local, regional, and international researchers can use the findings to conduct further research and compare the results to develop uniform strategies for formulating WASH programs. The report would form a consultative and informative database for the county. Other researchers can use

recommendations from this research to carry out other research on identified gaps and form a solution to ODF sustainability.

1.6.4 To the development partners and other stakeholders

All those involved in funding, monitoring, and implementing open defecation-free programs would greatly benefit from these study findings by implementing WASH programs from an informed point of view on the exact areas requiring action support.

1.7. Scope of the research

1.7.1 Geographical scope

This study was conducted in Kibwezi East Sub-County, Makueni County, Kenya

1.7.2 Content scope

The study aimed to identify the predictors of the resurgence and sustainability of an open defecation-free status among adult residents in Kibwezi East, Makueni County. The researcher had focused on the following objectives: respondents' socio-demographic characteristics, individual characteristics, infrastructural factors and available interventions influencing resurgence and sustainability of open defecation free status among adult residents of Kibwezi East.

1.7.3 Time scope

From January 2023 through August 2023, the researcher, with permission from Mount Kenya University's Ethical Review Committee, NACOSTI, and the Makueni County Health Department in Kenya, collected data in the Kibwezi East sub-county, Makueni, Kenya.

1.7.4 Conceptual scope

The study used the researchers' conceptual framework to investigate the predictors influencing the resurgence and sustainability of an open defecation-free status among adult residents of Kibwezi East Sub-County, Makueni County, Kenya.

1.8.0 Constraints and exemptions in the research

1.8.1 Limitation

A long distance from sampled village and household to another was a challenge. Insufficient resources affected research, but a budget was prepared to seek research funding. Biasness in quantitative data collection but an observation checklist was used to compare and counteract biases in response. Money demands from study subjects but the study respondents where explained the study was only for learning purposes and they were free to participate or not to participate on voluntary basis.

1.8.2 Delimitation

This study focused on adult residents of the Kibwezi East sub-county. In addition, the study also looked at socio-demographic characteristics, individual and infrastructural factors and available interventions related to the resurgence and sustainability of ODF status. The study could be replicated to other sub-counties within Makueni County to allow generalizability of the results.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The conceptual framework and its summary are presented here. Also included are reviews of the relevant literature (both theoretical and empirical) and previous research.

2.1.0 Theoretical literature review

2.1.1 Health Believe Model

According to the health belief model developed by American social psychologists in the 1950s, several factors influence preventive measures (Sajjad *et al.*, 2016). These include individuals' perceptions of their susceptibility to health problems, the severity of medical conditions, the benefits and costs of participating in prevention activities, and whether they receive triggers to act.

In recent years, the principle of self-efficacy has been incorporated into the paradigm. One's confidence in their ability to accomplish a task is known as self-efficacy. The model can formally predict how community attitudes and knowledge affect the resurgence and sustainability of ODF status. Sometimes, community members may be less concerned about contracting fecal-oral disease (i.e., low perceived susceptibility). Additionally, community members can learn about the complications of fecal-oral infections, including dysentery, typhoid, and even death.

Community activities, such as handwashing with soap and water, are correlated with fewer cases of fecal-oral disease (benefits), more accurate estimates of the costs of interventions (costs), and more educated feelings of willingness and efficacy (costs), as described by the health model. Researchers can use the information to tailor content and instructional techniques to tailor components related to expected behavioral outcomes.

In this context, the researchers recommend improving the beliefs of community members about their vulnerability to fecal-oral infection while strengthening their prevention capacity. Health education methodologies and approaches for such interventions are widely available. In such cases, the direct engagement of community members with health professionals, for example, through the media and group discussions, can address the vulnerability.

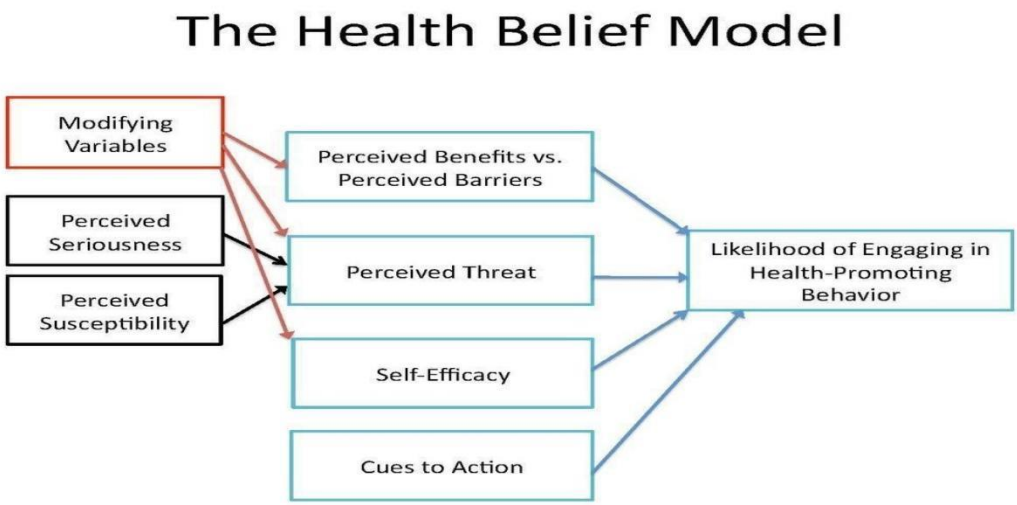

Figure 2.1: Health Believe Model

(Source: Source Sajjad *et al.*, 2016)

2.1.2 Social Cognitive Theory (SCT)

According to social cognitive theory (SCT), which has applications in psychology, teaching, and communication, people model their knowledge representations after those they observe in everyday social interactions, experiences, and media exposure. Albert Bandura popularized this idea as a development of his theory of social learning (Bandura, 2008).

According to this idea, people recall the order of events and use this knowledge to direct their behavior after witnessing healthy behavior patterns in action and the results of that behavior. Viewers adopt behaviors that they have already learned. In other words, people do not discover new behaviors simply by trying, succeeding, or failing. Instead, human survival depends on reproduction and other behaviors. Viewers may replicate similar behaviors if people are rewarded or punished for their acts and the results of those actions (Bandura *et al.*, 1989).

Many people's role models come from the media, and these role models come from a wide range of settings. The premise of the socio-cognitive theory is that students pick up new skills by seeing how their peers act. This acquired trait often forms an essential part of a person's identity. Social psychologists generally agree that a person's upbringing significantly impacts adult behavior.

Learning occurs through exposure to and imitation of others. Environment, actions, and thoughts primarily form ternary connections. Each observed behavior could change the way a person thinks (cognition). Likewise, the environment in which you grow up affects your later behaviour. For example, a caregiver's mindset (understanding) determines the environment in which a child grows up (Bandura, 2011).

2.1.3 The Trans-Theoretical Model (Stages of Change)

In the late 1970s, Prochaska and DiClemente conducted a study comparing the outcomes of regular smokers with those of smokers who need more help; this study resulted in the creation of the Trans theoretical model, often known as the phases of modification model. According to DiClemente et al., these studies sought to understand why some smokers successfully quit smoking on their own.

When people were ready to quit, they decided to do so. Hence, the Trans theoretical Model (TTM) is a model of deliberate action because it centers on the decisions of an individual. TTM operates

because people cannot make abrupt and permanent behavioral changes. Instead, shifts in behavior, especially profoundly ingrained ones, occur in a continual, cyclical process. TTM is a model, not a theory; DiClemente et al. (1970) can apply different behavioural theories and structures to the stages of the model where they are most effective. This theory can be applied to this study because attainment and sustainability of open defecation free status is not a one day event but a process which commences from pre triggering, triggering, follow up, verification, certification, celebration and post ODF activities leading to behavior change.

The Trans-theoretical Model (TTM) proposes that people go through six stages—contemplation, preparation, action, termination, and maintenance, as they work to change their lives. In the phase of changing one's behavior regarding one's health, dismissal is rarely used because it was not included in the original concept. According to the model, DiClemente et al. found that different intervention tactics were most effective for bringing people from one set of changes to the next and keeping them at the optimal behavioral stage (1970).

Stage 1: Foresight: People have no plans to take action anytime soon (within the next six months). Individuals frequently fail to see the harmful effects of their actions. Do people not realize the consequences of their actions? At this point, people are more likely to exaggerate the negative impacts of changing their behaviour than the positive ones.

Stage 2: Contemplation: The individual has plans to adopt more healthful routines from now on (defined as within the next six months). A greater emphasis is placed on the merits and drawbacks of changing one's conduct after realizing that one's actions may be causing problems. People may still have mixed feelings about altering their behavior despite this knowledge.

Stage 3: Preparation (Determination): In the following 30 days, people will take action. Little changes in behavior are made because people hope that a healthier lifestyle will result.

Step 4: Action: The individual has made a recent (within the previous six months) behavioral modification and plans to maintain it. Individuals might show they have achieved this by eliminating harmful habits and replacing them with more positive ones.

Stage 5: Maintenance: People maintain their behavior change over a long period (defined as more than six months) and want to continue to do so in the future. Participants in this stage work hard to prevent relapses into earlier stages.

Stage 6: Termination: The individual has lost interest in engaging in the harmful activity and is convinced they will not revert. This is rarely accomplished, and people typically remain in the maintenance phase, which is usually ignored by health promotion efforts.

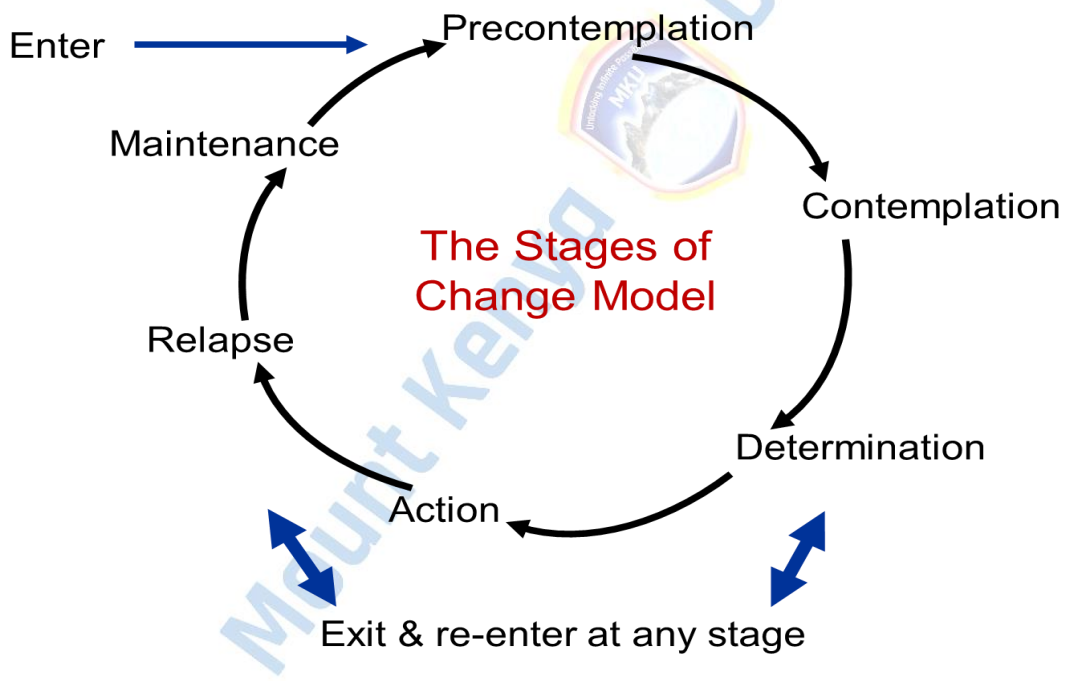

Figure 2.2: The Trans-Theoritical Model

Source: Prochaska and DiClemente in the late, (1970).

People use affective, cognitive, and evaluative processes to drive the stages of change. There are ten distinct revolution cycles, with some more applicable to certain transitional phases than others.

Because of going through these steps, people can create plans to implement and maintain their desired changes.

i). Consciousness Raising: Educating the public on the importance of healthy habits.

ii). Dramatic Relief: Feelings of excitement or anxiety associated with healthy behaviour.

iii). Self-Reevaluation: Introspection leads one to accept that positive actions are consistent with one's ideal self.

iv). Environmental reassessment: Social reassessment to understand how their unhealthy behavior affects others.

v). Social Liberation: Environmental opportunities to demonstrate social support for healthy behaviors.

vi). Self-liberation: Belief that positive changes in behavior are achievable motivates people to take action.

vii). Helping Relationships: Create bonds of mutual support that will propel you to make positive changes.

Viii). Counter-conditioning replaces Unhealthy behaviors and thoughts with healthy behaviors.

ix). Reinforce management: Reward positive behaviors and reduce rewards for negative behaviors.

x). Stimuli Control: Environments should reinforce healthy habits and discourage less desirable ones.

Based on review of the theoretical literature, the researchers used the Trans theoretical model (phases of change) proposed by Prochaska and Diclement in the late 1970s.

This theoretical model was used extensively in this study as it explains the process of behavioural change appropriate for predictors influencing the resurgence and sustainability of open defecation-free status among adult residents of the Kibwezi East sub county (Diclemente *et al*., 1970).

2.2.0 Empirical Literature Review

2.2.1 Global overview of open defecation

More than 2.4 billion individuals nationally lack access to basic sanitation, and nearly 15% practice open defecation (WHO, 2019). Open defecation is associated with various medical problems and disease burdens, such as diarrheal diseases, gastrointestinal diseases, and soil-borne parasitic diseases in children below five years old (Wolf *et al.,* 2018).

Evident from data gathered in a World Health Organization/United Nations International Children's Fund Joint Monitoring Program report, some 494 million people around the globe continue to perpetuate the open defecation behavior. However, achieving an ODF status should not be the sole improvement end result. Often, CLTS is the means to such advances. Sadly, especially vulnerable households will revert to ODF when they lack the financial means to maintain sustainable toilets after the breakdown of the existing ones (Mitabel et al. (2022).

Objectively, the purpose of this aimed at analyzing and determining the effectiveness of sanitation subsidizing enabling poor people to access the sewerage service. As a case in point, between October 2012-September 2013 an impact evaluation trial was conducted among 109 post-ODF communities in the northern region of Ghana using a pro-poor subsidy approach. This program initiated after assessment of the most extreme houses and provided them with water tight toilet support construction using vouchers. For this purpose, a survey was conducted to assess toilet quality, coverage and usage before and after the process implementation. The project expenditures and costs were recorded in detail properly (Delaire, 2022).The results showed that the overall

sanitation conditions deteriorated substantially from baseline to end line. In additional, controlled communities (not receiving the pro-poor subsidy), open defecation increased from 25% (baseline) to 69% (end line), open defecation increased from 25% to only 54% in subsidy communities, with great impacts among voucher-eligible households.

The research also showed that families who do not have access to readable toilets within the subsidized houses denoted instances of open defecation or they upgraded themselves to make use of durable ones within their houses (Peletz, 2022).

Furthermore, Sudden deterioration of the sanitation facilities is the most common case and this particular condition may appear due to a lack of infrastructure maintenance or if the CLTS strategy only is used as the sole solution. It can be inferred that without any particular policy targeting these households then these units are likely to continue to be financially out of their access for those not with clear eligibility (Agyei, 2022).

Due to open defecation, around 1.8 billion people worldwide drink heavily polluted drinking water from rivers, dams, and shallow wells, and about 361,000 children under five die from sanitation-related deaths (Harter *et al.,* 2020). The practice of open defecation has decreased significantly, but the world has still not reached its goal of eliminating open defecation by 2030. (Com, 2019). Between 2000 and 2015, an estimated three hundred thirty-seven million people, ceased practicing open defecation (WHO, 2019). Yet, if OD is to be eradicated by 2030, at least 60 million people will need to give up the practice annually from 2015 to 2030, doubling the present figure of 1.3 million (UNICEF, 2018).

A report by Water Aid said that despite the Indian government's efforts under the Swachh Bharat mission to eradicate open defecation, there were still about 522 million people in India in 2014 who lacked access to even the most basic forms of sanitation. Many factors, including poverty

and government corruption, played a role (Behera *et al.*, 2022). According to the World Bank (2017), more than 300 million Indians were still defecating in the open.

According to a research by Water Aid 2017, 79 million individuals in Pakistan lacked access to safe toilet facilities. UNICEF estimated that in 2018, 10% of Pakistan's population, or 22 million individuals, used the open defecation. In 2020, 7 percent of Pakistan's population, or 15 million people, used open defecation, according to a recent estimate by UNICEF (UNICEF, 2020). There were 28,084 public open defecation reports in San Francisco by 2018, a fivefold increase. This rise is mainly attributable to the city's growing homeless population (Joyce, 2022).

2.2.2 Indian open defecation-free state.

According to a report by the World Bank (2017), more than 300 million Indians still practiced open defecation. While toilet construction had increased in India, water scarcity, poor maintenance, and slow behaviour change prevented ending of open defecation. Between 2014 and 2018, researchers at the Research Institute for Compassionate Economics (RICE) polled 3,235 residents across four states in northern India. Their study, published in January this year, found that since the launch of a Clean India slogan, defecation outdoors decreased by 26%, and household toilet use increased from 37% in 2014 to 71% in 2018 (RICE, 2018).

A girl carries water jars, crosses track and railroads, and defecates in the open field in Mumbai [File: RajanishKakade, (2017).

Nevertheless, the study showed that even in the ODF states of Rajasthan and Madhya Pradesh, 23% of the population used public toilets. “In our research, we saw people defecating in ODF-declared villages (Khalid *et al.*, 2019)

CPR researchers found that building toilets was often done through coercion, with people telling themselves they would lose benefits under various government programs if they did not build a toilet. According to AvaniKapur of the Center for Policy Research (CPR), India is still OD, Challenges remained to be sustainable toilet technology, cleaning, and safe waste disposal (Kapur *et al.*, 2019).

The Bill & Melinda Gates Foundation honored Indian Prime Minister Narendra Modi in September 2019 for his efforts to better the country's sanitation systems. The number of people

worldwide without access to a toilet has decreased from 550 million to 50 million, according to a report by UNICEF (2019).

India was officially declared “open defecation free" by Modi in October 2019. However, experts have reacted skeptically to the statement, citing slow behavioural change, maintenance concerns, and water access issues as continuing barriers to India's development.

World Bank says the country has eliminated open defecation (2019). There is still some incidence of open defecation, although it is far lower than it was. Modi launched the Swachh Bharat Mission's second phase from 2020–2025. In the next stage, the government aims to end open defecation and improve trash-sorting (report from the World Bank, 2020).

2.2.3 Open Defecation in Pakistan

An estimated 79 million people in Pakistan do not have access to a safe toilet (Water Help 2017). UNICEF estimated that in 2018, 10% of Pakistani citizens, or 22 million individuals, defecated in the open. In 2020, 7 percent of Pakistan's population, or 15 million people, used open defecation, according to a recent estimate by UNICEF (UNICEF, 2020).

Open defecation is closely related to poverty and marginalization in rural areas and in informal urban settlements in developing countries. UNICEF and WHO’s Joint Monitoring Program collect data on the global prevalence of open defecation for Water Supply and Sanitation (JMP/UN/UNICE, 2019).

The data is broken down further by rural/urban status and poverty rate. The initiative monitors how far we have achieved the MDGs for safe drinking water and proper sanitation. Each country's example of poor sanitation is open defecation, which is why the Joint Monitoring Program (JMP) tracks and reports on the issue (United Nations, 2019). Poor sanitation conditions monitor each country's JMP and the findings are published regularly (UN, 2019). Since 2010 it was first

recorded, data on open defecation have been collected independently from other statistics on unimproved sanitation. Around 673 million people in Pakistan engage in open defecation, as reported by JMP (2019).

From 2000 to 2015, the percentage of persons who relied on open defecation dropped from 20% to 12%. In 2016, almost 892 million individuals didn't have access to proper sanitation; thus, they had to defecate in unsanitary locations like gutters, behind bushes, or even open water (UNICEF 2020). Nine out of ten people, who relieve themselves in an open area, do it in rural areas, yet the vast majority of those people are concentrated in only two places (Central Asia and South Asia). In 2016, 76% (678 million) of the world's 892 million people practiced open defecation in only seven countries.

Table 2.1 Countries with large numbers of people who openly defecate, WHO and UNICEF report (2017)

S/NO	COUNTRY	TOTAL POPULATION	% OF OPEN DEFECATION
1	CAMBODIA	16,949,415	17% or 2.8 million (2021)
2	CHAD	16,244,513	69% or 11 million (2018)
3	CHINA	1,411,778,724	<0.4% or ~ 5 million (2020)
4	ERITREA	5,228,000	76% or 4 million (2017)
5	ETHIOPIA	117,876,227	18% or 20.1 million (2020)
6	INDIA	1,352,642,280	<2% or 50 million
7	INDONESIA	270,203,917	9% or 25 million (2020)
8	NEPAL	28,095,714	<1 or 2.8 million (2019
9	NIGER	24,112,753	68% or 14 million (2017)
10	NIGERIA	211,400,708	24% or 48 million (2021)
11	PAKISTAN	225,199,937	7% or 15 million (2020)
12	PHILIPPINES	106,651,394	4% or 4 million (2020)
13	SOUTH SUDAN	12,778,250	63% or 6 million (2019)
14	SUDAN	44,909,353	27% or 11 million (2017)
15	VIETNAM	96,208,984	4% or 3.7 million (2017)

SOURCE: WHO and UNICEF report (2017)

2.2.4 Open defecation free in the United States

With an ever-increasing homeless population, the number of documented occurrences of public urination and feces has skyrocketed in San Francisco, California, from 2,808 in 2011 to 28,084 in 2018. Similar problems were observed in Los Angeles and Miami. An unnamed female jogger in the United States in the summer of 2017 earned the nickname "Crazy Pooper" for her habit of defecating in public—Colorado Springs, Colorado (Runner's World, 2017).

2.2.4 Open Defecation in Africa

Some 215 million individuals in sub-Saharan Africa still relieve themselves in exposed areas. In children younger than five years, however, an increase in the prevalence of diarrheal disorders is the leading cause of death young children (Com, 2019). Despite the high cost of poor sanitation, most African countries invest less than 0.1 percent of their GDP in sanitation. The World Bank found that five of the eighteen African countries surveyed spent nothing in sanitation.

Sanitation costs account for 1% - 0.5% of the country's GDP. In Rwanda, Third African Conference on Sanitation and Hygiene in 2011, African countries pledged to boost budgetary spending for sanitation to 0.5% of their GDP. However, no African country has yet reached this goal (WSP et al., 2011).

According to recently published figures, 122 million people in WCAR had defecated in the open in 2015. This number has increased by 34 million since 2000, as progress toward ending OD has not been enough to explain the increasing population. WCAR accounts for 14% of global OD, and eight countries have over 5 million people defecating openly, Nigeria is ranked second in the world with 47 million people defecating openly. Moreover, in 12 of the 24 countries in the region, more than 20% of the population is engaged in OD (UNICEF, 2020). Geographic and wealth inequalities persist, with nearly 85% people doing open defecations living in rural areas. At the

same time, the poorest quintile is nine times more likely to defecate in the open than the wealthiest quintile (WHO/UNICEF JMP, 2017).

Recent studies find that CLTS has been a straw that was broken in the back of the camel in the grassroots effort to get rural areas in the low-income countries out of open defecation. The basic issue of this type of approach is that a community would be open defecation free once the majority of families within the community meet the designated sanitation coverage criteria set in nationally issued directives for example, 80% in Ghana. Though CLTS is commendable, this may be only for the short term as there is no continuous monitoring and evaluation of the sanitation conditions after the ODF declaration hence the sustainability of the initiative has been a puzzle (Peletz, 2022). The Study of the sustainability of 109 rural communities of northern Ghana of toilet utilization and ownership following the community attainment of ODF status.

The results indicated that about 75% of the communities in question were not comparable with the parameters of Ghana according to the set regulation. The situation was rather severe, one-third of the households having never had (16%) or having ceased to practice (24%) open defecation while still 25% of them defecate into open spaces, a research showed. Undoubtedly, the major cause of slipping back in defecation openness was the destruction of toilet pits and the superstructures.

The study findings suggested that interventions that address rebuilding collapsed toilets, especially among the most vulnerable and poorest households, improved the longevity of CLTS-driven Open defecation-free and sanitation sustainability in rural Ghana (Prince Antwi Agyei 2022). Additional interventions are needed to address toilet collapse and the difficulty of rebuilding, especially among the most vulnerable and poorest households. Statistics indicate that in the absence of post-ODF interventions, toilet use and coverage decline by approximately 12%

annually. This research concludes that, Post-ODF interventions should thus start as early as in first year after ODF achievement to prevent large reversions (Stuat et al., 2022). I recommend that future research must include evaluations of strategies for increasing the durability of toilets across all wealth categories. Interventions that promote internal support (For instance, members of the same community helping their more vulnerable neighbors) might greatly help sustain toilet coverage and use over time. Again, developing markets for high-quality, durable toilets is another promising approach, especially with financial solutions (targeted subsidies, loans) to make materials and products affordable to all. (Caroline Delaire et al, 2022)

Another study conducted in Burkina Faso, which is a mixture of the author's investigation and literature review, offered a deep sight into the factors affecting the sustainability of the ODF status from which the setback usually arises within the communities. The research identified five main categories of factors: i. organizational, ii. technological, iii. behavioral, iv. social, and v. socio-political factors. The authors recommend incorporating all stages of the sanitation value chain (SVC) into Community-Led Total Sanitation (CLTS), developing sanitation marketing strategies, planning thorough follow-up activities post-ODF achievement, and reinforcing sanctions against open defecation practices to maintain community status. It is underlined that the donors and governments should give the top priority on the diverse tools like research on sustainable and pro-poor sanitation technologies, raising awareness, monitoring annually post-ODF certification and strengthening the capacity of operators, (including facilitators) from beginning to end (Hemez Ange AurelienKouassi *et al*., Int J Hyg Environ Health., 2023).

In West and Central Africa, UNICEF aims to implement multiple integrated strategies to accelerate progress towards changing the process of open defecation. Over the next four years (2018- 2022), the focus will be on supporting countries by Aligning their local health policies,

strategies, roadmaps, and action plans with new SDG areas and Pan-African commitments (UNICEF, 2017).

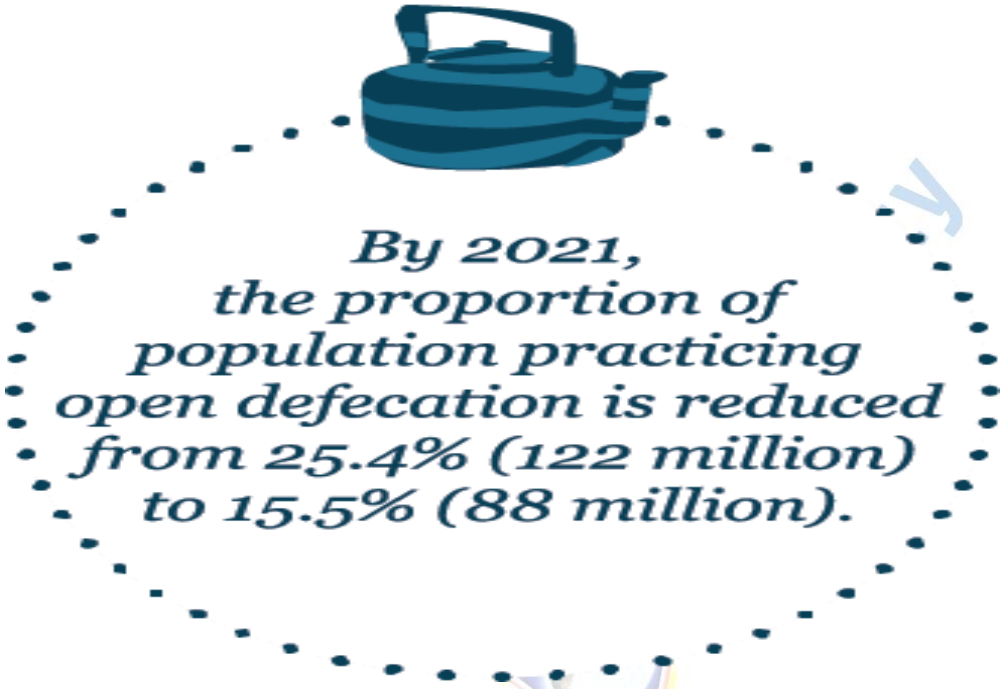

Figure 2.3: UNICEF 2015-2021 Strategies to reduce open defecation I WACAR.

(Source: UNICEF Report, (2017).

As shown in the figure, UNICEF generates and use evidence to advocate for policy prioritization in rural areas, peri-urban and urban health centers and the adoption of best health practices, plans, and budgets (JMP, 2018).

Population growth and a drop in certified open defecation (ODF) among people in communities that do not otherwise qualify as ODF-free are to blame for the rise in open defecation in sub-Saharan Africa. Surveys confirm the annual ODF decline rate across Africa is between 10 and 13 percent. Here, researchers define ODF slippage in terms of suboptimal toilet use and open defecation change (Tyndale *et al.*, 2023)

Public health has been a priority in Ethiopia since the constitution was amended to include it in 1995. As a result, in 2005 and 2006, the Ministry of Health formulated the National Sanitation and Sanitation Strategy, National Sanitation and Sanitation Protocol for use in the field (UNICEF, 2018).

According to the Ethiopian Demographic Health Survey, the percentage of Ethiopians practicing defecation in exposed areas decreased from 81.9% in 2000 to 61.9% in 2005, to 38.3% in 2011, and to 32.9% in 2016. Ethiopia has not reached the Sustainable Development Goals (SDGs) because 35.6% of the population still relies on open defecation, and 50% of the population still uses outdated sanitation (Leshargie *et al*.., 2019). A study in Zambia showed that about 40 children die daily due to a lack of sanitation and clean water, and 40% suffer from stunting, mainly due to fecal-oral-related diseases. Adverse effects disproportionately affect Zambian women and girls, who face additional safety risks when defecating or attempting to go to distant toilets (World Bank, 2012).

Economically, according to a study by the Water Supply and Sanitation Project (World Bank, 2012), Zambia loses ZW946 billion yearly due to deprived sanitation and the return of the country's population to open defecation.

2.2.6 Open defecation-free status in East Africa

In a multi-county study about ODF sustainability in four African countries, including Uganda, criteria for household-level ODF status certification was agreed upon. This required a household to have No human feces in the vicinity, a latrine cover (or water seal), a hand washing facility with water and soap, and evidence of the presence of a latrine and hand washing facility with soap and water (Ntaro *et al*, 2022).

Researchers in this study established that 8% of households with a functioning Latrine had visible signs of feces around the house. Households with latrines having handwashing facilities with water and soap were 25%, and only 19% had drop hole covers. Looking at the five non-negotiable ODF indicators across the study was only 8%. (BMC Health, 2022).

Open defecation is practiced in many countries like Rwanda, Burundi, Tanzania, Uganda, and South Sudan but is poorly documented in East Africa. In these countries, infectious diarrhea killed an estimated 700,000 children under five years and lost 50 million school days in 2011 (WHO/UNICEF, 2020).

This practice has serious consequences for malnutrition and stunting in children. Open defecation is the leading cause of death from diarrhea. According to (UNICEF, 2019), over two thousand (2,000) children under five die from diarrhea every day, every 40 seconds.

Statistics on the health of Tanzanian children under five years suggest that 7% die from diarrheal infections. Cleaner water and better toilets can help save lives. Approximately a quarter of the sub-Saharan African population lacks access to basic sanitation, and progress toward the MDGs sanitation targets has been modest. About 35% of households in rural parts of sub-Saharan Africa (compared to 8% of homes in metropolitan areas) report defecating in the open, or OD (UNICEF, 2022).

Tanzania has a high incidence of rural exodus (4.7%/year in 2010), yet most of the population (74%) still resides in rural regions where they are forced to defecate in the open. The number of people in Tanzania climbed from 25.4 million in 1990 to over 45 million in 2010; during this time, the percentage of the workforce engaged in OD rose from 8 to 12 percent. While the rate of OD in Tanzania's cities stayed at 2% from 1990-2010, it rose from 10% in the countryside to 16%. (UNICEF, 2020). In 2010, around 5.3 million people in rural areas participated OD.

The OD trend is surprising given that Tanzania is the estimated fifth-greatest receiver of international funding for WASH. The latest Demographic and Health Survey of Tanzanian data estimations have shown that OD incidence and trends vary considerably amongst rural regions of the country (WHO, UNICEF 2020). OD is most often practiced in the north-central part and the islands that make up Zanzibar. Half of Tanzania saw an increase in OD from 2004 to 2010, while most areas where OD prevalence was reduced saw only modest gains, with a <10% reduction in the prevalence of the DAL. In seven of the country's 26 districts, at least 30% of the population practiced OD in 2010 (Tanzania Demographic and Health Survey, 2018). Nearly everyone in Warrap State, South Sudan (located in the country's central-north), practices OD. The diarrhea epidemic, especially dangerous for small children, can be directly attributed to this occurrence (World Bank, 2020).

Today's ATPC exhibition was held at Adiam, a community in War Rap State situated on the Jur River. Taking up their walking sticks, the elders gathered beneath the tree adjacent to the chief's dwelling while the women left the cabin and the children stopped playing in the river. In the coming hours, the group will try to rally the citizens and take the helm in this transition. Evidence links sanitation and hygiene practices to economic position, according to studies (e.g., social status, income, education, occupation, etc.) and the practice of open defecation open air (Nunbogu, Harter, and Mosler, 2019) (Yimam, Gelaye and Chercos, 2014).

A relationship between household wealth/social status and CLTS surveys has been observed (P. J. Busienei *et al.*, 2019; Osumanu, Kosoe, &Ategeeng, 2019).

Owners of improved toilets were wealthier, more educated, and had higher literacy rates than owners of unimproved or open-defecation toilets (Nunbogu *et al.,* 2019; Ouma, Okeyo and Onyango, 2018; Yimam et al., 2014). Low-income groups do not spend more on manure removal

(Osumanu *et al*., 2019b). Low economic status strongly supports the practice of open defecation as people prioritize another more fundamental need than building toilets.

According to Osumanu and Kosoe *et al.* (2019), financial constraints pose some challenges. This prevents homeowners from building toilets for their families and makes them unable to pay the fees charged by public toilet operators. They, therefore, choose to defecate in the open.

The study also showed a significant relationship between the mother's work, the mother's level of education, the presence of secondary school students, frequency of latrine construction, latrine sanitation, and use of latrines (Nunbogu*et al.*, 2019; Yimam *et al.*, 2014) Denbia district is located in north-west Ethiopia. The research found that families with secondary school students were 3.7% more likely to have access to a toilet than those without and that households headed by literate mothers were 2.4% less likely to lack access to a toilet (Yimam *et al.*, 2014). According to another study conducted in Mozambique, the construction/reconstruction of toilets depends on several factors. Considerations such as education, soil quality, social cohesiveness, fear of diarrhea, the belief that most people in one's society have access to a toilet, and the certainty that one can fix or rebuild a damaged toilet all play a role (Mosler, Mosch, & Harter, 2018). Yet, in the end, they all raise their arms in victory. All of these emotional costs are a consequence of CLTS.

It's effective actions included mapping communities, encountering feces while walking through them, a public estimate of how many feces make OD, explaining OD's involvement in disease transmission pathways, and forming an action committee (World Bank, 2016). Following months of observation, CLTS team leader Bona declared that every home in Adiam was constructing a toilet using only locally sourced materials and no funding or equipment from ACTED. A month later, they finished building the toilets. Researchers found small grass shacks around the village

next to each family home. As a result, Adiam was declared open-defecation-free, the first South Sudanese village to do so (Bona *et al.,* 2016).

2.2.7 Open Defecation in Kenya

Kenya has not yet reached the Millennium Development Goals to improve water and sanitation since just 30% of the population has access to improved sanitation. More than 30 million Kenyans still rely on substandard toilets, and another 5.6 million go barefooted to the bathroom (Phylis *et al*., 2008, Ndungu, 2018). As a result, Kenya lags behind neighboring countries, Ethiopia and Uganda in reducing open defecation (Oketch, 2019). Kenya loses US$27 billion annually due to poor sanitation. These costs include the direct cost of poor sanitation, which results in approximately US$244 million in premature deaths from diarrhea, about US$51 million in hospitalization costs, and about US$26 million in lost time defecation (WHO, 2018). A Kenyan spend almost 2.5 days a year searching for a suitable toilet (UNICEF, 2019). There are also indirect costs associated with the practice of OD. This includes expenses related to loss of dignity and privacy. Women and girls in school are particularly at risk of violence and rape when searching OD sites, especially during late hours (Njuguna, 2019). According to the Kenyan Ministry of Health, 30% of the disease burden is fecal-oral related (MOH Kenya, 2018).

Most children under five years die from diseases that can be prevented, such as cholera, diarrhea, typhoid, and dysentery (Ministry of Health-Kenya, 2022). In May 2011, Kenya launched the Rural Kenya Open Defecation Free campaign (ODF) with community led total sanitation facilities. (CLTS) as the core strategy to become ODF by 2020 (Kenya Ministry of Health, 2017). The highest concentration of ODF declarations was in Busia, Kisumu, and Siaya counties, where 15% of villages had adopted CLTS, and 7% had declared ODF by year's end. These three counties have corresponding ODF rates of 33, 30, and 29 percent (Ministry of Health-Kenya, 2014). However,

despite many deliberate efforts, Kenya has failed to meet the Millennium Development Goal (MDG) for water and sanitation, halving the proportion of people without access to sustainable drinking water and basic sanitation by 2015 (UNDP, 2014).

Six million people still practice open defecation in Kenya (Kenya Ministry of Health, 2017; Njuguna and Muruka, 2017; WB-WSP, 2012). The CLTS approach is being tested under a new protocol in two counties in Kitui and West Asia (IDS, 2015; Kenya Ministry of Health, 2017 to establish factors related to acceptance of CLTS. The acceptance of CLTS by each community is influenced by many factors, including economic and socio-cultural factors, which must be fully understood before a health program can be successful (Osumanu, Kosoe, and Ategeeng, 2019).

Almost one-fifth of the population in Kenya uses the open defecation. Open defecation is correlated with low socioeconomic status. In Sustainable Development Goals, Kenya plans to eliminate all instances of open defecation by 2030. (John *et al*., 2019). Cholera, soil worms, and environmental enteropathy are only some diarrheal diseases that can be spread through open feces. This vice can lead to developmental delays in children (Spears *et al.,* 2013). The link between poverty and poor health is due to lack of access to clean water and sanitary facilities. People experiencing poverty can be more at risk for contracting infectious diseases. Poor people in Kenya are more likely to defecate in the open. Odagiri *et al.* (2017) found that low-income households that had successfully eliminated open defecation were more likely to revert to the practice.

The laudable reason for returning to the OD is the construction of simple, rudimentary toilets that fill quickly and are prone to collapse, such as when there is heavy rain or flooding, and the community result to defecate in the open. Research has linked socioeconomic status to the likelihood of slip and fall accidents (Muhammad *et al.,* 2017).

In Kenya, access to better sanitation is the responsibility of every household. At the same time, the government takes the lead in promoting sanitation education and fosters business sector participation. According to the KNBS (2018), 59.3% of people have access to better sanitation facilities, most use subpar toilets, and 13.9% live in rural areas with feces in the open.

Between 2009 and 2015, there was a 3% OD reduction (KDHS, 2015). Although products and technologies are available, there is still little desire for better sanitary conditions.

2.2.8 Open Defecation Makueni County

There is no provincial policy or legal framework to guide or regulate Environmental health services in Makueni County Policy documents such as the Kenya Environmental Sanitation and Sanitation Policy (KESHP) 2016-2030, the National ODF Campaign Framework (2016-2020), the Kenya School Health Plan (2018), and the Kenya Medical Waste Management Plan (2016-2021) are followed throughout the country organizational leadership for rolling out the NHS system. Although Makueni County has yet to pass or enact county-specific laws to regulate, and enforce health services, the Ministry of Health has drafted a prototype health care bill, Environmental health and county sanitation to help counties develop county-level accelerated sanitation legislation (Report on the Current State of Inclusive Sanitation in Makueni County, 2019). At the national level, primary sanitation functions in Makueni County are shared by several sectors, including Sanitation, Water, Sanitation Services and Environment, Public Works, Roads and Land, sports planning, and education sector, as well as municipal authorities, including the town and village councils, and water service providers (utilities).

Improved sanitation is not widely available in Makueni County. Over a third of the population uses modern sanitary facilities, while nearly half (46%) rely on traditional, unimproved systems, and almost a fifth (19%) rely on communal systems. About 2.4% of people defecated openly.

Inadequate funding for the community-led total sanitation (CLTS) process, particularly the verification process and village certification, has reduced the rate at which villages are declared ODF. High OD reversion rate in ODF certified villages could be attributed to lack of post ODF support.

The Department of Health's 2017 through County Health Benchmark, placed Makueni County in the bottom third among the counties in the country, ranking it at position 44. Makueni County does not have an effective solid waste disposal system despite the county's rapidly expanding urban population. Makueni County, in particular, lacks a centralized sewage treatment facility and a designated municipal dumpsite. Septic tanks and dry toilets are used as alternatives.

Septic tanks are built incorrectly, and fecal sludge is disposed of illegally since fecal sludge management services are not regulated. The county faces a severe threat of water pollution due to the ineffective handling of general solid, liquid and medical waste.

Waste managers in the health sector are exposed to health problems. Defecating openly is associated with child mortality and poor health from fecal-oral diseases, including diarrhea. Yet millions still lack access to adequate sanitation, with only 29% of residents in Makueni county having improved sanitation (CLTS Hub, 2022). Kibwezi East sub-county has the highest number of ODF-certified villages in Makueni County, with 488 villages. After the adoption of the CLTS model in 2015, careful monitoring of ODF villages in Makueni County revealed a mixed change in the prevalence of fecal-oral disease from 18% in 2018 to 38% in 2021 (KHIS, 2021)

2.2.9 Individual-related factors

Poor households now bear a more significant share of the cost of open defecation. The disadvantage stems from middle- and upper-class families being less likely to be source of open

defecation phase. More emphasis on low-income households may be necessary if Kenya is to become open-defecation-free by 2030 (Aluoch, 2022).

Wealth levels were also found to significantly affect achieving a sustainable ODF among most individual households in communities. Thus, such findings, together with qualitative analysis, concluded that Community approaches to total sanitation (CATS) programs, removal of perceived constraints through community support mechanisms and a combination of sanitation demand creation is paramount in ODF sustainability.

Continuous encouragement to pursue higher services with post-ODF follow-up can lead to the stability of social norms and eventually help sustain longer-term latrine Usage. Poor sanitation is generally associated with environmental and stunting enteropathy, which results in increased risks for infectious diseases, lower educational outcomes at schools, Poor cognitive development, and most likely lead to lower productivity in adult life (Michael *et al*, 2017).

Odagiri *et al*. (2017) found that a community-based approach to comprehensive sanitation programs, including removing perceived constraints and combining demand creation, could stabilize social norms and contribute to the long-term maintenance of sanitation toilet use in the study community.

Research of toilet use patterns in rural, middle-income Ecuador, a coastal nation, concluded that precise measurement of toilet usage is necessary for implementing and assessing sanitation projects. Effective proxy measures can be found in psychosocial variables such as norms, perceptions , knowledge, and attitudes. As many of these parameters can be influenced by long-term trends, new and future longitudinal research may also strengthen the use of these proxy measures. Additionally, subgroup analyses can clarify how these markers of bathroom use differ depending on personal traits (Lopez *et al.*, 2019).

Evaluating the determinants and patterns of toilet use in rural India, the report highlights low and inconsistent toilet use in rural Odisha. Therefore, government policies and implementation practices emphasizing the strategic change in toilet construction to induce behavior change in the population efficiently are likely to increase the demand for toilet use. However, targeted interventions to understand the individual and household-level factors that lead to sanitation use can contribute to this goal. (Sinha *et al.,* 2017). Villages that received behavioral health interventions without financial awards had the same rate of diarrhea as control villages, according to the Pickering et al. (2015) study on the effect of a comprehensive community-led health intervention on children's diarrhea and child growth in rural Mali. Access to toilets, however, has improved significantly, and children's development has enhanced, especially for those under two years old. CLTS can prevent developmental failure in ways other than reducing diarrhea.

Gebremariam *et al.* (2018) found that toilet usage was less in Kebeles with CLTSH executed than in non-implemented Kebeles in southern Ethiopia. Therefore, local and national governments and NGOs must work together to promote community attitude, knowledge, and behavior change to execute community-led comprehensive hygiene and sanitation for better bathroom use. A study on toilet use in the Tullo district in West Hararge, eastern Ethiopia, showed that more rural households used toilets in Kebeles with CLTS than in Kebeles without CLTS. Therefore, it is suggested that health units consider improving toilet utilization through sustainable and effective execution of the CLTS approach (Murad *et al.,* 2022).

Although toilet use increased due to CLTS, UNICEF (2015) study in 7 districts in Kenya showed that handwashing behaviors lagged, with only 27.1 % of sample households with handwashing facilities compared to farmers.

Most households have soap or hand sanitizer, but didn't have handwashing facilities always. In addition, more than 50% of households did not use functional and clean private toilets. HH returned to OD when their toilets collapsed, older people had challenges to use, and children shared with neighbours or were not close enough to be convenient. Additionally, the study found a high awareness of handwashing behaviors and a prevalence of simple handwashing practices, such as leaky jars and slanted faucets.

Okullo *et al.* (2017) reported in their study assessing fecal disposal practices in Kenya's UN ODF and FDA areas that most sampled water sources were heavily contaminated with microbial pathogens due to poor sanitation. Therefore, safe disposal of feces is recommended as it would significantly reverse this situation and improve human health.

2.2.10 Infrastructural factors

Bikas Short Kendra (2016) A study to determine the sustainability of an OD-free state and campaign in Nepal found that most households surveyed had improved and functioning toilets, a platform to wash hands with water, and members practiced hand washing after defecation. In addition, the study showed that all schools and health facilities surveyed had separate toilets for men and women. However, sanitary toilets were unsuitable for children, older people, or people with disabilities. The study also found that less than 50% of school with sanitation facilities had soap. Still, school toilets are suitable for children of all ages and sizes, according to Ministry of Education standards.

Contreras *et al.* (2022) found that existing toilet access and structural design increased toilet use at the study site. This means that improving the quality of on-site toilets can have health benefits if good toileting habits are adopted. Further research is needed to understand how toilet use is achieved and maintained in inaccessible environments. Properly disposing of children's excreta is

one example of how sanitation initiatives can take a more progressive stance on excreta management and contribute to cleaner communities. A study in Ghana, Africa, shows that without additional interventions to address collapsing toilets and reconstruction challenges, especially for the most vulnerable and poorest households, the ODF study in Northern Ghana found that ownership and use of community toilets wasn't sustainable. This study found that, for at least the first three years after ODF validation, there was a steady decline in both toilet coverage and use of roughly 12% per year in the absence of post-ODF follow up activities (Delaire *et al.*, 2022).

Another study in Ghana showed that sanitation was in decline, often due to collapsed toilets, highlighting the need for an approach beyond CLTS. Subsidy programs have reduced open defecation, but durable toilets may still be unaffordable for households that are not eligible. Steering a criteria which is more consistent with sanitation inequalities, such as female heads of households or women who have not completed primary education, can help achieve a more meaningful and lasting impact in African contexts faced with collapsing toilets (Trimmer *et al.*, 2022).

Participants from northern Ethiopia and East Africa exhibited lower sustainability in WASH facilities, according to Tessama *et al*. (2020). Given the distance from the water source, all parties involved in the activities must take part in the community engagement, CLTSH in the villages, ODF declared villages, and the existence of sanitary institutions. WASH before, throughout, and following the execution of the project was monitored closely to gauge the levels of ODF sustainability (Tessama, & Getachew, 2022).

According to Abebe *et al. (*2020), Open defecation and lack of monitoring, lack of technical support, poor quality building materials, financial constraints, poor implementation of comprehensive community-led sanitation programs in Ethiopia due to latrines and poor quality

shared latrines, soil conditions, prone to subsidence, lack of freely available materials and lack of land.

2.2.11 Interventions for a sustainable ODF status

Sustainable Open defecation-free (ODF) and sanitation are crucial for better nutrition and health outcomes. Sustainable Development Goal 6 (SDGs) helps reduce and eradicate OD; hence, sustainability and universal access to sanitation and ODF can be achieved. Effective sustainability programs and goals for Open Defecation Free (ODF) will be essential for achieving gender, equity, sustainability, and dignity (Ntaro *et al*., 2022).

CLTS approach is portrayed as a non-subsidy approach for the sustainability of Open Defecation Free (ODF) that generates collective demand for sanitation within many communities and has shown effectiveness and possible sustainability in ODF among studied communities as it helps to create new social norms (Mitsunori Odagiri *et al*., 2017, BMC Health 2022). The study findings suggested that interventions that address rebuilding collapsed toilets, especially among the most vulnerable and poorest households, improved the longevity of CLTS-driven Open defecation-free and sanitation sustainability in rural Ghana. Therefore, for sustenance, additional interventions are needed to address toilet collapse and the difficulty of rebuilding, especially among the most vulnerable and poorest households. Statistics indicate that in the absence of post-ODF interventions, toilet use and coverage decline by approximately 12% annually.

Households studied on ODF sustainability in Ethiopia, Kenya, Uganda, and Sierra Leone virtually found the toilets were universally built of locally available materials. Still, there was little sign of increased cleanliness within the homes, as Paul *et al*. (2013) reported. The study found that higher-quality toilets and more durable materials were associated with an ODF household surplus.

Nonetheless, this highlighted the importance of actions to increase access to higher-quality building materials for constructing toilets. Commercial materials for pit slabs and liners prevents families from risk of abandoning their toilets and returning to the OD, primarily due to collapse. For households still using latrines, post-ODF planning should encourage the replacement of simple pit latrines with improved latrines. Training masons and other private sector players and establishing village savings and credit are two initiatives mentioned in the study that enhance the demand and supply for market services and products, which are critical to ensuring the ODF's continued success (Paul e*t al.*, 2013).

Sanitation marketing uses social and commercial marketing strategies to raise the demand for and supply better sanitary facilities. Before the government took over the production and installation of concrete slabs, ventilated upgraded pit latrines dominated the Kenyan sanitation sector. These technologies have primarily failed despite significant investment from the government and donors. The USAID/KIWASH initiative worked with Lixil Corporation, the manufacturer of SATO products, and other local firms to test knitted products for SATO and SAFI toiletries to increase the technology options accessible to the sanitation market. Research (Coffey *et al*., 2017) revealed that households ready to make minor adjustments to their housing were more likely to upgrade to improved sanitation facilities. Even tiny improvements do not give optimal sanitation in favor of full sanitation interventions. Partner initiatives are concentrated on guaranteeing small-scale advancements in fundamental sanitation, with long-term trajectories coordinated with better health systems.

SATO is a straightforward toilet top that may be added on pit latrines to raise the standard and an appealing design that will eliminate odour. A low-cost ventilated pit toilet is often created to

reinforce the circular pit against external pressure. In contrast, a SAFI toilet is a modified sanitation system. Both methods are displayed in Figure 2.2 of the supporting data.

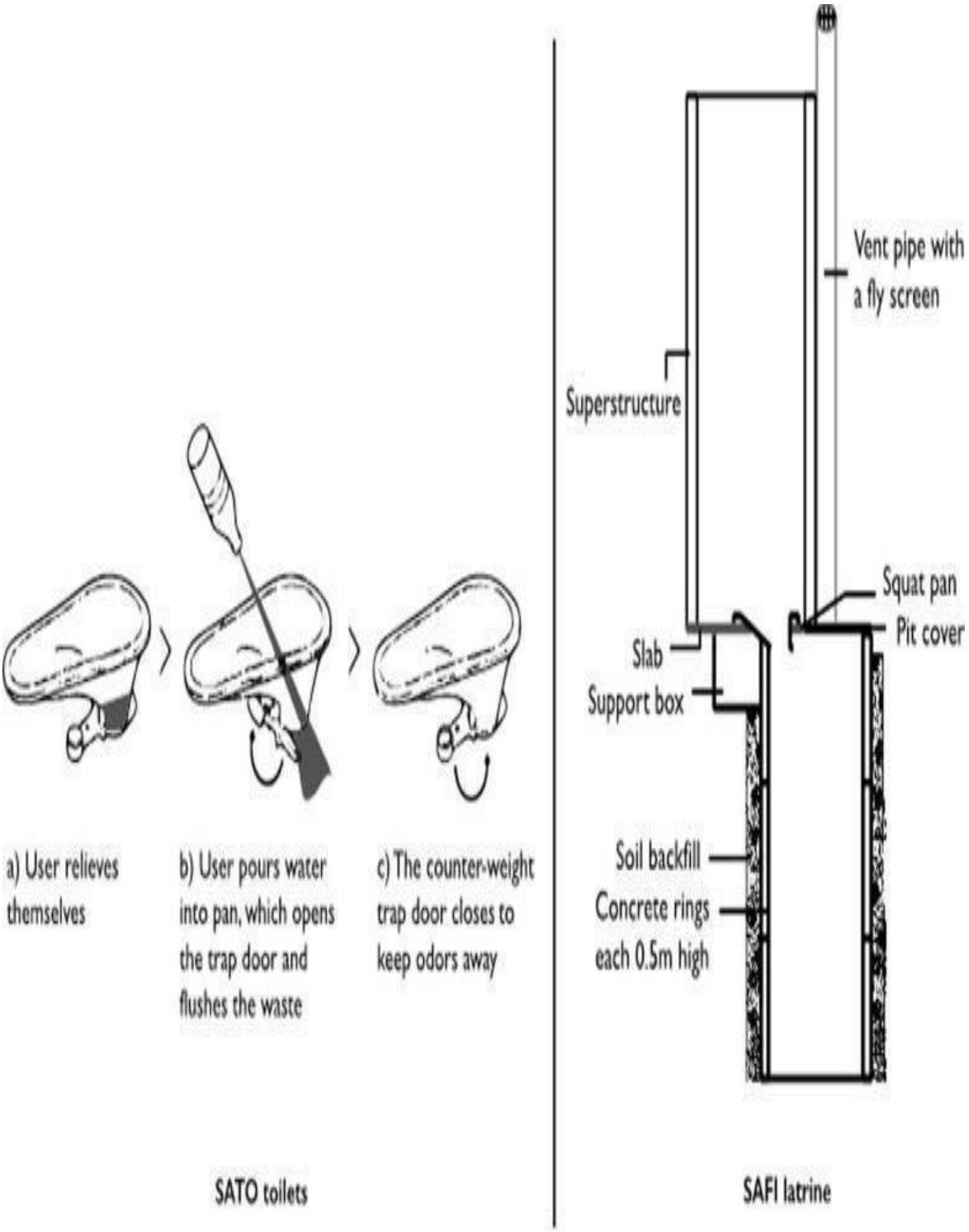

Figure 2.4 various sanitation products

2.3 Critical review.

Open defecation is a risk factor for diarrheal diseases, including soil worms, cholera, and environmental enteropathy. This behavior may negatively impact child development. Since 2013, the number of people who defecate in the open has decreased from 1.23 billion to 892 million, or 22 million years on average (Spears *et al.*, 2013).

According to Tidwell *et al*.,(2019), socioeconomic obstacles, high capital costs (unsubsidized), a lack of credit facilities for low-income households to invest in sanitation (Lipscomb & Schechter, 2018), low awareness of the health benefits, a lack of privacy (Winter *et al*., 2018), or the availability of infrastructure development, such as running water (Jenkins & Cairncross, 2010). According to other studies, households with greater incomes are more likely to spend money on sanitation as their disposable income rises. The desire to pay for better sanitation correlates with education levels and environmental awareness (Coffey *et al.*, 2017).

When people are poor, their health suffers. Because they often have less access to clean water and sanitary facilities, people experiencing poverty can be more at risk for contracting infectious diseases. Open defecation is a sign of poverty in Kenya. As low-income families progress toward better sanitation, they often revert to defecating in the open (Odagiri *et al.*, 2017).

The reason the applause goes to OD is the construction of simple, crude toilets that fill up quickly and tend to collapse. For example, when there is heavy rain or flooding, they collapse and adopt the practice of communal open defecation. Research has linked socioeconomic status to the likelihood of slip and fall accidents (Muhammad *et al.*, 2019)

The study concluded that poor households had an increased burden of open defecation, which could be attributed to higher rates of non-poor families leaving the open defecation phase than

poor households. More emphasis on low-income households may be required if Kenya achieves open-defecation-free status by 2030. (Njuguna *et al.,* 2019).

Almost one-fifth of the population in Kenya uses the open air as a toilet. Open defecation is correlated with low socioeconomic status. According to Sustainable Development Goal 6, Kenya plans to eliminate all instances of open defecation by 2030 (Njuguna *et al., 2019*).

Table 2.2 Trend of diarrhea-related cases for under 5s and above 5s in Makueni County

	Year	**Cases**	**Percentage**
Diarrhoeal Related Disease Burden	2018	7040	18
	2019	9629	25
	2020	7460	19
	2021	14527	38

Source: KHIS, (2021)

Kibwezi East Sub-county adopted Community Led Total Sanitation (CLTS) campaign since 2015. Since then, (488) of 603 villages have been certified open-defecation-free. However, despite the high number of ODF-certified villages (488, or 81%), the incidence of fecal-oral diseases was increasing. The open defecation reversion rate in villages in the area is high (48%), which is higher than the ODF return rate in Busia (10%) and Siaya counties (12.5%) (UNICEF, 2015) and 32% in Kitui District (UNICEF, 2021).

Therefore, the high rate of return to OD status in the Kibwezi East sub-county, Makueni County, becomes an appropriate place to study the factors influencing resurgence and sustainability of ODF status. The results will contribute to knowledge on maintaining and sustaining ODF status

in certified villages. Returning to open defecation in certified villages is a negative phenomenon, so it is extremely important to research the factors affecting the open defecation status of community members in Kibwezi East Sub County.

2.4: Conceptual framework

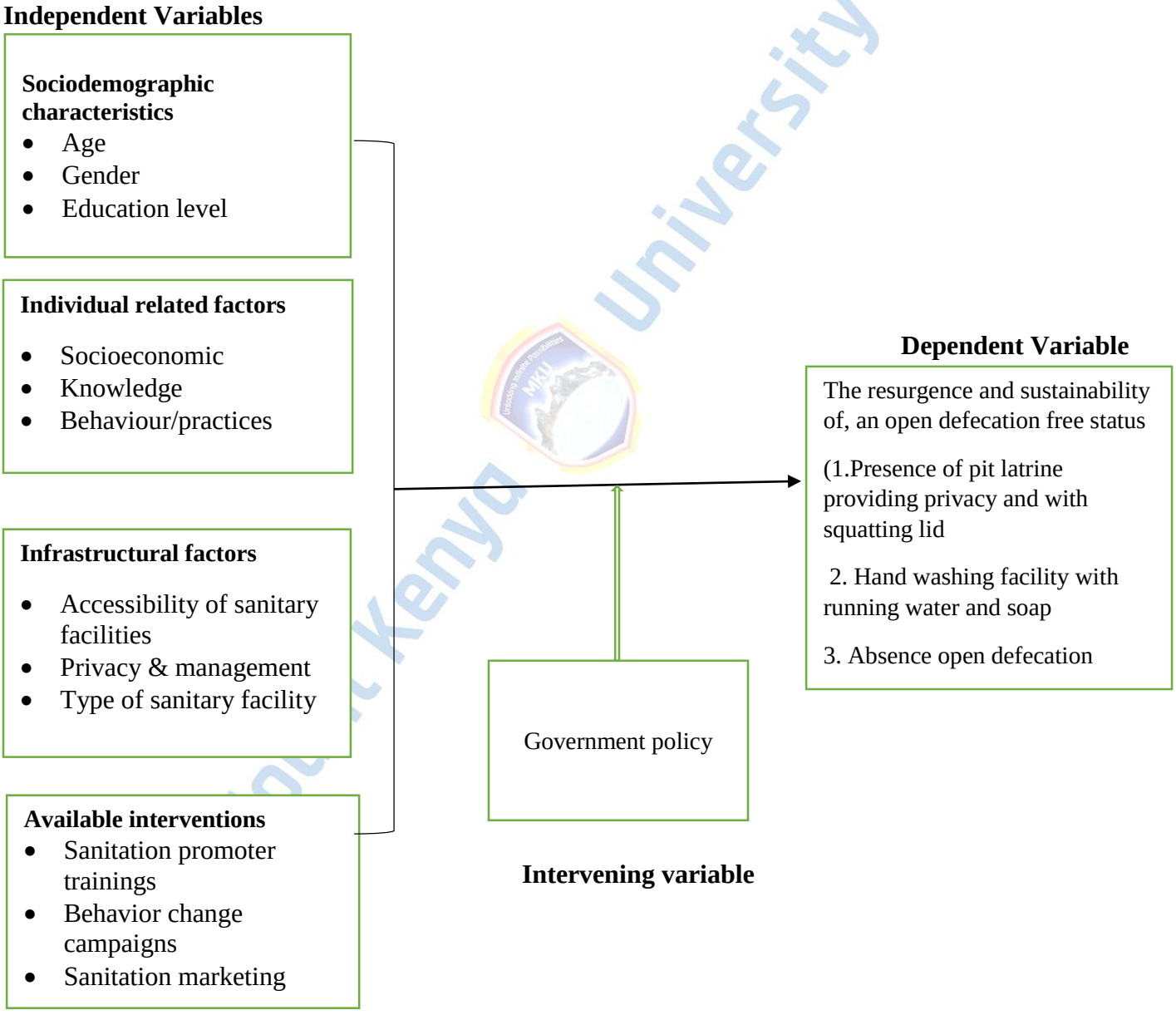

Figure 2.5 Conceptual Framework
(Source: Primary data)

2.5.0 The study variables

In this study, the dependent variable was the resurgence and sustainability of open-defecation-free status in the study area. It was measured using the following five items, which were operationalized and combined into a composite scale: Presence of pit latrines: This item was measured by observing whether households had a designated pit latrine facility within their compound or immediate vicinity. A "1" was assigned if a pit latrine was present, and a "0" if it was absent. Presence of handwashing facilities: This item was assessed by observing whether households had handwashing facilities, such as a handwashing station or a designated area with soap and water. A "1" was assigned if handwashing facilities were present, and a "0" if absent. Presence of a latrine that provides privacy in the compound: This item was determined by evaluating whether the existing pit latrine offered sufficient privacy for the users. A "1" was assigned if the toilet provided privacy, and a "0" if privacy was lacking. The pit latrine had a lid: This item was assessed by examining whether the pit latrine was equipped with a lid or cover. A "1" was assigned if the latrine had a lid and a "0" if it did not. Absence of open defecation: This item was determined by observing signs of open defecation in the study area, such as visible feces or evidence of defecation in open spaces. A "1" was assigned if open defecation was absent, and a "0" if it was present.

The outcome variable, “ODF sustainability and Resurgence,” was categorized as either “Yes” (indicating sustainability) or “No” (representing non-sustainability). This categorization was based on five non-negotiable indicators, where a household was deemed ODF sustainable only if it achieved a perfect 100% score across all five indicators; otherwise, it was classified as unsustainable and prone to resurgence.

Socioeconomic, individual, and infrastructural factors were treated as independent variables.

CHAPTER THREE

RESEARCH MATERIALS AND METHODS

3.0 Introduction.

This chapter described the methods used in the study. It covered study design, study area, population, study variables, sample size determination, sampling techniques, sampling frames, tools and procedures of data collection, methods of analyzing data for validity and reliability, techniques of data presentation, and ethical issues that this noble research should address.

3.1 Study design

Study participants involved residence of the Kibwezi East Sub-County of Makueni County who participated in a descriptive cross-sectional study utilizing quantitative and qualitative methods to collect data on the predictors of the resurgence and sustainability of the area's open defecation-free status.

3.2 Study location

The study was conducted in the Kibwezi East Sub-County in Makueni County, Kenya. Kibwezi East is one of the administrative divisions within the larger county and is known for its diverse rural communities. Makueni County is situated in the southeastern part of Kenya and is bordered by Machakos County to the north, Kitui County to the east, Taita-Taveta County to the south, and Kajiado County to the west. The county has a varied landscape, including arid and semi-arid areas and fertile agricultural lands. Kibwezi East Sub-County is predominantly rural, with a mix of small-scale farming, livestock rearing, and other agricultural activities.

3.3 Target Population

This study specifically targeted households in the Kibwezi East Sub-county, with a population of 152,706 individuals. This population has approximately 76,964 females and 75,742 males,

making it relatively balanced in gender distribution. In Kibwezi East Sub-county, there are a total of 37,245 households. These households form the primary units of analysis for collecting data and examining the predictors of the resurgence and sustainability of the area's open-defecation-free status.

3.4 Study population

Data was collected from household heads and key informants. The study included heads of households or individuals who had lived in the research area for at least two years and are aged 18 or older. A person to be regarded as household head and legible to participate in this study was the one chosen by all household members found in the household to represent their views. This criterion ensures that the study included individuals who understood the area's sanitation and hygiene practices.

Key informants for the study included public health officials and Community Health Assistants (CHAs). These individuals possess valuable knowledge and expertise in public health matters, including the open-defecation-free status of the area. By including them as key informants, the study gathered qualitative information from knowledgeable sources who deeply understood predictors of the resurgence and sustainability of open defecation-free practices in the Kibwezi East Sub-county.

3.5 Sample size determination

The Fisher method calculated the sample size (Fischer et al., 1998).

Since more than 10,000 households are in this data set (N = 18,142), we can use this calculation to get the least feasible sample size for the classification.

N = z2pq/d2

The ideal data set is denoted by **n**, and the confidence interval for the study is **z**. Using UNICEF's 2015 data, we can say that 49% of the world's population possesses the trait of interest (**P**), which we can predict the outcome with 95% confidence (z = 1.96), and that we need to calculate with 5% precision (d). That is why n = [1.9621.960.4910.49] **384** households/participants, divided by 0.0025.

To account for damaged questionnaires, 10% (38.4) was added to the total number of respondents, bringing it to 422.4, or 423.

3.6 Sampling procedure

The study site (Kibwezi East Sub County) was purposively sampled due to high number of ODF villages (488 out 860) in Makueni County. Cluster sampling by considering each ward as a cluster was employed to get study villages, proportionate sampling was utilized to get study units (households), and a simple random by use of rafts was employed to select and gather information from study participants.

Table 3.1 Sampling Frame

Sub County	**Ward**	**Total Households**	**Number of Households to be sampled** ***(ODF HH in the ward/Total ODF HH in Kibwezi East x Sample size)***
Kibwezi East	Mtito Andei	1025	24
	Thange	3552	83
	Ivingoni/ Nzambani	6525	152
	Masongaleni	7040	164
	Total	**18142**	**423**

Source: Primary Data

3.7. Inclusion and exclusion criteria

3.7.0 Inclusion criteria

i. Any person over the age of 18

ii. Must have been a resident in the area for over or more than two years

iii. Any CHV Who has completed Form IV

3.7.1 Exclusion criteria

i. Any person under the age of 18

ii. Non-residents or visitors

iii. Those who have resided in the area for less than two years

iv. Participants with mental illness

v. Household heads or participants who failed to consent to the study.

3.8 Data Collection Methods and Tools

Quantitative data was collected using questionnaires and observation checklists. In contrast, KII was used for qualitative information.

3.8.0 Data collection tools/instruments

The principal researcher together with research assistants, who are qualified and practicing healthcare workers administered a questionnaire directly to the household heads or designated individuals to collect quantitative data. The questionnaire, provided in Appendix II, consists of four sections: Section A: Biodata/Socio-demographic Characteristics; Section B: Individual-related Factors; Section C: Infrastructural Factors – Accessibility; and Section D: Available Sanitation Interventions. Special attention had been given to crafting questions that align with the study objectives and generate the necessary data. In addition to the questionnaire, an observation

checklist (see Appendix III) was attached to each questionnaire. After completing the questionnaire, with permission from study participant through signing of consent form, the researcher or research assistant assessed the open defecation-free sanitation indicators within the compound and marked the appropriate indicators in the checklist during the observation. This combined approach of using questionnaires and an observational checklist allowed for collecting important data on the predictors of the resurgence and sustainability of open defecation-free practices in the study area.

3.8.1 Key informant interviews

Key informants for this qualitative study were Community Health Assistants (CHAs) and Public Health Officers (PHOs). They were interviewed using a key informant guide (see Appendix IV) that contains key talking points focusing on areas relevant to sustainability of Open Defecation-Free (ODF) practices.

Interviewing CHAs and PHOs as key informants was essential to gain valuable insights and generate themes related to ODF-related factors. CHAs are community health workers who possess in-depth knowledge of local health practices and actively promote sanitation and hygiene within the community. As public health officials, PHOs have expertise in public health management and can provide valuable insights into the broader context of ODF initiatives.

By conducting interviews with CHAs and PHOs, this qualitative study aimed at capturing their perspectives and experiences, generating meaningful themes that shed light on the predictors of the resurgence and the sustainability of ODF practices in the Kibwezi East Sub-county.

3.8.2 Validity

The research tools were developed after a thorough literature review of relevant and similar studies conducted elsewhere. This ensured that the questions in the tools aligned with the study objectives

and captured the necessary data. Additionally, the tools had undergone peer reviews and received input from supervisors, further enhancing their quality and effectiveness (validity). To maintain consistency in data collection, the principal investigator trained the research assistants. This training covered the proper techniques for recording responses and administering the research instruments.

3.8.3 Reliability

To ensure the reliability of the study tools, a pretesting phase was conducted by use of residents in ODF certified villages in Kibwezi West Sub-county to identify potential errors or issues with the research instruments. This allowed for necessary corrections and refinements of the study tools before the actual study commenced.

3.8.4 Data Analysis, presentation, and Interpretation

The quantitative data collected from the questionnaire and observation checklist was entered into SPSS version 27 for analysis. The analysis process involved three steps. Firstly, a descriptive analysis was conducted to calculate means, frequencies, and percentages where applicable. This analysis provided an overview of the data and summarized the key characteristics and patterns. Secondly, the association between the dependent variable "resurgence and sustainability" and other independent variables was examined. Since most of the independent and dependent variables are categorical, a chi-square analysis was performed to measure the association between them. In the final step, the variables that showed significant associations in the chi-square analysis were isolated. The quantitative data was presented using charts, tables, figures, and prose to communicate the results and findings effectively.

The transcripts were coded and analyzed for the qualitative data obtained from the interviews to identify emerging themes. The data was narrated, and the findings were presented in prose, allowing for a comprehensive understanding of the qualitative insights gained from the study.

3.9.0 Ethical consideration

Ethical considerations were prioritized throughout the research process and ensured the protection and well-being of the study participants. First and foremost, researchers obtained informed consent from all study participants before participating in the research. Each participant was provided with a permission form that clearly outlined the purpose of the study, the procedures involved, and any potential risks or benefits. Furthermore, participants were allowed to ask questions and seek clarification before voluntarily giving consent.

Confidentiality and privacy were also strictly maintained to safeguard participants' personal information. Data collected during the study was stored securely and accessed only by authorized researchers. Personal identifiers were removed or anonymized during data analysis and reporting to protect participants' privacy. In addition, the use of data was strictly limited to the scholarly purposes of the study. Participants were informed that the data collected would be used solely for the intended research and would not be shared or disclosed for any other purposes without their explicit consent.

Furthermore, to ensure ethical compliance, the research study underwent a thorough ethical review by relevant authorities such as the Mount Kenya Ethical Review Committee and the National Commission for Science, Technology, and Innovation (NACOSTI). Approvals were obtained before the study commenced to ensure it adhered to established ethical standards. Lastly, permission to conduct the research in Kibwezi East was sought from the Chief Officer of the

Department of Health, Makueni County Government, to ensure proper authorization and collaboration with local authorities.

CHAPTER FOUR

RESEARCH FINDINGS/ RESULTS AND DISCUSSIONS

4.0 Introduction

This study aimed to assess sociodemographic characteristics, individual characteristics, infrastructural factors, and interventions influencing open defecation-free resurgence and sustainability in Kibwezi East sub-county. It achieved an acceptable response rate, with 431 respondents participating out of the targeted 423, exceeding 100%.

4.1 Sociodemographic characteristics of Community members

Table 4.1 presents the sociodemographic characteristics of surveyed members. Regarding religion, 98.8% (n=418) of the majority were Christians, while Muslims constituted 0.7% (3). Concerning education, 52.9% (n=226) completed primary, 35.4% (n=151) secondary, and 6.3% (n=27) college. Regarding gender, 68.6% (n=269) were female, and 31.4% (123) male. On marital status, 89.1% (383) were married, 8.8% (n=38) single, and the rest included divorced (0.5%, 2), separated (0.5%, 2), cohabiting (0.2%, 1), and "Others" (0.9%, n=4). Most respondents were aged 48.40 years (SD = 13.35, Min = 20, Max = 84). Out of the 428 valid data sets for this item, as presented in Table 4.1, the data reveals that ODF resurgence and sustainability was observed in 43.2% of cases, equivalent to 185 households. Conversely, non-sustainability was prevalent in 56.8% of cases, representing 243 households.

Table 4. 1 Sociodemographic Characteristics of Community Members

Characteristic		n	%
Religion	Christian	418	98.8%
	Muslim	3	0.7%
	Others	2	0.5%
	Total	423	100.0%
Education level	None	23	5.4%
	Primary	226	52.9%
	Secondary	151	35.4%
	College	27	6.3%
	Total	427	100.0%
Gender	Female	269	68.6%
	Male	123	31.4%
	Total	392	100.0%
Marital status	Married	383	89.1%
	Single	38	8.8%
	Divorc.	2	0.5%
	Separ.	2	0.5%
	Cohab	1	0.2%
	Others	4	0.9%
	Total	430	100.0%
Age Min=20 , Max=84, Range=64, Mean=48.40, mdn=48, SD=13.35			
Outcome Variable			
ODF Sustainable	No	243	56.8%
	Yes	185	43.2%
	Total	428	100.0%

Source: Primary data

A chi-square association test was then conducted to explore the relationship between various sociodemographic characteristics and the sustainability of ODF (Open Defecation Free) practices. "No" served as the reference category for the analysis. As presented in Table 4.2, the results provide insights into the associations observed.

Beginning with religion, the analysis revealed no statistically significant association between religious affiliation and ODF sustainability ($\chi^2 = .615$, df = 1, p = 0.433). The likelihood of ODF unsustainability among individuals of the Christian faith (utilized as the reference group) did not

differ significantly from those of other religious groups. The unadjusted odds ratio (uOR) for individuals of other religions compared to Christians was 0.494 (95% CI: 0.082-2.986).

However, a statistically significant relationship existed between education level and ODF sustainability ($\chi^2 = 5.117$, df = 1, p = 0.024). Specifically, individuals with education levels at or below primary education exhibited higher odds of not sustaining ODF practices than those at or above secondary education (uOR = 1.567, 95% CI: 1.061-2.315).

Regarding marital status, the analysis showed no significant association with ODF resurgence and sustainability ($\chi^2 = .001$, df = 1, p = .971). Being married did not substantially affect the likelihood of ODF sustainability compared to other marital statuses. The uOR for individuals with marital statuses other than married was 0.988 (95% CI: 0.533-1.832). Similarly, when considering gender, there was no statistically significant link with ODF resurgence and sustainability ($\chi^2 = 1.969$, df = 1, p = .161). The odds of not sustaining ODF practices among females did not significantly differ from those among males. The uOR for females compared to males was 0.732 (95% CI: 0.473-1.133). Lastly, treated as a continuous variable (with equal variances assumed), age exhibited no significant association with ODF sustainability (t (418)= -0.034, p = 0.973).

Table 4. 2 Association of Selected Sociodemographic Characteristics with ODF resurgence and Sustainability

Characteristic		ODF Sustainable			P≤0.05	uOR(95% CI)
		No (Reference)	Yes	Total		
		N	n	N		
Religion	Others	2	3	5	χ^2=.615 df=1 p=0.433	.494(.082-2.986)
	Christian	239	177	416		Ref
	Total	241	180	421		
Education level	<=Primary	152	97	249	χ^2=5.117 df=1 **p=.024**	1.567(1.061-2.315)
	>=Secondary	88	88	176		Ref
	Total	240	185	425		
Marital status	Others	26	20	46	χ^2=.001, df=1, p=.971	.988(.533-1.832)
	Married	217	165	382		Ref
	Total	243	185	428		
Gender	Female	144	125	269	χ^2=.1.969, df=1, p=.161	.732(.473-1.133)
	Male	74	47	121		Ref
	Total	218	172	390		
Age	418	t(418) = -0.034, p = 0.973 (Equal variances were assumed				

uOR=Unadjusted Odds Ratio

Dependent Variable (DV): "ODF resurgence and Sustainability". Reference Category: "NO"

Source: Primary Data

4.2 Individual characteristics of Community members

4.2.0 Knowledge

Individual factors, such as knowledge of the ODF prevalence in the community, the frequency of toilet usage, and household waste disposal practices, were evaluated, and the perceptions about ODF were compared with the actual status of OD prevalence in the residents' compounds. The results are presented in this subsection.

Table 4.3 presents community perception and while figure 4.6 presents the actual presence of Open Defecation (OD) seen in the compounds. Among the surveyed individuals (N=426), 82.4% (n=351) believed that OD had been eradicated. This was consistent with physical inspection where out of (N=402), it was found that 79.1% (n=318) of them showed no signs of OD. This indicates a relatively small difference between community perception and the observed presence of OD. Therefore, approximately 17.1% to 20.9% of the households surveyed practiced OD.

The question regarding the source of information on ODF status was a multiple-response item(Table 4.3), the findings indicate that the majority of respondents (64.2%, n=262) identified community meetings as their primary source of information regarding Open Defecation-Free (ODF) status. Public campaigns were mentioned in 23.50% (n=96) of cases, while 24.6% (n=100) reported receiving information from local leaders. Additionally, 11.3% (n=45) of respondents indicated 'Other' sources for their ODF information.

Among the sample of N=429 individuals (Figure 4.8), the majority, 73.40% (n=315), reported consistently using the toilet, while 20.50% (n=88) used it sometimes (indicating potential instances of open defecation), and 6.10% (n=26) used it most of the time. There appears to be internal consistency, as this aligns with the questions on perceptions of ODF status (Table 4.3), which observed that 82.4% (n=351) believed that OD had been eradicated among the surveyed

individuals (N=426). Furthermore, the outcome of the actual physical inspection of the compounds (Figure 4.6), involving N=402 compounds, likewise noted that 79.1% (n=318) of them showed no signs of OD. This indicates a relatively small difference between community perception, the observed presence of OD, and those who reported using the toilet. It is noteworthy that 20.5% (n=88) potentially practiced open defecation (Figure 4.) despite the overwhelming majority, 96.5% (n=408), being aware of the risks associated with open defecation.

In a sample of N=421 respondents who answered this question (See Figure 4.6), 93.30% (n=393) were aware of proper disposal methods for child wastes, while 6.70% (n=28) were not. A question on different waste disposal methods followed this. The question concerning household child waste disposal methods was structured as a multiple-response item. The dataset, generated from N=483 responses (Figure 4.10), offers the following insights: Disposable diapers emerged as the primary choice for child waste disposal, with approximately 48.0% (n=199) of participants adopting this method. Cloth diapers, subject to washing and reuse, were favored by about 27.2% (n=113) of respondents. A small proportion 1.2% (n=5) specified other methods, although these were unspecified. Notably, 40.0% (n=166) indicated an absence of children in their households over the past six months.

Table 4. 3 Individual characteristics of family members

		n	%
Open defecation eradicated?	No	75	17.6%
	Yes	351	82.4%
	Total	426	100.0%
Community meetings	No	146	35.8%
	Yes	262	64.2%
	Total	408	100.0%
Public campaigns	No	312	76.5%
	Yes	96	23.5%
	Total	408	100.0%
Information from local leaders	No	307	75.4%
	Yes	100	24.6%
	Total	407	100.0%
Other (please	No	354	88.7%
	Yes	45	11.3%
	Total	399	100.0%
Sign of OD within the compound	Yes	84	20.9%
	No	318	79.1%
	Total	402	100.0%
Understanding of open defecation-free status.	Poor	15	3.6%
	Good	406	96.4%
	Total	421	100.0%
Knowledge of the health and environmental benefits of avoiding open defecation.	No	15	3.5%
	Yes	408	96.5%
	Total	423	100.0%
Methods of Household Child Waste Disposal			
Awareness of proper disposal methods for child wastes.	No	28	6.7%
	Yes	393	93.3%
	Total	421	100.0%
Disposable diapers	No	226	53.2%
	Yes	199	46.8%
	Total	425	100.0%
Cloth diapers (washed and reused)	No	312	73.4%
	Yes	113	26.6%
	Total	425	100.0%
Others (Specify)…….	No	419	98.8%
	Yes	5	1.2%
	Total	424	100.0%
No child in our household in last 6 months.	No	259	60.9%

	Yes	166	39.1%
	Total	425	100.0%

Source: Primary Data

Table 4.4 presents an analysis of knowledge factors in relation to Open Defecation-Free (ODF) sustainability. It shows that respondents who believed that open defecation had not been eradicated were less likely to have ODF sustainability (uOR=0.481, 95% CI [0.289-0.799], p=0.004). Similarly, those who reported no attendance at community meetings were less likely to have ODF sustainability (uOR=0.551, 95% CI [0.36-0.831], **p=0.004**). The remaining factors, which included public campaigns, information from local leaders, toilet usage frequency, understanding of ODF status, knowledge of the health and environmental benefits of avoiding open defecation, awareness of proper child waste disposal methods, and the choice between disposable and cloth diapers, did not show statistically significant associations with ODF sustainability.

Table 4. 4 Association Between individual factors (e.g. Knowledge, methods of waste disposal) and ODF Sustainability

Knowledge Factor		ODF Sustainable			P≤0.05	uOR(95% CI)
		No (Ref)	Yes	Total		
Open defecation eradicated?	No	31	43	74	χ^2=8.165	.481 (.289-.799
	Yes	210	140	350	df=1	Ref
	Total	241	183	424	**p=.004***	
Community meetings	No	69	76	145	χ^2=8.149	.551(.36-.831)
	Yes	163	99	262	df=1	Ref
	Total	232	175	407	**p=.004***	
Public campaigns	No	181	130	311	χ^2=.0.771 df=1	1.229(.776-1.946)
	Yes	51	45	96	p=0.380	Ref
	Total	232	175	407		
Information from local leaders	No	179	128	307	χ^2=.1.020 df=1	1.264(.802-1.992)
	Yes	52	47	99	p=0.312	Ref
	Total	231	175	406		
Toilet usage frequency.	Otherwise	69	43	112	χ^2=.1.504 df=1	1.317(.848-2.047
	Always	173	142	315	p=0.220	Ref
	Total	242	185	427		
Understanding of open defecation-free status.	Poor	8	7	15	χ^2=.0.057	.882(.3142-.479
	Good	228	176	404	df=1	Ref
	Total	236	183	419	p=0.812	
Knowledge of the health and environmental benefits of avoiding open defecation	No	10	5	15	χ^2=.0.667 df=1	1.570(.527-4.676
	Yes	228	179	407	p=0.414	Ref
	Total	238	184	422		
Awareness of proper disposal methods for child wastes.	No	19	9	28	χ^2=.1.725 df=1	1.720(.759-3.897
	Yes	216	176	392	p=0.189	Ref
	Total	235	185	420		
Disposable diapers	No	124	102	226	χ^2=.0.443	.877(.597-1.290
	Yes	115	83	198	df=1	
	Total	239	185	424	p=0.506	
Cloth diapers (washed and reused)	No	187	124	311	χ^2=6.710 Df=1	**1.769(1.146-2.730**
	Yes	52	61	113	**.010***	**Ref**
	Total	239	185	424		

uOR=Unadjusted Odds Ratio
Source: Primary Data

4.2.1 Socioeconomic characteristics

The socioeconomic characteristics of the community members surveyed, as shown in Table 4.5, indicate that most respondents were unemployed (91.5%, n=388) and had an outside toilet (89.6%, n=380). The primary type of toilet facility used was pit latrines (95.1%, n=405), most of which were covered (92.9%, n=392). Measures to ensure cleanliness and maintenance of shared toilet facilities were mainly regular rotating cleaning (50.8%, n=213) and regular designated cleaning (46.3%, n=194). Most respondents found constructing a simple toilet affordable (92.2%, n=390). A vent pipe in the pit latrine was absent in most cases (68.5%, n=252). The diarrhea within the family in the last two weeks was relatively low, with only 1.7% (n=7) reporting it. Furthermore, the data revealed that respondents had an average monthly income of 9,586 Kshs (SD = 29,500 Kshs), and an approximate average of 1.4 family members experienced diarrhea (SD = 1.14).

Table 4. 5: Socioeconomic Characteristics of Surveyed Community Members

Socioeconomic factor		n	%
Employed	No	388	91.5%
	Yes	36	8.5%
	Total	424	100.0%
Presence of a lavatory/toilet on the compound.	Yes(Outside)	380	89.6%
	Yes(Indoor)	23	5.4%
	Yes(Indoor/Outdoor)	11	2.6%
	No	6	1.4%
	Yes(Under construction)	3	0.7%
	Yes(Not in use)	1	0.2%
	Total	424	100.0%
Primary type of toilet facility used.	Pit	405	95.1%
	Flush	13	3.1%
	Composting	8	1.9%
	Others	0	0.0%
	Total	426	100.0%
Status of pit latrine or composting toilet (covered or open-air).	Covered	392	92.9%
	Not Covered	30	7.1%
	Total	422	100.0%
Measures taken to ensure cleanliness and maintenance of shared toilet facilities.	Regular (Rotating)	213	50.8%
	Regular (Designated)	194	46.3%
	Never	12	2.9%
	Total	419	100.0%
Affordability of constructing a simple toilet.	Yes	390	92.2%
	No	33	7.8%
	Total	423	100.0%
Presence of a vent pipe in the pit latrine.	No	252	68.5%
	Yes	116	31.5%
	Total	368	100.0%
Occurrence of diarrhoea within the family in the last two weeks.	No	414	98.3%
	Yes	7	1.7%
	Total	421	100.0%
Monthly earnings		m=9585.96, Min=400.00, Max=200000.00, SD=29499.82	
Approximate number of family members with diarrhoea.		M=1.40, Min=0.00, Max=3.00, SD=1.14	

Source: Primary Data

Table 4.6 presents the analysis of the association between socioeconomic factors and ODF resurgence and sustainability. The table includes variables such as employment status, the presence of a lavatory or toilet in the compound, the primary type of toilet facility used, the status of pit latrine or composting toilet (covered or open-air), measures taken for cleanliness and maintenance of shared toilet facilities, affordability of constructing a simple toilet, presence of a vent pipe in the pit latrine, and recent occurrences of diarrhoea within the family. The results indicated that families lacking vent pipes in their pit latrines were 1.701 times more likely not to maintain ODF sustainability compared to those with vent pipes (p = 0.019, 95% CI = 1.091-2.652). Additionally, not having a toilet within the compound (p = 0.163, 95% CI = 0.340-1.204) and not having a covered pit latrine (p = 0.235, 95% CI = 0.732-3.515) were associated with lower ODF sustainability although these associations were not statistically significant. Conversely, variables such as employment status (p = 0.189, 95% CI = 0.793-3.181), the type of toilet facility used (p = 0.431, 95% CI = 0.560-3.726), measures taken for cleanliness (p = 0.208), affordability (p = 0.382, 95% CI = 0.664-2.898), and recent occurrences of diarrhoea (p = 0.020) did not show a statistically significant impact on ODF sustainability. Additionally, the analysis incorporated monthly income data, revealing a mean income of Kshs. 8276.3 (SD=32049.3) for households without ODF sustainability (No) and Kshs. 12205.3 (SD=24190.2) for households with ODF sustainability (Yes). A Ravene's test indicated that the variances between the two groups were statistically equal (p=.640). This suggests that, on average, households with ODF sustainability had a slightly higher mean monthly income (higher by Kshs. 3928.9) compared to those without ODF sustainability, although this difference was not statistically significant.

Table 4. 6: Association between Socioeconomic Characteristics and ODF sustainability

Knowledge Factor		ODF Sustainable						P≤0.05	uOR(95% CI)
		No (Reference)		Yes		Total			
		n		N		N			
Employed	No	222		166		388		χ^2=1.726 1 .189	1.588(.793-3.181)
	Yes	16		19		35			Ref
	Total	238		185		423			
Presence of a lavatory/toilet in the compound.	Others	20		23		43		χ^2=1.943 1 .163	.639(.340-1.204)
	Yes(Outside)	219		161		380			Ref
	Total	239		184		423			
The primary type of toilet facility used.	Others	13		7		20		χ^2=.621 1 .431	1.456(.56-3.726)
	Pit	227		178		405			Ref
	Total	240		185		425			
Status of Toilett/Latrine	Not Covered	20		10		30		χ^2=1.412 1 .235	1.604(.732-3.515)
	Covered	217		174		391			Ref
	Total	237		184		421			
Toilet cleanliness measures.	Regular (Designated)	116		78		194		χ^2=3.143 2 .208	
	Regular (Rotating)	110		102		212			
	Never	8		4		12			
	Total	234		184		418			
Affordability of constructing a simple toilet.	No	21		12		33		χ^2=.763 1 .382	1.387(.664-2.898)
	Yes	217		172		389			Ref
	Total	238		184		422			
Presence of a vent pipe in the pit latrine.	No	154		97		251		χ^2=5.544 1 .019	1.701(1.091-2.652)
	Yes	56		60		116			Ref
	Total	210		157		367			
Occurrence of diarrhea within the family in the last two weeks.	No	231		182		413		χ^2=5.444 1 0.020	
	Yes	7		0		7			
	Total	238		182		420			
Monthly income in Kshs.	N=38.0	M=8276.3	SD=32049.3	N=19.0	M=1220s5.3	SD=24190.2	MD=3928.9	t=.471	d=55 p=.640[a]

uOR=Unadjusted Odds Ratio Dependent Variable (DV): "ODF Sustainability." Reference Category: "NO"
[a]Ravene's test p<0.05. Therefore, equal variances were assumed.
Source: Primary Data

4.2.2 Individual Behavior/Practices

This study also examined individual behaviors and practices concerning Open Defecation Free (ODF) Sustainability (See Table 4.7). The findings revealed that most residents, 69.6% (296), had handwashing facilities in their toilets. Additionally, 60.8% (256) had cleansing facilities in their toilets. Furthermore, regarding the frequency of handwashing after using the toilet, a significant proportion, 78.4% (333), reported constantly washing their hands with soap and water. Regarding latrine cleaning practices, a considerable number of respondents, 60.8% (256), indicated daily cleaning.

Table 4. 7: Individual Behavior/Practices

Behavioral/practice factors		**n**	**%**
Availability of cleansing facilities in the toilet facility.	Others	11	2.7%
	No	48	11.8%
	Yes	347	85.5%
	Total	406	100.0%
Presence of a handwashing facility.	No	45	10.6%
	Yes(+water)	84	19.8%
	Yes(-water)	296	69.6%
	Total	425	100.0%
Frequency of handwashing with soap and water after using the toilet.	Never	5	1.2%
	Rarely	20	4.7%
	Sometimes	67	15.8%
	Always	333	78.4%
	Total	425	100.0%
Frequency of latrine cleaning.	Occassionary	33	7.8%
	Rarely	60	14.3%
	Weekly	72	17.1%
	Daily	256	60.8%
	Total	421	100.0%

Source: Primary Data

Further, as shown in Table 4.8, this study assessed the association between individual behavioral practices and ODF sustainability. It was found that households without toilet cleansing facilities were 2.583 times more likely to experience ODF unsustainability than those who had access to such facilities (uOR=2.583, 95% CI=1.385-4.815, p=.002*). Similarly, households lacking handwashing facilities in the toilet were 4.757 times more likely to have ODF unsustainability compared to those with handwashing facilities (uOR=4.757, 95% CI=2.072-10.920, p=.000*). Moreover, individuals who did not frequently wash their hands were 3.007 times more likely to have ODF unsustainability than those who always practiced handwashing after toilet use (uOR=3.007, 95% CI=1.778-5.088, p=0.000*). In contrast, when examining the frequency of latrine cleaning, there was no statistically significant association with ODF sustainability (χ^2=2.529, df=1, p=0.112). Likewise, handwashing facilities without water in the toilet did not show a significant association with ODF sustainability (χ^2=15.886, df=1, p=.000*).

Table 4. 8: Association between Individual behavior and ODF sustainability

Individual behavior and practices		**ODF Sustainable**			**P≤0.05**	**uOR(95% CI)**
		No (Reference)	**Yes**	**Total**		
Availability of toilet cleansing facilities	No	44	15	59	χ^2=9.38 df=1 **p=.002***	2.583(1.385-4.815
	Yes	184	162	346		Ref
	Total	228	177	405		
Presence of a handwashing facility.	No	38	7	45	χ^2=15.886 1 **.000***	4.757(2.072-10.920
	Yes	202	177	379		Ref
	Total	240	184	424		
Frequency of handwashing	Otherwise	69	22	91	χ^2=17.834 df=1 **p=0.000***	3.007(1.778-5.088
	Always	170	163	333		Ref
	Total	239	185	424		
Frequency of latrine	Otherwise	101	64	165	χ^2=2.529	1.381(.927-2.056

Individual behavior and practices		ODF Sustainable			P≤0.05	uOR(95% CI)
		No (Reference)	Yes	Total		
cleaning.	Daily	136	119	255	df=1	Ref
	Total	237	183	420	p=0.112	

uOR=Unadjusted Odds Ratio
Dependent Variable (DV): "ODF Sustainability." Reference Category: "NO"
Source: Primary Data

4.3 Infrastructural factors

Table 4.9 summarizes key infrastructural factors related to sanitary facility accessibility, privacy, and management. Most sanitary facilities, 59.5% (254), were located at distances of 10-50 meters. Based on 201 valid data points, the median time for walking to/from the sanitary facility was 3.0 minutes, with 25% requiring 2.0 minutes or less and 75% taking 5.0 minutes or less. Majority of sanitary facilities 91.70 %(388) were accessible to people of all ages. Most respondents,67.1%(275), reported no open defecation sites in their community. Mudbricks were the predominant choice for lavatory wall materials at 42.3%, while sand and cement screed dominated lavatory floors at 59.9%. A significant majority, 88.6% (373), had a roof in their lavatory, and 93.8% (390) were considered to have adequate privacy. However, 40.4% (169) encountered unpleasant odors from the toilet, and 42.4% (176) frequently encountered insects in the lavatory.

Table 4. 9:Infrastructural factors

a) Accessibility of the facilities		N	%
Distance to sanitary facility	10-50M	254	59.5%
	<10M	143	33.5%
	>50-100	27	6.3%
	>100M	2	0.5%
	I dont have a sanitary Facility	1	0.2%

	Total	427	100.0%
Walking time to/from the facility(Minutes)(N=201) 25th Percentile =2,50th Percentile =3,75th Percentile=5			
Walking time	long(>3min)	67	33.3%
	Short(<=3min)	134	66.7%
	Total	201	100.0%
Sanitary facility accessibility for all ages	No	35	8.30%
	Yes	388	91.70%
	Total	423	100.00%
Open defecation sites in the community	No	275	67.10%
	Yes	135	32.90%
	Total	410	100.00%
b) Privacy and facility management			
Lavatory wall material	Iron sheets	29	6.9%
	Tree branches walling	31	7.4%
	Cement	34	8.1%
	Cement bricks	149	35.4%
	Mud Bricks	178	42.3%
	Total	421	100.0%
Lavatory floor material	Tiles	13	3.1%
	Mud floor	156	37.1%
	Sand & Cement Screed	252	59.9%
	Total	421	100.0%
Roof presence in the lavatory	No	48	11.4%
	Yes	373	88.6%
	Total	421	100.0%
Latrine privacy adequate	No	26	6.3%
	Yes	390	93.8%
	Total	416	100.0%
Un pleasant odors from the toilet	Yes	169	40.4%
	No	249	59.6%
	Total	418	100.0%
Often encounter insects in the lavatory	Yes	176	42.4%
	No	239	57.6%
	Total	415	100.0%

Source: Primary Data

Across-tabulation analysis (see Table 4.10) was conducted to investigate the association between infrastructural factors and ODF (Open Defecation Free) sustainability status. Five variables exhibited strong associations with ODF sustainability. Specifically, ODF sustainability was less likely in households lacking user-friendly sanitary facilities (UOR = 2.47, 95% CI 0.098-0.625, p

= 0.000) and in households with roofless toilets (UOR = 0.355, 95% CI 0.187-0.675, p = 0.000). A significant association was also found between walking time and ODF sustainability (p < 0.001). Specifically, households with longer walking times (>3 minutes) were less likely to be ODF sustainable (uOR = 0.341, 95% CI [0.186, 0.625]). However, the absence of designated open defecation sites in the community increased the odds of ODF sustainability by 1.669 times (UOR = 1.669, 95% CI 1.254-2.222, p = 0.000). Likewise, households with toilets that did not emit unpleasant odors were more likely to sustain ODF (UOR = 1.287, 95% CI 1.018-1.628, p = 0.030). None of the other infrastructural-related variables in this study demonstrated significant associations with ODF sustainability.

Table 4. 10: Infrastructural characteristics and ODF sustainability

Infrastructural factors		**ODF Sustainable**			**≤0.05**	**uOR(95%CI)**
		No	Yes(Ref)	Total		
Distance to sanitary facility	>10M	150	132	282	3.666 1 0.056	1.263(.986-1.617
	<10M	90	53	143		Ref
	Total	240	185	425		
Walking time	long(>3min)	27	40	67	12.486 1 .000	.341(.186-.625)
	Short(<=3min)	89	45	134		Ref
	Total	116	85	201		
Sanitary facility accessibility for all ages	No	31	4	35	15.85, df=1 .000*	.247(.0-.625)
	Yes	208	179	387		Ref
	Total	239	183	422		
Open defecation sites in the community	No	139	136	275	14.526 1 .000*	1.669(1.254-2.222)
	Yes	95	40	135		Ref
	Total	234	176	410		
Lavatory wall Material	Cement	22	12	34	5.767, df=4, p=0.217	
	Cement bricks	76	73	149		
	Mud Bricks	101	77	178		

	Tree branches Walling	22	9	31		
	Iron sheets	18	11	29		
	Total	239	182	421		
Lavatory floor Material	Tiles	5	8	13	3.978	
	Sand & Cement Screed	136	116	252	2	
	Mud floor	96	60	156	0.137	
Roof presence in the lavatory	Total	237	184	421	15.837	.355(.187-.675)
	No	40	8	48	1 .000*	
	Yes	198	175	373		
	Total	238	183	421		
Latrine privacy Adequate	No	19	7	26	3.142	.602(.316-1.145)
	Yes	215	174	389	1 0.076	
	Total	234	181	415		
Unpleasant odors from the Toilet	No	129	119	248	4.684	1.287(1.018.628
	Yes	106	63	169	1 .030*	
	Total	235	182	417		
Often encounter insects in the lavatory	No	126	112	238	1.851	1.167(.932-1.460
	Yes	105	71	176	1 0.174	
	Total	231	183	414		

uOR=Unadjusted Odds Ratio
Dependent Variable (DV):"ODF Sustainability "Reference Category "Yes"
Source: Primary Data

4.4 Sanitation Interventions

Table 4.11 presents findings on sanitation interventions and respondent responses. More than half attended recent sanitation training (237), despite most not receiving incentives (71.3%, 263) during the training. Regular sanitation campaigns (44.9%, 180) were common in the village, with most being aware of village sanitation campaigns (72.4%, 299). A majority knew of sanitation marketing (64.6%, 268). Most reported the absence of sanitation marketing days (60.6%, 240), and partner support for sanitation marketing was low (21.2%, 87).

Table 4. 11: Available sanitation Interve ntions

Available sanitation Interventions		N	%
Attendance at sanitation promotion training last year	No	237	56.7%
	Yes	181	43.3%
	Total	418	100.0%
Incentives received for training	No	263	71.3%
	Yes	106	28.7%
	Total	369	100.0%
Awareness of village sanitation campaigns	Yes	299	72.4%
	No	114	27.6%
	Total	413	100.0%
Frequency of sanitation campaigns	Regular	180	44.9%
	Occasionally	104	25.9%
	Never	75	18.7%
	Rarely	42	10.5%
	Total	401	100.0%
Awareness of sanitation marketing	Yes	268	64.6%
	No	147	35.4%
	Total	415	100.0%
Presence of sanitation marketing days	No	240	60.6%
	Yes	156	39.4%
	Total	396	100.0%
Partner support for sanitation marketing	No	323	78.8%
	Yes	87	21.2%
	Total	410	100.0%

Source: Primary Data

Table 4.12 reveals significant associations between some interventions and ODF sustainability. Specifically, statistically significant associations were observed between ODF sustainability and awareness of sanitation campaigns (p = 0.006), awareness of sanitation marketing (p = 0.009), and partner support for sanitation marketing (p = 0.013). Individuals who were not aware of village sanitation campaigns were more likely to have no ODF sustainability (Unadjusted Odds Ratio, uOR = 1.290, 95% CI: 1.088-1.529) compared to those who were aware. Similarly, non-sustainability was more likely in individuals who were not aware of sanitation marketing in the community (uOR = 1.259, 95% CI: 1.065-1.490) compared to those who were aware. Furthermore, non-sustainability was less likely in community members who reported having no partners supporting sanitation marketing (uOR = 1.330, 95% CI: 1.036-1.708). All other interventions showed no significant associations with ODF sustainability.

Table 4. 12:A ssociation Between sanitation inverventions and ODF Sustainability

Sanitation intervention		ODF Sustainable			P≤0.05	uOR(95% CI)
		No	Yes	Total		
Attendance at sanitation promotion training last year	No	134	102	236	0.04	1.018(.858-1.207
	Yes	101	80	181	1	Ref
	Total	235	182	417	0.842	
Incentives received for training	No	153	109	262	2.668	1.190.956-1.482
	Yes	52	54	106	1	
	Total	205	163	368	0.102	
Awareness of village sanitation campaigns	No	76	38	114	7.512	1.290(1.088-1.529
	Yes	154	144	298	1	Ref
	Total	230	182	412	**.006***	
Frequency of sanitation campaigns	Otherwise Rare/Occasion.)	113	108	221	2.61	.863(.723-1.031
	Regular	106	73	179	1	
	Total	219	181	400	0.106	
Awareness of sanitation marketing	No	94	52	146	6.742	1.259(1.065-1.490
	Yes	137	131	268	1	Ref
	Total	231	183	414	**.009***	
Presence of sanitation marketing days	No	132	107	239	0.127	.968(.810-1.156
	Yes	89	67	156	1	Ref
	Total	221	174	395	0.722	
Partner support for sanitation marketing	No	192	130	322	6.103	1.330(1.036-1.708
	Yes	39	48	87	1	Ref
	Total	231	178	409	.013*	

uOR=Unadjusted Odds Ratio
Dependent Variable (DV): "ODF Sustainability." Reference within Category: "NO"
Source: Primary Data

4.5 Qualitative Interview Findings

The key informants interviewed during the study provided valuable insights on several themes related to open defecation-free (ODF) status and its sustainability in the Kibwezi East sub-county.

ODF Status:

The study revealed that the ODF status in the sub-county varied, with some wards achieving rates as high as 90%, while others were at 60%. One informant number 11 stated, "*Generally, the sanitation status of the sub-county is good. We have celebrated 2 out of 4 wards that make up the sub-county with 75% ODF*." However, it was noted that open defecation was still practiced in certain areas, with evidence such as the persistence of amoebiasis and diarrhea cases.

Sustainability of ODF: Opinions on the sustainability of ODF status were divided among the informants. Those who expressed doubts about sustainability cited factors such as "lack of knowledge" and "poverty" as barriers. On the other hand, those who believed in the possibility of sustaining ODF status pointed that if handwashing facilities is availed, it is possible to sustain ODF.

Infrastructural Factors: The study identified infrastructural factors affecting ODF status. In areas where SATO-PAN toilets were used, a common challenge was the lack of water. Additionally, concerns were raised about the user-friendliness of sanitary facilities, especially for the elderly population.

Role of Sanitation Products: Sanitation products played a role in promoting ODF status. They were noted for their ability to reduce odors and create a more pleasant environment.

Role of Government (GoK) in Sustaining ODF: The role of the Government of Kenya (GoK) in sustaining ODF status was discussed. It was suggested that motivating Community Health Volunteers (CHVs) through incentives or allowances could be an effective strategy for ensuring the continued efforts of these volunteers in promoting ODF practices.

4.6 DISCUSSION

4.6.0 Socio-demographic characteristics and ODF Sustainability

Most of the respondents (98.8%, n = 418) were Christians. This reveals the dominance of Christianity in the study area. In regards to education, most of the participants (52.9%, n = 226) reported to have completed primary education. Education is a key determinant of the lifestyle and status an individual enjoys in society. Studies have consistently shown that educational attainment has a strong effect on health behaviours and attitudes towards sanitation adoption and use .Education helps in building awareness and empowers household members to know the consequences of practicing open defecation. In the study, females (68.6%, n = 269) dominated the sample. This could be attributed to the fact that households were visited during the day, hence most of the males were away on occupational duties. It is a clear indication that women and young girls may suffer a lot when a household lacks a decent sanitary facility for use by the members. This is in line with a study in Kenya by Njuguna (2019), whose findings revealed that women and young girls in school are particularly at risk of violence and rape when searching OD sites, levels at or below primary education had higher odds of not sustaining ODF practices. The findings concur with the studies by Nunbogu *et al.* (2019) and Ntaro *et al.* (2022), where they reported a significant relationship between the mother's level of education, the presence of secondary school students, the frequency of latrine construction, latrine sanitation, and the use of latrines.

4.6.1 Individual characteristics and ODF sustainability

4.6.1.0 Knowledge on ODF sustainability

The key findings demonstrated that community meetings were the most preferred channels for handing over information regarding ODF status to community members. The findings concur with the study by Odagiri *et al.* (2017), where they concluded that a community-based approach to comprehensive sanitation programs could stabilize social norms and contribute to the long-term maintenance and use of sanitary facilities. Additionally the findings concurs with HBM

where, direct engagement of community members with health professionals, for example, through the media and group discussions, can address the vulnerability of diseases related to OD practices. The study reported that members preferred the use of disposable diapers as the primary choice for child waste disposal. This is additionally referred to in an investigation by Okullo *et al.* (2017), who reported that safe disposal of faeces is recommended as it would significantly reverse the rate of microbial contamination of food and water sources and hence improve human health. Similarly, Contreras *et al.* (2022) reported that proper disposal of children's excreta is one example of how sanitation initiatives can take a more progressive stance on excreta management and contribute to cleaner communities. Additionally the findings concurs with Kapuret *et al*,(2019) who reported significant relationship between toilet cleansing and ODF sustainability in households in India. Further, the study revealed that respondents who believed that open defecation had not been eradicated were less likely to ensure ODF sustainability, and those not attending community meetings had lower ODF sustainability odds. These results call for sanitation promoters to prepare communities to participate in enhancing sanitation and cleanliness practices through adopting behaviour change models. This concurs with social cognitive theory where individuals adopt behaviours that they have already learned, through either community meetings or media. In addition, this is supported by Murad *et al.'s* (2022) study, which suggested that health units should consider improving toilet utilization through sustainable and effective execution of the CLTS approach.

4.6.1.1 Socioeconomic Status and ODF sustainability

The majority of the participants (91.5%) reported having no formal employment, and households with ODF sustainability had a slightly higher mean monthly income (Kshs. 3928.9). The study findings concurs with those of Caroline Delaire *et al*, (2022) who reported financial solutions as having a significant relationship to ODF sustainability through making sanitation materials and products available to all people. The lack of employment depicts the level of poverty in the study area, which affects their health status as the residents may often have less access to clean water

and sanitary facilities and may be more at risk for contracting infectious diseases. Key informants in the study area also cited poverty as a contributor to ODF unsustainability. Conversely a study carried out in Kisumu found households with at least one person who was employed was likely to build, upgrade or rebuild a sanitation facility after collapse or when the sanitation is full (Maitabel *et al.*2021). The pit latrines were reported to be the primary sanitary facility in the study area. Despite the unemployment and low-income status, residents have made a milestone in ensuring safe disposal of human waste, as shown by the low number of cases of diarrhea (1.7%, n = 7) reported by the study participants, clear evidence which demonstrated a high success rate for CLTS programs. In order to increase the demand for toilet construction and use, policies advocating for a strategic change in toilet construction to efficiently induce behaviour change in the population should be emphasized (BMC2022). Additionally, this concurs to the findings of Hemez Ange Aurelia Konassi *et al*., (2023) who reported financial support from donors and government agencies as having significance relationship with ODF sustainability through making funds available for community awareness and capacity building of ODF implementers.

4.6.1.2 Individual Behavior and Practices

A large proportion of participants (69.6%) had handwashing facilities and cleaning products (60.8%) in their restrooms. The availability of water and, more specifically, the responsibility of providing enough water for hand washing, which typically falls on the women in the family, may be the key factors influencing hand-washing habits among the study population. This concurs to study done by Ntaro *et al.,* (2022) which found women had a greater responsibility in facilitating hand washing in the community. In addition, the study reported that 71.9% of residents of Kibwezi East perceived that, the sub county is ODF. These study findings are in line with Health Believe Model by Sajid *et al*. (2016) who reported that, individual perception count in stages of behavior change from a negative behavior to a positive behavior.

The study also shows that households without toilet paper were 2.583 times more likely, households without hand washing facilities with water and soap were 4.757 times more likely,

and people who did not frequently wash their hands were 3.007 times more likely to experience ODF unsustainability (p 0.05). The results support a study by UNICEF (2015) that found that simple hand-washing facilities, like leaking jars and slanted faucets, were widely used by the study population and that they were highly aware of good hand-washing habits. According to TTM, hand washing is a deliberate action and when people are ready to quit, they decide to do so. On the other hand, the study diverges significantly from a UNICEF study conducted in Kenya in 2015, which found that just 27.1% of the households had a handwashing facility, indicating a delayed uptake of handwashing practice among the investigated population The diverge in the study findings is due to the period of study and the extend of CLTS implementation to both levels. The findings concurs with a research by Ntaro *et al*, (2022) which concluded that among other non-negotiable ODF indicators, hand washing facilities with water and soap are significant in ODF sustainability. Additionally, the study concurs with Kapuret *et al*,(2019) who pointed out households with toilet cleansing materials were more likely to sustain ODF compared to house hold without cleansing materials.

4.6.2 Infrastructure and ODF Sustainability:

The study revealed that most of the sanitary facilities (59.5%) were located within 10–50 meters, with a median walking time of 3.0 minutes, and the longer walking times (>3 minutes) were associated with reduced ODF sustainability. The results are in line with WHO's (2019) recommendations that the pits be built at a reasonable distance from the house, ideally balancing easy access against smell. Additionally, the findings concurs with those of Tessama *et al.*, (2020) who reported a significant relationship between the distance from the household to the toilet and ODF sustainability. The distance from water wells and surface water should be at least 10 metres (30 feet) to decrease the risk of groundwater pollution. The convenience of toilets is one of the motivating factors for sustaining ODF at the community level, as indicated in a study conducted in Kenya by Njuguna *et al*. (2019). In addition to these studies, the Health and Safety Executive's Approved Code of Practice to the regulations, L24, states that "sufficient toilet and washing

facilities should be provided to allow everyone to use them without unreasonable delay" and that "facilities should be located so they are convenient". The findings also concur with those of Gatachew (2022) who reported a significant relationship between sanitation monitoring on toilet accessibility by all ages, provision of roof structure and toilet facilities without odour and sustainability of ODF in households.

In this study, ODF sustainability was less likely in households without user-friendly sanitary facilities. This result agrees with Bikas Short Kendra's (2016) report that, in order to maintain the status of ODF, all sanitary facilities, including school toilets, should be suitable for the elderly and children of all ages and sizes. Further analysis from qualitative data revealed that, user-friendliness of sanitary facilities especially for the elderly population in the study area was a public health concern if we were to sustain ODF.

On the other hand, the study found that the absence of designated open defecation locations raised the odds of ODF sustainability by 1.669 times (UOR = 1.669, p 0.001) and that families with toilets that didn't release any offensive odours had a higher likelihood of maintaining ODF (UOR = 1.287, p = 0.030). Additionally, reports from qualitative analysis indicated that, common challenge was the lack of water in areas where SATO-PAN toilets were in use. The reasons why households return to open defecation are likely to vary among contexts, according to Odagiri's report from 2017, which supports these conclusions. Many people who practice the open defecation method in some places may own toilets, but they may not use them because of poor construction, a lack of privacy, the availability of designated OD sites, or an offensive odour from the toilets.

4.6.3 Sanitation Interventions and ODF Sustainability:

According to the survey, about 57% of the participants attended recent cleanliness instruction; however, the majority (71%) did not get incentives. Although it does advocate the building of pits with high-quality materials for their endurance, CLTS recognizes all types of latrines and is not just interested in building costly ones although the initiatives that promote access to better-quality

materials and construction would be worthwhile. According to a 2013 study by Paul *et al,*. in Ethiopia, Kenya, Uganda, and Sierra Leone, households there all constructed incredibly basic pit latrines out of materials that were readily available in their communities, with little evidence that this resulted in improved hygiene within the homes.

Statistically significant associations were found between ODF sustainability and awareness of sanitation campaigns (p = 0.006), sanitation marketing awareness (p = 0.009), and partner support for sanitation marketing (p = 0.013). In addition, non-sustainability of ODF status in this study was more likely when community members were unaware of village sanitation campaigns (uOR = 1.290, 95% CI: 1.088–1.529) or sanitation marketing (uOR = 1.259, 95% CI: 1.065–1.490), and less likely when partners supported sanitation marketing (uOR = 1.330, 95% CI: 1.036–1.708).The focus of partner programmes is on ensuring modest improvements in basic sanitation, with long-term trajectories aligned with improved health systems. The Kenyan government is working on integrated ways to make sure county governments have included sanitation and CLTS funds in their yearly work plans and finance latrines for public areas. This collaboration involves several important sanitation actors, including USAID and KIWASH. By doing this, the partners and the county government strengthened their commitment to the CLTS communities, increasing the prominence of sanitation messages and inspiring the communities to obtain and maintain ODF status. Further, motivating Community Health Volunteers (CHVs) through incentives or allowances could be an effective strategy for ODF sustainability as suggested by key informants.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This section discusses the findings based on the order of research objectives, socio-demographic characteristics, individual characteristics, and infrastructural factors influencing the resurgence and sustainability of open defecation-free status among adult residents in the Kibwezi East sub-county and establishes available interventions and how they contribute to the resurgence and sustainability of open defecation-free status among adult residents in the Kibwezi East sub-county.

5.1 Summary of the study

5.1.0 Prevalence of ODF

About 43.2% of households maintained ODF sustainability, while approximately 17.1% to 20.9% practiced open defecation.

5.1.1 Socio-demographic and ODF Sustainability

Most respondents were Christians (98.8%), had completed primary education (52.9%), were female (68.6%), married (89.1%), and had an average age of 48.40 years. Individuals with education levels at or below primary education had higher odds of not sustaining ODF practices (uOR = 1.567, 95% CI: 1.061-2.315, p = 0.024).

5.1.2 Individual Characteristics and ODF Sustainability:

a) Knowledge:

The majority identified community meetings (69.50%) as their primary source of information regarding ODF status. Disposable diapers were the primary choice for child waste disposal (approximately 48.0%).

Respondents believing that open defecation had not been eradicated were less likely to maintain ODF sustainability (uOR = 0.481, p = 0.004), and those not attending community meetings had lower ODF sustainability odds (uOR = 0.551, p = 0.004).

b) Socioeconomic Status:

Characteristics included unemployment (91.5%), outside toilets (89.6%), and pit latrines as the primary toilet facility (95.1%).

Lack of vent pipes in pit latrines was associated with a 1.701 times higher likelihood of not maintaining ODF sustainability ($p = 0.019$).Households with ODF sustainability had a slightly higher mean monthly income (Kshs. 3928.9 more).

c) Individual Behavior and Practices

A substantial majority had handwashing facilities (69.6%) and cleansing facilities (60.8%) in their toilets.

Households lacking toilet cleansing facilities were 2.583 times more likely, those without handwashing facilities were 4.757 times more likely, and individuals who did not frequently wash their hands were 3.007 times more likely to experience ODF unsustainability ($p < 0.05$).

5.1.3 Infrastructure and ODF Sustainability

Most sanitary facilities (59.5%) were located within 10-50 meters, with a median walking time of 3.0 minutes. ODF sustainability was less likely in households without user-friendly sanitary facilities (uOR = 2.47, $p < 0.001$) and roofless toilets (uOR = 0.355, $p < 0.001$).Longer walking times (>3 minutes) were associated with reduced ODF sustainability (uOR = 0.341, $p < 0.001$).

Conversely, the absence of designated open defecation sites increased the odds of ODF sustainability by 1.669 times (UOR = 1.669, $p < 0.001$), and households with toilets emitting no unpleasant odors were more likely to sustain ODF (UOR = 1.287, $p = 0.030$).

5.2.4 Sanitation Interventions and ODF Sustainability

Approximately 57% attended recent sanitation training, with the majority (71%) not receiving incentives.

Statistically significant associations were found between ODF sustainability and awareness of sanitation campaigns ($p = 0.006$), sanitation marketing awareness ($p = 0.009$), and partner support for sanitation marketing ($p = 0.013$).Non-sustainability was more likely when unaware of village sanitation campaigns (uOR = 1.290, 95% CI: 1.088-1.529) or sanitation marketing (uOR = 1.259,

95% CI: 1.065-1.490), and less likely when partners supported sanitation marketing (uOR = 1.330, 95% CI: 1.036-1.708).

5.2 Conclusions

In conclusion, this study achieved a high response rate exceeding 100% with ODF sustainability rate of 79.1% and an open defecation rate of 20.9% in already existing ODF villages.

In reference to the study objectives;

1. The findings indicated that sociodemographic factors, only education level was statistically significant to ODF sustainability ($\chi^2 = 5.117$, df = 1**, p = 0.024**).
2. Individual characteristics like knowledge and practices play a significant role in ODF sustainability (uOR=0.481, 95% CI [0.289-0.799], **p=0.004),** Community meetings as source of information (uOR=0.551, 95% CI [0.36-0.831], **p=0.004**), Use of Cloth diapers as a child waste disposal method (χ^2=6.710Df=1.**010)**. Socioeconomic status variables like recent occurrences of diarrhoea (**p = 0.020**) and presence of vent pipes in toilets (p = 0.019, 95% CI = 1.091-2.652) exhibited statistically significance association to ODF sustainability.

3. Infrastructural factors which were statistically significance to ODF sustainability were; households lacking user-friendly sanitary facilities (UOR = 2.47, 95% CI 0.098-0.625, **p = 0.000**), households with roofless toilets (UOR = 0.355, 95% CI 0.187-0.675, **p = 0.000**), walking time **(p < 0.001),**absence of designated open defecation sites (UOR = 1.669, 95% CI 1.254-2.222, **p = 0.000**), toilets that did not emit unpleasant odors (UOR = 1.287, 95% CI 1.018-1.628**, p = 0.030).**
4. Sanitation interventions in the study which exhibited significance to ODF sustainability were awareness of sanitation campaigns (**p = 0.006**), awareness of sanitation marketing (**p = 0.009**), and partner support for sanitation marketing (**p = 0.013**).

5.3 Recommendations

1. The ministry of education should continue advocating for 100% transition of pupils to secondary schools and other institutions of higher learning, as this will contribute to knowledge gain among the residents.
2. The department of Health Services Makueni county to enhance social behavior change campaigns at community level on dangers of practicing open defecation and viable strategies that can be used to scale up hygiene and sanitation in the community.
3. The community members should enhance infrastructural factors such as the provision of vent pipes, toilet roofing, construction of permanent toilets, latrine aperture covers, and hand washing facilities with running water and soap through subsidized government intervention.
4. The government of Kenya should enhance income-generating activities for the local communities through social marketing, sanitation technologies, and partner support interventions through the provision of sanitation loans.

5.4 Recommendation for further study

This research recommends further research on strategies that can be used to upscale open defecation free status in Kibwezi East, Makueni, Kenya.

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Appendix i: Research tools

SECTION A: BIODATA/SOCIO-DEMOGRAPHIC CHARACTERISTICS	
1. Age	……(Write age in Yrs)
2. Religion (Tick if indicated)	☐ a) Christian ☐ b) Muslim ☐ c) Hindu ☐ d) Others (Specify
3. Education level	☐ a) None ☐ b) Primary education ☐ c) Secondary education ☐ d) College/University
4. Gender	☐ a) Male ☐ b) Female
5. Ward of residence	……. (Specify)
6. What is your Marital status(Tick one)	☐ a) Married ☐ b) Single ☐ c) Divorced ☐ d) Separated ☐ e) Cohabiting ☐ f) Others (Specify)
SECTION B: INDIVIDUAL-RELATED FACTORS • **KNOWLEDGE**	
7. Has your community eradicated open defecation?	☐ a) Yes ☐ b) No c) I don't know
8. If yes in 7 above, how did you know? (**Please Tick all that apply**)	☐ Community meetings ☐ Public campaigns ☐ Information from local leaders ☐ Other (please specify)……
9. How often should one use a toilet?	☐ a. Sometimes ☐ b. Always ☐ c. Most of the time
10. How well do you understand the concept of open defecation-free status?	☐ Not at all ☐ Somewhat ☐ Moderately Very well
11. Do you know the health and environmental benefits of avoiding open defecation?	☐ Yes ☐ **No**
12. If 'yes' in 11 above, please specify some of the benefits …….	
13. Are you aware of the proper disposal methods for child wastes?	☐ **Yes** ☐ **No**

14. What methods does your household use or have used in the last six months to dispose of child waste?*(Tick all that apply)*	☐ Disposable diapers ☐ Cloth diapers (washed and reused) ☐ Others (Specify)……. ☐ No child in our household in last 6 months.
• **Socio economic variables**	
15. Are you employed?	☐ a. Yes ☐ **b.** No
16. If yes, what is your occupation?	Specify ……...
17. How much do you earn per month?	Specify ……..
18. Do you have a lavatory/toilet on your compound?	○ Yes, indoor toilet ○ Yes, outside toilet ○ Yes, both indoor and outdoor toilet ○ No ○ Yes, but not in use ○ In the construction process
19. What type of toilet facility do you primarily use?	○ Flush toilet connected to a sewer system ○ Pit latrine ○ Composting toilet ○ Other (please specify)…..
20. If you use a pit latrine or composting toilet, is it covered or open-air?	○ Covered ○ Not-covered (Open-air)
21. If the toilet facilities are shared, how do you ensure cleanliness and maintenance?	○ Regular cleaning by designated individuals ○ Rotating cleaning responsibilities among users ○ Never cleaned ○ Other (please specify)]
22. Is your household able to afford the cost of constructing a simple toilet?	☐ a. Yes ☐ b. No
23. Does your pit latrine have a vent pipe?	☐ a. Yes ☐ c. No
24. Are there members of your family who have had diarrhea in the last two (2) weeks?	☐ a. Yes ☐ b. No

25. If yes, in the above question, approximately how many members?	Specify……..……
26. How many got hospitalized as a result of the diarrhea?	Specify……..……..
• **Behavioral/ practices relate factors**	
27. Are there any cleansing facilities in the toilet facility?	☐ a. Yes, toilet paper ☐ b. No c. Other (specify)……
28. Is there a handwashing facility?	☐ a. Yes, with water ☐ b. Yes, with soap and water ☐ c. No
29. How often do you typically wash your hands with soap and water after using the toilet?	☐ Always ☐ sometimes ☐ Rarely ☐ Never
30. How often is the latrine cleaned?	☐ a. Daily ☐ b. Weekly ☐ c. Rarely ☐ d. Only on certain occasions
SECTION C: INFRASTRUCTURAL FACTORS **Accessibility**	
31. How far is the sanitary facility from your house?	○ Less than 10 meters ○ 10-50 meters ○ 50-100 meters ○ More than 100 meters ○ I don't have a sanitary facility
32. On average, how many minutes does it take for you to walk to and from the sanitary facility?	Specify time in minutes…….
33. Is your sanitary facility accessible and user-friendly for children and older people?	☐ a. Yes ☐ b. No
34. If the sanitary facility is not friendly to children, where do children go to relieve themselves?	Specify…….
35. And if the sanitary facility is not friendly to older people, where do older people go to relieve themselves?	Specify…….
36. Does this community have any locations where open defecation occurs?	☐ a. Yes ☐ b. No
37. If there are open defecation sites, please specify which sites (e.g. bush, open field etc) ……	

Privacy and management variables	
38. What are the walls of your lavatory made of?	☐ a. Cement ☐ b. Cement bricks ☐ c. mud bricks ☐ d. Tree branches walling ☐ e. Corrugated iron sheets
39. What is the floor made of?	☐ a. Tiles ☐ b. Sand and cement screed ☐ c. mud floor
40. Is there a roof on the lavatory?	☐ a. Yes ☐ b. No
41. Generally, does the latrine structure provide adequate privacy?	☐ a. Yes ☐ b. No
42. Do you experience any unpleasant odors emanating from the toilet?	☐ a. Yes ☐ b. No
43. Do you often encounter flies, cockroaches, or other insects in your lavatory?	☐ a. Yes ☐ b. No
SECTION D: AVAILABLE SANITATION INTERVENTIONS	
44. Have you attended any sanitation promotion training in the last 1 year?	☐ a. Yes ☐ b. No
45. If yes, above, who was the host for the training?	Specify……
46. Did you receive any incentive for attending the training?	☐ c. Yes ☐ d. No
47. How long did the training take?	Specify ……
48. Have you heard of any sanitation campaigns in your village in the last 1 year?	☐ a. Yes ☐ b. No
49. How frequently are the above campaigns conducted? Please select one of the following options	○ Regularly (e.g., monthly) ○ Occasionally (e.g., every few months) ○ Rarely (e.g., once a year) ○ Never conducted
50. Have you heard of sanitation marketing?	☐ e. Yes ☐ b. No
51. If yes, are there sanitation marketing days in your village?	☐ a. Yes ☐ b. No
52. If so, what common sanitation products are being marketed?	Specify…….
53. Are there partners supporting sanitation marketing in your area?	☐ Yes ☐ No

Observation Checklist

S/No	INDICATOR	RESPONSE *(Tick Appropriate)*		REMARK (S)
		YES	NO	
1.	Presence of a sanitary facility			
2.	Type of sanitary facility *(Tick one)*			
	• Ordinary pit latrine			
	• VIP latrine			
	• Sato latrine			
	• Water closet			
3.	Presence of a squatting lid			
4.	Sanitary facilities provide privacy.			
5.	Sign of OD within the compound			
6.	Presence of hand washing facility			
7.	Hand-washing facilities have soap & water *(Tick common one)*			
8.	○ Type of HWF			
	○ Tippy tap			
	○ Leaky tin			
	○ Tapped container			
9.	Distance of sanitary facility from the main house			
	< 50 meters			
	50 – 100 meters			
	>100 meters			
10.	Presence of a refuse pit			
11.	Presence of clothesline			
12.	Presence of a dish rack			
13.	Presence of water treatment			

Key Informant Interview Guide

i. In your opinion, what is the sanitation status in your sub-county? …….

ii. Do community members in this sub-county practice OD?.....

If yes, why? ……..

iii. Do community members from this sub-county able to sustain ODF status ……

If yes, how can they sustain it? ……..

iv. Are there sanitation-related products in your market?.....

If yes, mention a few…….

v. Explain briefly how the sanitation products can contribute to the sustainability of ODF status in sub county…… ……

vi. Are the community members able to pay for the products mentioned above?.....

If no, what best can be done to ensure community members can purchase the products…… ……

vii. According to you, how is the relationship between education levels and ODF status sustainability in your sub-county? ……

viii. What are the key infrastructural factors affecting the sustainability of ODF status in your sub-county? …….

ix. Are some community practices/behaviors that may positively or negatively affect the sustainability of ODF status in the sub-county? …….

If yes, what are these practices/behaviors? ……

x. In your opinion, what role (s) can government play to ensure the sustainability of ODF status in the sub-county? ……..

xi. In your opinion, what role (s) can partners play to ensure the sustainability of ODF status in the sub-county? …….

xii. In your opinion, what role (s) can the community play to ensure the sustainability of ODF status in the sub-county? ……

Consent Form

Mount Kenya University

Unlocking Infinite Possibilities

OFFICE OF THE CHAIRMAN ETHICS REVIEW COMMITTEE

Informed Consent

I'm Joshua Mutuku, a Mount Kenya University master's student. The study topic I'm working on is named "Predictors Influencing the Resurgence and Sustainability of Open Defecation Free Status Among adult residents in Kibwezi East Sub County, Makueni County." The data will be used to determine how long your village can maintain its open defecation-free status in the hopes that the results will enable policymakers and other interested parties to more effectively know how address open defecation.

Procedures to be followed

I will ask you specific questions to participate in this investigation, and you will be obligated to respond. We will fill a questionnaire with the information you provide, aided and by research assistants.

Voluntarism

Anyone can choose not to participate in this study. Remember that this entire study was conducted without incentives. You are free and welcomed to ask more questions concerning this research. Each participant has the option to end the interview at any point by declining to provide an answer. Without affecting the services, you may receive from me or any other institution, now or in the future, you are free to end the investigation at any time.

Discomforts and Risks

There will be some personal inquiries that might be distressing or uncomfortable. You have the option to ignore these questions if this occurs. The interview can be ended at any time. You might have to wait an additional half-hour after the interview before you can resume your regular duties.

Benefits

Participating in this study will aid us in determining variables that influence the resurgence and sustainability of open defecation-free status among Kibwezi East Sub County adult residents.

Reward

There will be no incentives or remuneration if you are involved in this research.

Privacy and confidentiality

The discussions and evaluations will take place in the privacy of your residence. Your personally identifiable information will not be included in the questionnaire. The questionnaire will be kept secure in a cabinet at Mount Kenya University. Everything will be kept strictly confidential, with only the investigation team accessing it.

Contact Information

Call Mr. Joshua Mutuku at 0721567427, Dr. Joseph Juma at 0799067806, or Dr. BibianneWaiganjo at 0722338708 if you have any queries concerning the research.

If you have any concerns about your rights as a study participant, don't hesitate to contact the Mount Kenya University Ethical Review Committee Secretariat at chairman.mkuerc@mku.ac.ke.

Participant's statement

I am aware of the details provided above regarding my engagement in research. I am allowed to ask questions and receive clear answers from the interviewer. This research is entirely voluntary for me. I value the privacy of my information and the flexibility of my exit. Whether I continue my study or not, I won't feel threatened.

Participant's code: ..... Date……

Signature or Thumbprint…….

Investigator's statement

I, the undersigned, have clarified the study's protocols and the risks and benefits to the participant in a language s/he comprehends.

Interviewer's Name: …… Date: ……. Signature: ……

Appendix ii: ERC Certificate

Mount Kenya University

REF: **MKU/ISERC/2885**
TO: **JOSHUA MAKILA MUTUKU**

Date: 29 June 2023

REG: **MPH/2020/68983**

Dear Sir/Madam,

RE: PREDICTORS INFLUENCING THE RESURGENCE AND SUSTAINABILITY OF OPEN DEFECATION-FREE STATUS AMONG ADULT RESIDENTS IN KIBWEZI EAST SUB COUNTY, MAKUENI COUNTY, KENYA

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1929.** The approval period is **29/06/2023 - 28/06/2024.**

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approva period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Yours sincerely,

Dr. Alfred Owino, PhD
Chairman, Mount Kenya University ISERC

Appendix iii: Introduction Letter from MKU

Mount Kenya University

DIRECTORATE OF GRADUATE STUDIES

MPH/2020/68983

30th June, 2023

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete,
P.O Box 30623- 00100
NAIROBI, KENYA

Dear Sir/Madam,

RE: JOSHUA MAKILA MUTUKU – REGISTRATION NO. MPH/2020/68983

The purpose of this letter is to introduce the above named student who is pursuing **Master of Public Health** in the department of **Epidemiology and Biostatistics** in the school of **Public Health.**

The title of the research is **"Predictors Influencing the Resurgence and Sustainability of Open Defecation-Free Status among Adult Residents in Kibwezi East Sub-County, Makueni County, Kenya."** It has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **July, 2023 and September, 2023.**

Any assistance accorded to the student will be highly appreciated.

Thank you.

Mount Kenya University
P. O. Box 342 - 01000, THIKA
Office of the Director
Graduate Studies

Dr. Samuel M. Karenga, Ph.D
Director, Graduate Studies
Enc.

Appendix iv: NACOSTI research license

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **419158**

Date of Issue: **25/July/2023**

RESEARCH LICENSE

This is to Certify that Mr.. joshua makila mutuku of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Makueni on the topic: predictors influencing the resurgence and sustainability of open defecation- free status among adult residents in kibwezi east sub county makueni county, kenya for the period ending : 25/July/2024.

License No: **NACOSTI/P/23/27546**

419158

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix v: Field entry/ Research Authorization

REPUBLIC OF KENYA

GOVERNMENT OF MAKUENI COUNTY

OFFICE OF DIRECTOR HEALTH SERVICES
PO BOX 89-90300 MAKUENI
Email: county.health@makueni.go.ke, *contact@makueni.go.ke, Website: www.makueni.go.ke*

REF: GMC/DOH/COH/RES.I (34)

1st August, 2023

Mr. Joshua M. Mutuku
MPH/2020/68983
Mount Kenya University

RE: AUTHORIZATION TO CONDUCT RESEARCH IN MAKUENI COUNTY

Reference is made to your application letter received on 31st July, 2023 requesting for ethical approval to conduct research on '**Predictors Influencing Resurgence and Sustainability of Open Defecation Free-status among adult residents in Kibwezi East Sub-county**'. We are also in receipt of your research protocol and ethical approval letters from Mount Kenya University Ethics Review Committee (**Approval no. 1929**) and NACOSTI License (**NACOSTI/P/23/275546**).

The Department of Health Services, Makueni County hereby glad and ready to support the Research Project and therefore authorizes you to conduct the research in Kibwezi East Sub County - Makueni County.

Kindly ensure that the following additional requirements will be adhered:-

1. Ensure all ethical considerations pertaining handling of sensitive health data are practiced during data collection.
2. Share the findings of the research study to the Department of Health Medical Services via the Research and Knowledge Management Coordinator.

Yours.

Dr. Harvey Mbithi.
Ag. Director Health Planning and Management

COUNTY DIRECTOR OF HEALTH
MAKUENI COUNTY
01 AUG 2023
P. O. Box 89 - 90300, MAKUENI.
Email: countyhealthmkx@gmail.com

Copy to:

- CECM – Health Services
- CO - Health Services
- Directors – Health Services
- Research and Knowledge Management Coordinator- Health
- SCMOH- Kibwezi East

Appendix vi: Turntin report: First two (2) pages

Joshua Makila Mutuku

PREDICTORS OF THE RESURGENCE AND SUSTAINABILITY OF OPEN DEFECATION-FREE STATUS AMONG ADULT RESIDENTS...

THESIS
STUDENT THESIS
Mount Kenya University

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Appendix vii: Figure 3.5 Map of Kibwezi East Sub County