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**Determinants of sustaining open defecation free (ODF) status among households in Kowili sub-location, Rachuonyo North sub-county, Homa Bay County, Kenya: a case-control study**

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## Abstract

***Introduction:*** *globally, there is a focus towards improving hygiene and sanitation as demonstrated in the 6th Sustainable Development Goal which aims at supporting and strengthening communities to participate and improve their hygiene and sanitation. This is primarily because implementation of global strategies such as Community-Led Total Sanitation (CLTS) has been derailed, as shown by communities reverting to open defecation (OD). Therefore, this study aimed at determining factors influencing the sustenance of the open defecation free (ODF) environment in Kowili sub-location.* ***Methods:*** *the study implemented a descriptive cross-sectional study design where a structured questionnaire and FGD guide were used. Random sampling and purposive sampling were used to identify households and FGD participants, respectively. The quantitative data was subjected to descriptive and regression analysis, while the qualitative data was subjected to thematic analysis. Data was analysed using SPSS version 20 at a 95% confidence interval. Data was presented using graphs and tables. Ethical clearance was sought from the University of Eastern Africa, Baraton, Kenya. Permission and consent were sought from* National Commission for Science, Technology & Innovation, Kenya *(NACOSTI) and the study participants, respectively.* ***Results:*** *the rate of sustenance of the ODF environment in Kowili sublocation was 77.5%. Socio-demographic factors reported to significantly influence the sustenance of ODF status were age, marital status, household head, and family size. Additionally, other factors reported to influence the sustenance of ODF status were continuous health education, continuous follow-up, provincial administration involvement, and law enforcement by relevant agencies.* ***Conclusion:*** *the sustenance of the ODF environment in Kowili sub-location is considerably good. However, there should be more intervention by stakeholders in ensuring that an ODF environment is sustained.*

## Introduction

Globally, sanitation is recognized as a basic need and a fundamental human right [1]. Inadequate access to hygiene and sanitation can lead to the contamination of water and food, subsequently causing diarrheal diseases when consumed by humans [2]. Diarrhoea contributes to malnutrition, weakens the immune system, and impairs growth and development, particularly affecting vulnerable groups such as infants, children, women, and adolescent girls [3,4]. According to a WHO report, diarrheal diseases resulting from contaminated water and food remain among the leading causes of child mortality and morbidity worldwide [5]. A study in India also linked poor sanitation to poor nutritional status among adolescent girls [3], underscoring the global burden of diarrheal infections and highlighting the urgent need to improve hygiene and sanitation, especially in developing countries.

There is currently a global emphasis on improving access to quality drinking water and sanitation services. The 6th Sustainable Development Goal (SDG) on clean water and sanitation aims to strengthen community participation in water and sanitation management by 2030 [6]. Despite these efforts, significant disparities remain in many developing countries. A UNDP report from 2015 indicated that approximately 4.5 billion people lacked safely managed sanitation services, and 2.3 billion lacked basic sanitation globally [6]. In Eastern and Southern Africa, an estimated 340 million people lack basic sanitation services, with about 98 million practicing open defecation [7]. Similarly, in Kenya, open defecation remains a significant challenge, with rates of 15% in rural areas and 3% in urban settings [8].

To address these challenges, strategies such as Community-Led Total Sanitation (CLTS) have been introduced globally to eliminate open defecation and sustain ODF status. In Kenya, CLTS was launched in 2007 with support from the government and health partners, leading to notable progress [8]. Over the past decade, open defecation rates in Kenya have declined by approximately 11% [9]. Despite these improvements, the sustainability of the ODF status has faced challenges such as income disparities, limited awareness, the high cost of constructing sanitation facilities, and socio-cultural barriers [10].

In 2011, Kenya officially launched the open defecation-free campaign with the support of the government and non-governmental organizations (NGOs). By 2015, approximately 3,369 villages had achieved ODF status. Homa Bay County has made significant strides in improving sanitation, particularly through the implementation of CLTS, resulting in a notable reduction in open defecation rates [11]. Kowili sub-location in Rachuonyo North sub-county was declared open defecation-free five years ago as part of this initiative. However, the long-term sustainability of this achievement remains uncertain, as there is limited evidence on whether households in this area have maintained their ODF status over time.

There is a critical need to investigate the factors influencing the sustainability of the ODF status in the Kowili sub-location. Understanding whether this area has successfully maintained its ODF status and identifying the factors that contribute to its sustenance or potential reversion will provide valuable insights for future sanitation interventions and policy decisions. This study aims to assess the sustainability of the open defecation free (ODF) status in Kowili sub-location, Rachuonyo North sub-county, Kenya, five years after its declaration. Specifically, it seeks to determine the current open defecation status in the area and identify socio-demographic, economic, and cultural factors influencing the maintenance of ODF status. Additionally, the study will evaluate household sanitation practices, infrastructure, and access to sanitation facilities, while also examining community perceptions, awareness, and participation in sanitation initiatives.

## Methods

**Study site:** this study was conducted in Kowili sub-location of Rachuonyo North sub-county (0°22'S, 34°39'E) in Homa Bay County, Kenya. The primary economic activities in the study area are fishing and small-scale agricultural farming, with crops such as maize, sugarcane, millet, potatoes, and vegetables being commonly cultivated. Homa Bay County spans an area of 4,267.1 $km^2$, including a water surface of 1,227 $km^2$. It is situated in Kenya along Lake Victoria, bordered by Kisumu and Siaya Counties to the north, Kisii and Nyamira Counties to the east, Migori County to the south, and Lake Victoria and the Republic of Uganda to the west. The total population of Kowili sub-location is 147,824, comprising 78,330 males and 69,494 females [12].

**Study design:** the study utilized a descriptive cross-sectional design to assess the factors influencing the sustainability of open defecation-free status among households in Kowili sub-location, Rachuonyo North sub-county.

**Study population:** the study focused on household heads within Kowili sub-location. Inclusion criteria: to be included in the study, participants had to meet the following criteria: they needed to be household heads aged 18 years or older, provide informed consent to participate, and have lived in Kowili sub-location for at least the past six months. Household heads who did not consent to participate or were unable to participate due to any personal reason were excluded from the study. Additionally, any household heads who did not meet the inclusion criteria were not considered for participation

**Sample size:** a total sample size of 240 respondents was determined for this study. The sample size was guided by standard procedures for population-based surveys where the target population exceeds 10,000 individuals [13]. The choice of 240 participants was informed by the need to ensure sufficient statistical power to detect meaningful effects, achieve representativeness, and maintain a 95% confidence level with an acceptable margin of error. The estimate also considered previous similar studies and expert judgment regarding the expected proportion of the population exhibiting the characteristics of interest.

**Sampling strategy:** the study employed a multistage sampling technique that combined purposive and random sampling methods. Initially, purposive sampling was used to select Kowili sub-location, as all villages within the sub-location had been officially declared Open Defecation Free (ODF) by 2010. This selection was based on the need to assess factors influencing the sustainability of ODF status over time. Within the sub-location, proportionate to size sampling was used to ensure fair representation from all villages, with households selected proportionally based on each village's population size.

**Sampling:** subsequently, simple random sampling was employed to select 240 household heads from the identified households that met the inclusion criteria. First, a complete list of all households in Kowili sub-location was compiled from local administrative records and verified through community mapping. Each household was then assigned a unique identification number. Using a computer-generated randomization process (via statistical software like R or Excel), 240 households were randomly selected. Eligibility was then confirmed based on the inclusion criteria: household heads aged 18 years or older who had lived in the area for at least six months and provided informed consent. If a selected household did not meet the criteria or declined participation, a replacement was randomly drawn from the remaining pool. This approach ensured every eligible household had an equal chance of selection, minimizing bias and enhancing the representativeness of the sample.

In addition, purposive sampling was used to select participants for 10 Focus Group Discussions (FGDs) to gather qualitative insights on factors affecting ODF sustainability. The selection process was guided by specific criteria to ensure diverse perspectives. Participants were identified based on gender, age, socioeconomic status, household sanitation practices (both those who sustained ODF and those who reverted), and leadership roles (e.g., village elders, community health volunteers, and local administrators). Community leaders and health workers assisted in identifying suitable participants who were then invited to take part in the FGDs. Each discussion group consisted of 8 participants, with stratification applied to encourage open and meaningful discussions (e.g., separate groups for men, women, and community leaders). Before participation, individuals were briefed on the study objectives, and informed consent was obtained. This purposive sampling approach ensured that the FGDs provided in-depth qualitative insights from a wide range of community members, complementing the quantitative findings.

**Data collection tools:** for the quantitative survey, a proportionate sampling method was applied to determine the number of household heads to be sampled from each village within Kowili sub-location of Rachuonyo North sub-county. This approach ensured that the sample accurately represented the diverse villages in the sub-location proportionally to their population sizes. Subsequently, households were randomly selected from the identified villages, enhancing the representativeness and reducing potential sampling bias.

Data collection tools included a pretested structured questionnaire for the quantitative survey and an FGD guide for the qualitative data collection. The questionnaire was designed to capture comprehensive information on socio-

demographic characteristics, household sanitation practices, awareness of ODF status, and factors influencing adherence. Before the actual data collection, the questionnaire was pretested in a demographically similar area to ensure clarity, reliability, and cultural relevance. Cronbach´s alpha was used to assess internal consistency and reliability of the questionnaire. For the qualitative component, the FGD guide was structured to facilitate discussions on sanitation practices, barriers to maintaining ODF status, and community perceptions. Trained research assistants conducted the interviews, with the assistance of local village elders who helped in household identification. The FGDs were conducted until thematic saturation was reached, ensuring that no new themes emerged and all relevant insights were captured.

**Data analysis and presentation:** quantitative data were entered, cleaned, and analyzed using SPSS Version 20. Descriptive statistics, including frequencies and percentages, were used to summarize socio-demographic characteristics and household sanitation practices. To determine associations between socio-demographic factors and the sustainability of ODF status, Chi-square tests were performed, with statistical significance set at $p < 0.05$. For the qualitative data, FGDs were transcribed and analyzed thematically. The analysis focused on identifying recurring patterns and insights related to community perceptions and factors affecting ODF sustainability. This approach allowed for a comprehensive understanding of both quantitative trends and qualitative experiences within the community.

**Ethical considerations:** ethical clearance was sought from the University of Eastern Africa, Baraton (REF NO UEAB/09/042019). Furthermore, a research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI-REF NO 142871 - Supplementary data S2). Permission to conduct the study was sought from the county, sub-county, and location leaders. Additionally, informed consent was sought from the study participants.

## Results

**Sociodemographic characteristics:** the study findings in Table 1 revealed that two-thirds of the participants 160/240 (66.7%,) were female, while the remaining third were male, 80/240 (33.3%). The majority of interviewees were in the age categories of 35-45 years, 84/240 (35.0%), and above 45 years 77/240 (32.1%). About a quarter of the participants were aged 25-34 years, 63/240 (26.3%), while only 16/240 (6.7%) were aged 18-24 years. The majority of participants were married, 156/240 (65.0%). A quarter were widowed 64/240 (26.7%), and 12/240 (5.0%) were single, while 8/240 (3.3%) were divorced. More than half of the households were headed by the father, 121/240 (57.4%), while 87/240 (41.2%) were headed by the mother. A small proportion of households were headed by the uncle, 1/240 (0.5%), or the father-in-law, 2/240 (0.9%).

In terms of family size, about half of the families had 3-6 members 126/240, 52.5%), while those with 1-3 members 55/240, 22.9%) and 6-9 members 53/240, 22.1%) were almost equally represented. A very small proportion of families had 9-12 members, 2/240(0.8%), or more than 12 members, 4/240 (1.7%). Amongst the study population, it was also deduced that the majority had either one 92/240 (38.3%) or two 78/240 (32.5%) children who were under the age of 5 years old. Twenty percent 48/240 (20%), had more than four children, while 12/240 (5.0%) had four children, and 10/240 (4.2%) had three children.

Educational attainment showed some disparities across the board, with more than half of the participants having a primary education (55.8%, or 134/240 individuals), with about a third having secondary education (30.8%, or 74/240 individuals). Only a small proportion had tertiary education or higher (4.6%, or 11/240 individuals), while 8.8% (21/240 individuals) had informal education. This could have also influenced the employability of the study population, as half of the participants were unemployed 120/240,

50.0%), while a third was engaged in business 77/240, 33.5%). The remaining participants were equally distributed between formal salaried employment 19/240 (8.3%) and informal salaried employment 19/240 (8.3%). This, in turn, had a net effect on the household's monthly income, with the majority of households having an income of less than Ksh. 5,000 (69.2%, 166/240 households). Fourteen percent (14.2%, 34/240 households) had a monthly income between Ksh. 5,000 and 10,000. A smaller proportion had incomes between Ksh. 10,000 and 15,000 (5.8%, 14/240 households) and Ksh. 15,000 and 20,000 (6.3%, or 15/240 households). The remaining households had monthly incomes greater than Ksh. 20,000 (4.6%, or 11/240 households). The sociodemographic characteristics of the respondents from Kowili Sub-location in Rachuonyo North Sub County are summarized in Table 1. The FGD findings supported the survey results by highlighting similar socio-demographic patterns. Participants frequently discussed economic challenges and their influence on household practices, particularly regarding sanitation sustainability. The FGDs also confirmed that limited income and lower education levels were significant barriers to maintaining Open Defecation Free (ODF) status, reinforcing the quantitative findings. Additionally, the qualitative data revealed cultural influences on household leadership and family size, which were consistent with the survey results.

**Sustenance of ODF status in Kowili sub-location:** the study also sought to fact-find on the sustenance of ODF, and from the findings, it was revealed that more than three-quarters, 186/240 (77.5%) of the households in Kowili sub-location had sustained ODF, and 54/240(22.5%) of the respondents had reverted to OD. Sustenance of ODF status was measured by the existence of functioning pit latrines.

**Association between socio-demographic characteristics and sustenance of ODF status:** statistical analysis in Table 2 revealed significant associations between all sociodemographic characteristics-age, gender, marital status, household head, family size, number of children below 5 years, level of education, occupation of the household head, and monthly income of the household head-and the sustenance of ODF status ($p<0.05$), as shown in Table 2. In terms of age category, a substantial proportion of respondents aged 35-45 years (35%) maintained ODF status, followed by those aged 25-34 years (26.2%). Conversely, individuals aged 45 years and older had a lower rate of sustained ODF status (22.5%). This variation is statistically significant, with a Chi-square value of 145.64 and a P-value of <0.001. Gender also plays a crucial role in sustaining ODF status, with all female respondents (66.7%) maintaining ODF status, while 22.5% of male respondents did not. This disparity is significant, as indicated by a chi-square value of 137.6 and a P-value of <0.001.

Marital status significantly influences ODF status (Chi-square = 194.89, $p<0.001$). All married individuals (65%), single individuals (5%), and divorced individuals (3.3%) maintained ODF status, whereas 22.5% of respondents who did not sustain ODF status were widowed. Regarding household headship, households headed by fathers (57.4%) and a majority of those headed by mothers (38.4%) sustained ODF status. In contrast, all households headed by uncles or fathers-in-law did not sustain ODF status. This association is statistically significant, with a Chi-square value of 11.94 and a P-value of <0.001. Family size significantly impacted the sustenance of ODF status (Chi-square = 211.05, $p<0.001$). Households with 1-3 members (22.9%) and 3-6 members (52.5%) were more likely to sustain ODF status. However, the majority of households with 6-9 members (20%) and those with more than 9 members did not sustain ODF status. The number of children below 5 years also significantly affected ODF status (Chi-square = 223.72, $p<0.001$). Households with one (38.3%), two (32.5%), or three (4.2%) children under five years sustained ODF status. In contrast, all households (20%) with

four or more children under five years did not sustain ODF status.

Education level was another significant factor (Chi-square = 135.0, p<0.001). Respondents with informal education (8.8%) and primary education (55.8%) were more likely to sustain ODF status. However, the majority of respondents with secondary education (17.9%) and all those with tertiary education or higher (4.6%) did not maintain ODF status. Occupation of the household head also showed a significant association with ODF status (Chi-square = 98.37, p<0.001). A majority of households headed by unemployed individuals (50%) sustained ODF status, while most households headed by individuals engaged in business ventures (19.1%) did not. Finally, household monthly income was significantly associated with ODF status (Chi-square = 131.49, p<0.001). All households with a monthly income below Ksh. 5000 (69.2%) and a notable proportion with a monthly income of Ksh. 5000-10000 (8.3%) sustained ODF status. In contrast, all households with a monthly income above Ksh. 10000 did not sustain ODF status.

**Socio-demographic factors influencing the sustenance of ODF villages in Kowili sub-location Using regression model:** the analysis in Table 3 shows that the sociodemographic factors affecting the sustainability of the Open Defecation Free (ODF) status in Kowili sub-location reveal several significant findings. The age of the respondent significantly influences the likelihood of sustaining ODF status. Specifically, respondents aged 35-45 years are more likely to sustain ODF status. The regression coefficient for age is -0.134 (95% CI: -0.185 to -0.082, p < 0.001), indicating that with each additional year of age, the likelihood of sustaining ODF status decreases. This suggests that older respondents are less likely to sustain ODF status compared to younger ones.

Marital status is a significant predictor of ODF sustainability. The coefficient for marital status is 0.171 (95% CI: 0.098 to 0.244, p < 0.001), showing that married individuals are more likely to maintain ODF status. This positive association highlights the role of marital stability in supporting sustained sanitation practices. The coefficient is 0.103 (95% CI: 0.065 to 0.141, p < 0.001), suggesting that households led by a husband are more likely to sustain ODF status. This implies that the presence of a husband as the household head positively influences the likelihood of maintaining ODF status. Also, the family size has a notable effect on ODF sustainability. With a coefficient of 0.136 (95% CI: 0.061 to 0.210, p < 0.001), larger families are more likely to sustain ODF status. Specifically, households with 3-6 members are more likely to maintain ODF practices compared to smaller or larger families.

Gender, on the other hand, was not a significant predictor in this analysis (coefficient = -0.044, p = 0.485), indicating that male or female respondents do not differ significantly in their likelihood of sustaining ODF status. However, the presence of children below 5 years showed a positive but not statistically significant association with ODF status (coefficient = 0.058, p = 0.088). Just like other variables, too, the level of education of the respondent did not significantly impact ODF sustainability (coefficient = 0.065, p = 0.317). Since education level also influences the occupation of a given individual in most cases, it was also analyzed, and it was found that the occupation of the household head and the household´s monthly income were not significant predictors of ODF status in this model. The regression analysis identifies age, marital status, household head, and family size as significant factors influencing the sustainability of ODF status in Kowili sub-location. Older respondents, those who are not married, households with non-husband heads, and larger families are more likely to sustain ODF practices.

**Factors influencing sustenance of ODF villages in Kowili sub-location:** in Kowili sub-location, a series of focus group discussions (FGDs), as summarized in Table 4, revealed several key factors that significantly impact the sustainability of Open Defecation Free (ODF) villages. The analysis of these discussions underscores the importance of

certain interventions and community involvement in maintaining ODF status. The most frequently cited factor, highlighted by all ten FGDs, 9/9 (100%), is the role of law enforcement. Effective enforcement of sanitation regulations ensures adherence to ODF standards and plays a crucial role in sustaining ODF status over time. This factor was identified by nine out of ten FGDs 9/10, 90%) as critical to the sustainability of ODF villages. Ongoing follow-up helps address challenges that arise, reinforces the importance of hygiene practices, and provides support to communities. The involvement of provincial administration was also emphasized by nine FGDs, 9/10 (90%). Local government engagement ensures that sanitation efforts receive the necessary support and resources, which is vital for the long-term maintenance of ODF status.

Eight FGDs 8/10 (80%), continuous health education is essential for maintaining ODF practices. Regular educational initiatives inform and remind communities about the importance of sanitation and hygiene, reinforcing good practices. Three FGDs 3109 (30%) pointed out the positive influence of faith-based organizations and theatre groups. These entities contribute to the sustainability of ODF villages through community outreach and behavior change programs. Only one FGD 1/10 (10%) identified the SNV (Netherlands Development Organisation) approach to sanitation as a significant factor. While acknowledged, it was less frequently cited compared to other factors. The FGDs reveal that sustained ODF status in Kowili sub-location is strongly influenced by the consistent enforcement of sanitation laws, continuous follow-up, active involvement of provincial administration, and ongoing health education. Although other factors like the involvement of faith-based organizations and the SNV approach also play roles, they are less central to the sustainability of ODF villages compared to the more frequently cited factors.

## Discussion

This study has revealed that over three-quarters, 186/240 (77.5%) of households in Kowili sub-location maintained an open defecation free (ODF) status. However, the rate of reversion to open defecation, 74/240 (22.5%) in the study area, is notably lower than the national average of 23.5% [14]. This elevated rate of open defecation suggests a significant public health issue on the horizon that demands immediate attention. The higher incidence of open defecation in Kowili sub-location may be linked to changes in economic status among households, competing household expenditures, lax enforcement of sanitation laws, and insufficient social pressure to deter open defecation practices. Such factors have been documented to influence ODF status in other communities as well [15]. In addition, they could be associated with the rise on diarrhoeal infections in the study area as documented by Ondieki *et al.* (2023). The findings of this study are consistent with those of a study conducted in Kisumu County in 2018, where a majority (84.3%) of households in ODF-certified regions successfully maintained an open defecation-free environment [14]. This study in Kisumu identified several crucial factors influencing the sustainability of ODF behavior, including continuous health education, active involvement of local leadership, and the implementation of effective community management practices. These elements were essential in preventing the reversion to open defecation practices among the inhabitants of Kisumu County.

Similarly, our findings align with a study conducted by Plan International in rural villages in Kenya. This research highlighted that community engagement, access to affordable sanitation materials, and the involvement of local leaders were pivotal in sustaining improved sanitation practices. Both studies underscore the significance of ongoing community-based interventions and the importance of local leadership in maintaining an open defecation-free status. Thus, a holistic

approach that integrates continuous education, local resource utilization, and effective community management is crucial for the long-term success of sanitation programs [15]. It was deduced from this study that factors such as continuous health education, local engagement, and effective management practices significantly influence the maintenance of ODF status in the study areas. Additionally, another study conducted by Abebe (2020) documented that the sustenance of ODF status in Africa ranges between 87% and 90% [16]. The study findings demonstrated the benefits associated with the proper implementation of Community-Led Total Sanitation (CLTS), which includes a significant reduction in sanitation-related diseases, such as diarrhoea. These gains have been achieved through the active involvement of the county government of Homa Bay in continuous health education and an increased budget allocated to sanitation-related ministries of health and environment [17]. The sustainability of ODF status is crucial for public health, as studies have shown that the rate of childhood diarrhoea is high (38%) in open defecation villages and significantly lower (7%) in ODF villages [18].

Several socio-demographic factors were determined to influence the sustenance of ODF status in this study. The age of the household head significantly influenced the maintenance of ODF status (P<0.001), with respondents aged 35-45 years being more likely to sustain ODF status. This is likely due to their greater awareness of the importance of an ODF environment gained over time through public health education. findings are in tandem with findings from a study conducted in Ghana that also documented that respondents aged 31-45 years were more likely to sustain ODF status, attributed to their increased activity and ability to utilize indigenous materials and new technologies for toilet construction [10].

Marital status was also found to significantly influence ODF status (P<0.001), with married individuals more likely to sustain an open defecation-free status. This is likely due to the division of labor and resource availability within households with both spouses. Studies have shown that married women are more likely to ensure hygiene and sanitation, including upgrading toilets [19]. In Ghana, higher rates of open defecation were reported among divorced and separated individuals, highlighting the impact of marital status on sanitation practices [20]. Household headship significantly influenced ODF status (P<0.001), with households headed by men being more likely to sustain ODF status compared to those headed by women. Men are likely to have better access to resources for constructing and maintaining sanitary facilities. Studies have shown that female-headed households may be more likely to revert to open defecation due to financial constraints and potential insecurity, especially at night [21,22].

Family size also had a significant impact on the sustenance of ODF status (P<0.001), with households of 3-6 members being more likely to sustain an ODF status. This may be because smaller families have less competition for toilet use, resulting in better maintenance of sanitation facilities. Conversely, larger families may face challenges in managing sanitation due to increased toilet use and potential neglect [23]. This finding is consistent with research from Meru County, Kenya, where smaller household sizes were associated with better ODF sustainability [24]. Larger families often prioritize immediate needs such as housing, clothing, and education over sanitation, leading to poorly maintained facilities and a higher likelihood of reverting to open defecation [19,25].

According to focus group discussions (FGDs), key factors influencing the sustenance of ODF status include continuous health education, regular follow-up, provincial administration involvement, and law enforcement by various agencies. These findings are supported by studies that highlight the role of continuous public education and law enforcement in raising awareness and sustaining sanitation practices [26,27]. A global review emphasizes that effective health education,

leadership involvement, and strict law enforcement are crucial for maintaining ODF status [28]. Additionally, the development and enforcement of laws prohibiting open defecation by governments, along with active community participation and oversight, are essential for ensuring the long-term success of sanitation programs [29,30].

## Conclusion

The rate of sustenance of the ODF environment in Kowili sub-location was 77.5%. Socio-demographic factors reported to significantly influence sustenance of ODF status were age, marital status, household head, and family size. Additionally, other factors reported to influence the sustenance of ODF status were continuous health education, continuous follow-up, provincial administration involvement, and law enforcement by relevant agencies.

***What is known about this topic***

- *Achieving open defecation free (ODF) status significantly reduces waterborne diseases such as diarrhea, cholera, and typhoid by improving sanitation and hygiene practices;*
- *Many communities revert to open defecation due to poverty, inadequate sanitation infrastructure, cultural beliefs, weak enforcement of sanitation laws, and lack of continuous health education;*
- *Community-led total sanitation (CLTS) programs, strong local leadership, and consistent follow-up by health and government agencies are crucial for sustaining ODF status and preventing slippage.*

***What this study adds***

- *Seven-point-five percent (7.5%) of households sustained open defecation free (ODF) status, with a 22.5% reversion rate-slightly below Kenya's national average of 23.5%; key factors influencing sustainability included age, marital status, household headship, and family size (all $p < 0.001$); lower-income households were more prone to reversion due to financial limitations;*
- *Reversion was driven by low household income, competing financial priorities, weak enforcement of sanitation laws, and cultural or social norms; weak social deterrents and a lack of ongoing support contributed to slippage from ODF status;*
- *Sustained ODF status was strongly linked to continuous health education, strong local leadership, and strict sanitation enforcement; villages practicing open defecation had a 38% diarrhea prevalence, compared to only 7% in ODF villages, underscoring the health benefits of long-term sanitation practices.*

## Competing interests

The authors declare no competing interests.

## Authors' contributions

All the authors have read and agreed to the final version of this manuscript.

## Tables

**Table 1**: socio-demographic characteristics of respondents in Kowili sub-location in Rachuonyo sub-county

**Table 2**: association between socio-demographic characteristics and sustenance of ODF status

**Table 3**: socio-demographic factors associated with the sustenance of ODF villages in Kowili sub-location

**Table 4**: factors reported to influence the sustenance of ODF villages in Kowili sub-location

## References


1. Guterres ICL, Yamarat K, Xenos P. Factors Influencing Households to Use Latrines after the Open Defecation Free Declaration in Ermera District, Timor-Leste. Journal of Health Research. 2017;28(3): 191-198. **Google Scholar**
2. World Health Organization. Drinking water. 2019. Accessed on May 2 2025.
3. Chattopadhyay A, Sethi V, Nagargoje VP, Saraswat A, Surani N, Agarwal N *et al*. WASH practices and its association with nutritional status of adolescent girls in poverty pockets of eastern India. BMC Womens Health. 2019 Jul 5;19(1): 89. **PubMed**| **Google Scholar**
4. UNICEF. Water, sanitation and hygiene. 2019. Accessed on May 2, 2025.
5. World Health Organization. Diarrheal diseases. 2021. Accessed on May 2, 2025.
6. United Nations Development Programme. Sustainable development goals. 2015. Accessed on May 2, 2025.
7. UNICEF. Sanitation and hygiene. 2019. Accessed on May 2, 2025.
8. UNICEF. Sustainability of ODF practices in Kenya. 2015. Accessed on May 2, 2025.
9. Njuguna J. Progress in sanitation among poor households in Kenya: evidence from demographic and health surveys. BMC Public Health. 2019 Jan 31;19(1): 135. **PubMed**| **Google Scholar**
10. Alhassan A, Anyarayor BK. Determinants of adoption of open defecation-free (ODF) innovations: A case study of Nadowli-Kaleo district, Ghana. Journal of Development and Communication Studies. 2018 Jul 16;5(2): 54-69. **Google Scholar**
11. County Government of Kericho. Understanding the effects of poor sanitation on public health, the environment, and well-being: Report of research findings - Kericho County. SNV Netherlands Development Organisation; 2018. Accessed on May 2, 2025.
12. Kenya National Bureau of Statistics. 2009 Kenya Population and Housing Census: Analytical Report on Kenya Population Atlas. Nairobi, Kenya: KNBS; March 20. Accessed on May 2, 2025.
13. Onyango RO, Mugambi G, Muriungi R, Mworia L. The Influence of social factors on the promotion of Safe Fecal Management in flood-prone areas: A case of Nyando Sub-County, Kenya. African Journal of Science, Technology and Social Sciences. 2024 Nov 15;3(2): 7-17. **Google Scholar**
14. Tyndale-Biscoe P, Bond M, Kidd R. ODF sustainability study. FH Designs Australia: PLAN International. 2013 Dec: 1-81. **Google Scholar**
15. Abebe TA, Tucho GT. Open defecation-free slippage and its associated factors in Ethiopia: a systematic review. Syst Rev. 2020 Nov 3;9(1): 252. **PubMed**| **Google Scholar**
16. County Government of Homa Bay. Homa Bay County: Alternative Budget Memo on Sanitation 2020/21. Institute of Economic Affairs (IEA Kenya); 2021. Accessed on May 2, 2025.
17. Water and Sanitation Program. Community-Led Total Sanitation in Rural Areas: An Approach That Works. Field Note. Washington, DC: World Bank; February 2007. Accessed on May 2, 2025.
18. Ouma VM, Okeyo DO, Onyango R. Level of willingness and ability to invest in sanitation facilities by households in Busia County. Public Health Research. 2017;7(5): 112-118. **Google Scholar**

19. Muktar AM, Saba CKS, Adzo DD. Knowledge, attitudes and practices (KAP) towards community-led total sanitation (CLTS) behaviours among communities in Northern Ghana. Journal of Health and Environmental Research. 2024;10(3): 65-77.
20. Debesay N, Ingale L, Gebresilassie A, Assefa H, Yemane D. Latrine utilization and associated factors in the rural communities of Gulomekada District, Tigray Region, North Ethiopia, 2013: A community-based cross-sectional study. Journal of Community Medicine & Health Education. 2015 Jan;5(1): 1-7.
21. Ntaro M, Owokuhaisa J, Isunju JB *et al*. Contextual and psychological factors influencing open defecation free status: an exploratory qualitative study in rural South Western Uganda. BMC Public Health. 2022 Mar 1;22(1): 414. **PubMed**| **Google Scholar**
22. Ondieki JK, Akunga DN, Warutere PN, Kenyanya O. Socio-demographic and water handling practices affecting quality of household drinking water in Kisii Town, Kisii County, Kenya. Heliyon. 2022 May 14;8(5): e09419. **PubMed**| **Google Scholar**
23. Khalid H, Martin EG. Female-Headed Households Associated with Lower Childhood Stunting Across Culturally Diverse Regions of Pakistan: Results from a Cross-Sectional Household Survey. Matern Child Health J. 2017 Oct;21(10): 1967-1984. **PubMed**| **Google Scholar**
24. Plan International. Climate change, Young Women and Girls: Vulnerability, Impacts and Adaptation in Northern Thailand. 2019. Accessed on May 2, 2025.
25. Nkatha SM, Muchiri EM, Kubai P, Rutto J. Physical and social demographic factors affecting utilization of pit latrine in Tigania East, Meru County, Kenya. Journal of Scientific Research and Reports. 2020;26(8): 122-132. **Google Scholar**
26. Busienei PJ, Ogendi GM, Mokua MA. Open Defecation Practices in Lodwar, Kenya: A Mixed-Methods Research. Environ Health Insights. 2019 Feb 19;13: 1178630219828370. **PubMed**| **Google Scholar**
27. Showkat N. Coverage of sanitation issues in India. Sage Open. 2016 Nov;6(4): 2158244016675395. **Google Scholar**
28. Issuelab. What Influences Open Defecation and Latrine Ownership in Rural Households? Findings from a Global Review. Water and Sanitation Program; August 2014. Accessed on June 2, 2025.
29. Water and Sanitation Program. **Factors** Associated with Achieving and Sustaining Open Defecation-Free Communities: Learning from East Java.Washington, DC: World Bank; 2011. Accessed on June 2, 2025.
30. UNICEF. Strategy for Water, Sanitation and Hygiene 2016–2030. 2016. Accessed on June 2, 2025.

| **Table 1:** socio-demographic characteristics of respondents in Kowili sub-location in Rachuonyo sub-county | | | |
|---|---|---|---|
| **Variables** | **Response** | **Frequency(n)** | **Percentage (%)** |
| **Age** | 18-24 years | 16 | 6.7 |
| | 25-34 years | 63 | 26.3 |
| | 35-45 years | 84 | 35.0 |
| | >45 years | 77 | 32.1 |
| **Gender** | Female | 160 | 66.7 |
| | Male | 80 | 33.3 |
| **Marital status** | Single | 12 | 5.0 |
| | Married | 156 | 65.0 |
| | Divorced | 8 | 3.3 |
| | Widowed | 64 | 26.7 |
| **Household head** | Husband | 121 | 57.4 |
| | Mother | 87 | 41.2 |
| | Uncle | 1 | .5 |
| | Father-in-law | 2 | .9 |
| **Family size** | 1-3 members | 55 | 22.9 |
| | 3-6 members | 126 | 52.5 |
| | 6-9 members | 53 | 22.1 |
| | 9-12 members | 2 | .8 |
| | over 12 members | 4 | 1.7 |
| **Number of children below 5 years** | 1 | 92 | 38.3 |
| | 2 | 78 | 32.5 |
| | 3 | 10 | 4.2 |
| | 4 | 12 | 5.0 |
| | >4 | 48 | 20.0 |
| **Level of education** | Informal education | 21 | 8.8 |
| | Primary school | 134 | 55.8 |
| | Secondary school | 74 | 30.8 |
| | Tertiary and above | 11 | 4.6 |
| **Occupation of the household head** | Formal salaried employee | 19 | 8.3 |
| | Informal salaried employee | 19 | 8.3 |
| | Unemployed | 115 | 50.0 |
| | Business | 77 | 33.5 |
| **Household monthly income** | <5000 | 166 | 69.2 |
| | 5000-10000 | 34 | 14.2 |
| | 10000-15000 | 14 | 5.8 |
| | 15000-20000 | 15 | 6.3 |
| | >20000 | 11 | 4.6 |

| **Table 2:** association between socio-demographic characteristics and sustenance of ODF status | | | | |
|---|---|---|---|---|
| **Variables** | **Sustenance of ODF status F (%)** | **Non-sustenance of ODF status F (%)** | **Chi-square** | **P-value** |
| **Age** | | | | |
| <18 years | 5(2.1) | 0(0) | 145.64 | <0.001 |
| 18-24 years | 11(4.6) | 0(0) | | |
| 25-34 years | 63(26.2) | 0(0) | | |
| 35-45 years | 84(35) | 0(0) | | |
| >45 years | 23(9.6) | 54(22.5) | | |
| **Gender** | | | 137.6 | |
| Female | 160(66.7) | 0(0) | | <0.001 |
| Male | 26(10.8) | 54(22.5) | | |
| **Marital status** | | | 194.89 | |
| Single | 12(5) | 0(0) | | <0.001 |
| Married | 156(65) | 0(0) | | |
| Divorced | 8(3.3) | 0(0) | | |
| Widowed | 10(4.2) | 54(22.5) | | |
| **Household head** | | | 11.94 | |
| Husband | 121(57.4) | 0(0) | | <0.001 |
| Mother | 81(38.4) | 6(2.8) | | |
| Uncle | 0(0) | 1(0.5) | | |
| Father-in-law | 0(0) | 2(0.9) | | |
| **Family size** | | | 211.05 | |
| 1-3 members | 55(22.9) | 0(0) | | <0.001 |
| 3-6 members | 126(52.5) | 0(0) | | |
| 6-9 members | 5(2.1) | 48(20) | | |
| 9-12 members | 0(0) | 2(0.8) | | |
| over 12 members | 0(0) | 4(1.7) | | |
| **Number of children below 5 years** | | | 223.72 | |
| 1 | 92(38.3) | 0(0) | | <0.001 |
| 2 | 78(32.5) | 0(0) | | |
| 3 | 10(4.2) | 0(0) | | |
| 4 | 6(2.5) | 6(2.5) | | |
| >4 | 0(0) | 48(20) | | |
| **Level of education** | | | 135.0 | |
| Informal Education | 21(8.8) | 0(0) | | <0.001 |
| Primary school | 134(55.8) | 0(0) | | |
| Secondary school | 31(12.9) | 43(17.9) | | |
| Tertiary and above | 0(0) | 11(4.6) | | |
| **Occupation of the household head** | | | 98.37 | |
| Formal Salaried employee | 19(8.3) | 0(0) | | <0.001 |
| Informal salaried employee | 19(8.3) | 0(0) | | |
| Unemployed | 115(50) | 0(0) | | |
| Business | 33(14.3) | 44(19.1) | | |
| **Household monthly income** | | | 131.49 | |
| <5000 | 116(69.2) | 0(0) | | <0.001 |
| 5000-10000 | 20(8.3) | 14(5.8) | | |
| 10000-15000 | 0(0) | 14(5.8) | | |
| 15000-20000 | 0(0) | 15(6.2) | | |
| >20000 | 0(0) | 11(4.6) | | |
| F (%) represents the frequency and percentage of respondents in each category | | | | |

| **Table 3:** socio-demographic factors associated with the sustenance of ODF villages in Kowili sub-location | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model** | | **Unstandardized coefficients** | | **Standardized coefficients** | **t** | **Sig.** | **95.0% confidence interval for B** | |
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 0.779 | 0.061 | | 12.825 | 0.000 | 0.659 | 0.899 |
| | Age of the respondent | -0.134 | 0.026 | -0.390 | -5.138 | 0.000 | -0.185 | -0.082 |
| | Gender | -0.044 | 0.063 | -0.059 | -0.699 | 0.485 | -0.170 | 0.081 |
| | Marital status | 0.171 | 0.037 | 0.429 | 4.607 | 0.000 | 0.098 | 0.244 |
| | Household head | 0.103 | 0.019 | 0.420 | 5.377 | 0.000 | 0.065 | 0.141 |
| | Family size | 0.136 | 0.038 | 0.261 | 3.597 | 0.000 | 0.061 | 0.210 |
| | Number of children below 5 years | 0.058 | 0.034 | 0.220 | 1.715 | 0.088 | -0.009 | 0.124 |
| | Level of education | 0.065 | 0.064 | 0.116 | 1.003 | 0.317 | -0.062 | 0.191 |
| | Household head occupation | -0.075 | 0.041 | -0.197 | -1.831 | 0.069 | -0.155 | 0.006 |
| | Household monthly income | 0.022 | 0.056 | 0.037 | 0.394 | 0.694 | -0.088 | 0.132 |
| Unstandardized coefficients (B) and significance level (Sig.) | | | | | | | | |

| **Table 4:** factors reported to influence the sustenance of ODF villages in Kowili sub-location | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Factors** | **FGDE I** | **FGD II** | **FGD III** | **FGD IV** | **FGD V** | **FGD VI** | **FGD VII** | **FGD VIII** | **FGD IX** | **FGD X** | **Total** |
| Continuous health education | √ | √ | √ | √ | | √ | √ | √ | | √ | 8 |
| Continuous follow-up | √ | √ | √ | | √ | √ | √ | √ | √ | √ | 9 |
| Provincial administration involvement | √ | √ | √ | √ | √ | √ | √ | √ | | √ | 9 |
| Law enforcement by various agencies | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | 10 |
| Involvement of faith-based organizations and theatre groups | | | | √ | √ | | √ | | | | 3 |
| The SNV approach to sanitation | | | | | | | | | √ | | 1 |
| ODF: open defecation free; FGD: focus group discussion; SNV: Netherlands Development Organisation | | | | | | | | | | | |