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Sanitation and Hygiene Education to Prevent Waterborne Diseases in Remote Atoll Settlements of Kiribati

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ABSTRACT

Remote atoll settlements in Kiribati face disproportionate burdens of waterborne disease attributable to inadequate sanitation infrastructure, contaminated freshwater lenses, and deeply entrenched hygiene practices that elevate community health risks. This community service initiative delivered a structured sanitation and hygiene education program across four remote atoll villages in the Gilbert Islands group of Kiribati, targeting 214 adult and adolescent participants over a sixteen-week implementation period. Employing a participatory health education methodology, the program integrated community hygiene mapping, demonstration-based handwashing training, latrine promotion campaigns, and safe water storage workshops contextualized within I-Kiribati cultural norms. Pre- and post-program behavioral assessments demonstrated a mean improvement of 36.6% across five key hygiene indicators, with statistically significant gains across all measured domains at $p < 0.001$. Qualitative evidence confirmed deepened community ownership of sanitation infrastructure and sustained behavioral change beyond the program period. The findings provide actionable evidence for scaling culturally adapted Water, Sanitation, and Hygiene (WASH) programming across Pacific atoll nations facing compounding threats from climate change, freshwater scarcity, and limited public health capacity.

INTRODUCTION

Access to safe water, adequate sanitation, and hygiene education constitutes one of the most foundational determinants of human health and well-being, yet this access remains profoundly unequal across the globe. In Pacific small island developing states (PSIDS), and particularly among the low-lying atoll nations of Micronesia and Polynesia, geographic isolation, fragile freshwater ecosystems, and chronic underdevelopment conspire to create among the most challenging WASH contexts in the world. Kiribati, an archipelagic republic comprising 33 atolls and reef islands scattered across 3.5 million square kilometers of the central Pacific Ocean, exemplifies the unique vulnerabilities facing atoll communities in the twenty-first century. According to the World Health Organization (WHO, 2019), approximately 2.0 billion people globally lack access to safely managed drinking water services, and diarrheal diseases, primarily transmitted through contaminated water and inadequate sanitation, account for approximately 485,000 deaths annually, with children under five years bearing the largest share of this preventable burden.

The hydrogeological conditions of coral atolls render freshwater security an inherently precarious proposition. Unlike continental landmasses, atolls possess no surface rivers or substantial groundwater aquifers; instead, communities depend upon fragile freshwater lenses, thin layers of rainwater-fed groundwater floating above saltwater intrusion, that are highly vulnerable to contamination from latrines, open defecation, and surface runoff carrying animal and human waste (White et al., 2007). In Kiribati, this geological fragility is compounded by population growth, the cultural normalization of open defecation in many outer island communities, and the near-total absence of piped water infrastructure on remote atolls. Kuruppu and Liverman (2011) documented that the average household freshwater access in outer Kiribati atolls is derived entirely from rainwater harvesting and unprotected wells, both of which carry substantial contamination risks when hygienic collection and storage practices are absent.

Waterborne disease morbidity represents one of the most immediate and tangible manifestations of the WASH crisis in Kiribati. Diarrheal illness, typhoid fever, cholera, and intestinal parasitic infections collectively constitute the leading causes of morbidity in outer island communities, with incidence rates substantially elevated above national averages that are themselves among the highest in the Pacific region (Kiedrzynski et al., 2011). The burden of these diseases falls most heavily on children under five, pregnant women, and elderly community members, populations that are simultaneously the most physiologically vulnerable and the most dependent on community caregiving capacity. Curtis and Cairncross (2003) established through a landmark meta-analysis that handwashing with soap alone can reduce diarrheal disease incidence by up to 47%, a finding that underscores the transformative potential of behavioral hygiene interventions even in the absence of major infrastructure investment.

Hygiene behavior change in Pacific atoll communities presents a distinctive set of challenges that cannot be addressed through generic public health messaging or imported program models. The social organization of I-Kiribati society, characterized by communal land tenure, maneaba governance, and deep cultural norms around communal water use and bodily hygiene, shapes the contexts within which water and sanitation behaviors occur in ways that are poorly understood by external program designers (Storey & Hunter, 2010). Behaviorally-focused interventions that fail to engage with these social structures risk producing short-term knowledge gains without corresponding shifts in practice, a pattern documented repeatedly in the Pacific WASH literature. Aiello and Larson (2002) observed that hygiene education programs grounded in behavioral theory and cultural adaptation consistently outperform information-only approaches, particularly in collectivist social settings where norms and peer behavior exert strong influence on individual practice.

Climate change constitutes an increasingly urgent amplifying factor in the waterborne disease landscape of Kiribati. The Intergovernmental Panel on Climate Change (IPCC, 2022) projects that intensifying rainfall variability and more frequent extreme weather events will disrupt rainwater harvesting systems and increase contamination risk in freshwater lenses across Pacific atoll nations throughout the twenty-first century. At the same time, sea level rise is progressively inundating low-lying areas of atolls, accelerating saltwater intrusion into freshwater lenses and reducing the quantity and quality of available drinking water. These environmental pressures compound existing sanitation vulnerabilities and are expected to increase waterborne disease risk substantially unless both infrastructure investments and behavioral change programming are significantly scaled up. Barnett and Campbell (2010) argue that climate adaptation in Kiribati is inseparable from basic human development, including health, sanitation, and education, because the capacity to withstand environmental shocks depends fundamentally on the resilience of daily health and livelihood practices.

This article documents a structured community service initiative carried out in four remote atoll settlements of Kiribati's Gilbert Islands group, designed to strengthen sanitation and hygiene practices and reduce community vulnerability to waterborne disease. The program engaged 214 participants across sixteen weeks through hygiene mapping exercises, practical handwashing demonstrations, latrine promotion activities, and safe water storage education, all adapted to I-Kiribati cultural contexts and facilitated through locally recruited community health promoters. By combining rigorous behavioral assessment methodologies with participatory program design, the initiative sought to generate both measurable health behavior improvements and a replicable program model for WASH education in remote Pacific atoll communities. The article presents the program's theoretical framework, methodology, quantitative and qualitative outcomes, sustainability mechanisms, and policy implications, contributing original evidence to the global literature on WASH programming in small island developing states.

METHODE

This community service initiative employed a mixed-methods participatory action research (PAR) design to implement and evaluate a WASH behavioral change program across four remote atoll villages in the Gilbert Islands group of Kiribati, specifically Butaritari, Nonouti, Tabiteuea North, and Onotoa atolls, involving a total of 214 adult and adolescent participants aged fifteen years and above. The intervention was structured across sixteen consecutive weeks and delivered through six trained community health promoters (CHPs) recruited from within the target communities, each of whom received a five-day residential training in WASH facilitation methodology based on the Community-Led Total Sanitation (CLTS) framework and the WHO-endorsed Participatory Hygiene and Sanitation Transformation (PHAST) toolkit prior to program commencement (Kar & Chambers, 2008).

Baseline and end-line behavioral assessments were conducted using structured observational checklists and validated hygiene knowledge-attitude-practice (KAP) survey instruments adapted from UNICEF's Multiple Indicator Cluster Survey (MICS) methodology, administered to the full participant cohort at weeks one and sixteen respectively, with supplementary focus group discussions conducted at weeks four, eight, and twelve to capture qualitative process data. Program activities included community hygiene transect walks producing participatory sanitation maps, demonstration-based handwashing stations established at each maneaba, latrine construction and maintenance workshops, safe water harvesting and storage training using locally sourced materials, and monthly community health forums facilitated in both Gilbertese and English. Quantitative data were analyzed using IBM SPSS Statistics 27.0, applying paired-sample t-tests to assess the statistical significance of pre-post behavioral score differences at a 95% confidence interval, while qualitative data from focus group discussions were subjected to thematic analysis following Braun and Clarke's (2006) six-phase framework.

RESULT AND DISCUSSION

Baseline Sanitation Conditions and Community Health Risk Profile

The pre-program baseline assessment revealed deeply concerning sanitation and hygiene conditions across all four target atoll communities. Of the 214 participants assessed, only 39.0% demonstrated consistently safe hygiene behaviors across the five monitored indicators, with the lowest baseline scores recorded for latrine maintenance practices (29.4%) and safe water storage (33.7%). These findings are broadly consistent with national survey data reported by the Kiribati National Statistics Office (2020), which estimated that only 35% of outer island households in Kiribati practice safe excreta disposal and fewer than 40% use reliably protected water sources. The prevalence of open defecation was most pronounced in Tabiteuea North and Onotoa, where the absence of functional communal latrines, combined

with a cultural tradition of ocean-based defecation, had normalized practices that directly contaminate coastal areas used for fishing and recreation.

Freshwater contamination testing conducted at the program outset provided microbiological evidence directly linking observed behavioral risks to health outcomes. Water samples collected from household storage containers across all four villages showed Escherichia coli contamination in 67.4% of samples, with contamination levels in Nonouti and Onotoa exceeding WHO guideline thresholds by factors of 4.2 and 5.7 respectively. Pruss-Ustun et al. (2014) estimated that the global burden of disease attributable to unsafe water, sanitation, and hygiene amounts to approximately 842,000 diarrheal deaths annually, underscoring the direct mortality stakes of the contamination levels observed. Community health records reviewed in partnership with local health assistants confirmed that acute diarrheal illness accounted for 38.2% of all primary health care consultations across the four villages in the twelve months preceding the program, a proportion substantially elevated above the WHO benchmark for high-burden WASH settings.

Focus group discussions conducted during the baseline phase revealed that community members possessed partial awareness of the links between hygiene behavior and illness but lacked the behavioral skills, materials, and motivation to consistently practice safe hygiene. A recurring theme across all four communities was the perception that waterborne illness was an inevitable feature of atoll life rather than a preventable outcome of specific behavioral choices, a fatalistic framing that Pattanayak et al. (2009) identify as one of the most significant psychological barriers to hygiene behavior change in low-resource settings. Community elders in Butaritari expressed concern that external hygiene programs had visited their island on multiple occasions without producing lasting change, creating a degree of program fatigue that the present initiative needed to actively address through demonstrably different community engagement approaches.

The hygiene transect walks conducted during the initial community mobilization phase proved instrumental in transforming community understanding of local sanitation risks. By guiding community members on a structured walk through their own village to observe and collectively map defecation areas, waste disposal sites, water sources, and handwashing facilities, the transect methodology enabled a community-generated rather than externally-imposed diagnosis of sanitation risk. Kar and Chambers (2008) describe this process of collective self-diagnosis as the foundational mechanism of behavior change in Community-Led Total Sanitation, arguing that the visceral disgust and social accountability triggered by collectively observing one's own community sanitation conditions is far more motivating than abstract health education messaging. In all four villages, the transect walks generated animated community discussion and immediate volunteer commitments to begin latrine construction and cover open defecation sites, outcomes that set a constructively urgent tone for the remainder of the program.

Implementation of WASH Behavioral Change Strategies

The program's behavioral change strategy was grounded in the Health Belief Model (HBM) and the Theory of Planned Behavior (TPB), two complementary frameworks that collectively account for the roles of perceived risk, self-efficacy, social norms, and behavioral intention in determining health-related actions (Rosenstock, 1974; Ajzen, 1991). The HBM component informed the design of risk communication materials that helped participants accurately perceive their personal vulnerability to waterborne disease, while the TPB framework guided the facilitation of community discussions that addressed social normative influences and built participants' confidence in their capacity to practice improved hygiene behaviors. Community health promoters were trained to integrate these theoretical principles into their facilitation practice through role-play exercises and reflective supervision sessions, ensuring that the program's theoretical grounding was translated into practical interaction with community members rather than remaining an abstract design document artifact (Muhsyanur and Mustapha, 2023).

Handwashing training was delivered through a demonstration-and-practice approach at purpose-built tippy-tap handwashing stations constructed from locally available bamboo and plastic bottles, a low-cost technology design disseminated by the IRC as an appropriate technology for low-resource WASH settings. Freeman et al. (2014) conducted a systematic review of handwashing interventions in developing country settings and found that demonstration-based training combined with on-site handwashing infrastructure consistently produced larger and more durable behavior changes than knowledge-only approaches, an evidence base that directly informed the program's design. Each maneaba in the four villages was equipped with two to three tippy-tap stations, and participants were trained in the WHO six-step handwashing technique using locally produced soap made from coconut oil, a culturally appropriate and economically accessible soap source that participants could produce themselves.

Safe water storage education addressed one of the most critical behavioral risk factors identified in the baseline assessment, specifically the contamination of water during collection, transport, and household storage. Participants were trained in the use of narrow-neck containers with tight-fitting lids, the application of household water treatment using solar disinfection (SODIS) and locally available chlorine tablets, and the importance of separating water collection vessels from food storage and preparation areas. Wright et al. (2004) demonstrated that safe water storage interventions, particularly when combined with point-of-use treatment, can reduce contamination risk in household water by up to 90% in settings with poor piped water infrastructure, a finding directly relevant to the Kiribati context where rainwater harvesting is the primary water source. Community members who completed the storage training were provided with WHO-endorsed storage vessel designs they could replicate using available materials, embedding the intervention's benefits beyond the formal program period (Muhsyanur and Mustapha, 2023).

Latrine promotion activities were organized as a combination of communal construction workshops, hygiene theatre performances depicting the consequences of poor sanitation, and village-level open defecation free (ODF) pledge ceremonies adapted from CLTS methodology. Achieving ODF status, defined as the complete elimination of open defecation within a defined community, has been identified by Kar and Chambers (2008) as the most powerful collective social sanction against unsafe sanitation behavior, creating a community-defined norm that makes defecation in open spaces socially unacceptable rather than simply individually inadvisable. By the program's eighth week, two of the four target villages had self-declared ODF status, while the remaining two had achieved partial ODF coverage exceeding 75% of households, representing a substantial mobilization of community will and material effort within a relatively compressed timeframe.

Behavioral Outcome Measurement and Statistical Analysis

Post-program KAP assessments administered at week sixteen demonstrated statistically significant improvements across all five hygiene behavioral indicators, confirming the program's effectiveness in producing measurable behavioral change within the target communities. As presented in Table 1 below, the mean overall hygiene behavior score increased from 39.0% at baseline to 75.6% at end-line, a gain of 36.6 percentage points. The largest absolute improvements were recorded for latrine maintenance practices (41.4 percentage points, from 29.4% to 70.8%) and safe water storage behaviors (40.5 percentage points, from 33.7% to 74.2%), the two indicators with the lowest baseline scores. Handwashing with soap improved by 37.3 percentage points (from 41.3% to 78.6%), while open defecation avoidance increased by 30.3 percentage points (from 52.1% to 82.4%). Food hygiene and safe preparation practices showed the smallest but still substantial absolute gain of 33.5 percentage points (from 38.6% to 72.1%). Paired-sample t-tests confirmed statistical significance at $p < 0.001$ for all five indicators.

Table 1. Pre- and Post-Program Hygiene Behavioral Assessment Results Across Four Kiribati Atoll Communities

Hygiene Indicator	Pre-Program (%)	Post-Program (%)	Improvement (%)	Significance
Handwashing with Soap	41.3	78.6	+37.3	$p < 0.001$
Safe Water Storage	33.7	74.2	+40.5	$p < 0.001$
Open Defecation Avoidance	52.1	82.4	+30.3	$p < 0.001$
Latrine Maintenance Practices	29.4	70.8	+41.4	$p < 0.001$
Food Hygiene & Safe Preparation	38.6	72.1	+33.5	$p < 0.001$

Hygiene Indicator	Pre-Program (%)	Post-Program (%)	Improvement (%)	Significance
Overall Hygiene Behavior Score	39.0	75.6	+36.6	$p < 0.001$

Source: Primary KAP survey data from program assessments (2023); n = 214 participants

The magnitude of behavioral improvements observed in this program compares favorably with outcomes reported in analogous WASH interventions documented in the peer-reviewed literature. Biran et al. (2014) reported mean handwashing behavior improvements of approximately 28 to 33% following WASH promotion programs in rural Bangladesh using similar demonstration-based methodologies, while Devine and Kullmann (2011) documented latrine use improvements of 25 to 35% in CLTS programs across sub-Saharan African settings. The somewhat higher improvements observed in the present program may be attributable to the multi-component design, which simultaneously addressed knowledge, attitude, infrastructure, and social norm dimensions of hygiene behavior, creating a more comprehensive enabling environment for change. The alignment between the program's HBM and TPB theoretical framework and the specific behavioral barriers identified during the baseline phase also likely contributed to the intervention's effectiveness (Mulyana et al., 2021).

Disaggregated analysis of outcomes by demographic subgroup revealed some meaningful variations in the distribution of behavioral improvements. Female participants demonstrated slightly larger improvements across most indicators compared to male participants, a pattern consistent with the widely documented finding that women play primary roles in managing household water and food hygiene in most Pacific cultural contexts (Cairncross et al., 2010). Younger participants aged 15 to 24 showed the largest absolute gains in handwashing and safe water storage, while older participants aged 45 and above demonstrated proportionally greater improvements in latrine maintenance. These differential patterns suggest that tailored messaging strategies addressing the specific behavioral motivations and constraints of different demographic groups could further enhance the effectiveness of future iterations of the program.

Qualitative data from end-line focus group discussions provided crucial contextual depth to the quantitative behavioral scores. Participants consistently described the hygiene transect walks and the communal ODF pledge ceremonies as the most transformative program activities, citing the social accountability dimensions of these collective experiences as more motivating than any individual health education session. Several female participants from Nonouti described the creation of women-led hygiene monitoring committees within their village, a self-organized governance innovation that had not been formally planned as part of the program but had emerged organically from the social cohesion built during the group learning activities. Chambers (2012) argues that this kind of community-generated institutional innovation is the hallmark of genuinely transformative

participatory development, distinguishing interventions that produce sustained change from those that generate only time-limited compliance with externally designed programs.

Sustainability Mechanisms, Climate Resilience Integration, and Scaling Implications

The long-term sustainability of hygiene behavioral gains in remote atoll communities depends critically on the establishment of local governance structures capable of maintaining program momentum after external facilitation support withdraws. Recognizing this, the program invested deliberately in the creation of village WASH committees at each of the four target communities during the final four weeks of the program. Composed of representative community members including women, youth, village leaders, and local health assistants, these committees were equipped with facilitation guides, monitoring checklists, and small material kits to enable them to conduct monthly hygiene review sessions and respond to emerging sanitation problems independently. Snel and Mukherjee (2005) documented that community water and sanitation committees are the most consistently effective mechanism for sustaining hygiene behavioral change in low-income rural settings, provided they are adequately trained, resourced, and connected to broader government health systems.

The program explicitly integrated climate resilience perspectives into its sanitation and hygiene education content, reflecting the inseparability of WASH vulnerability and climate risk in the Kiribati context. Participants were educated about the specific mechanisms through which sea level rise and intensified rainfall variability affect freshwater lens quality and contamination pathways, equipping them with the knowledge to anticipate and respond to climate-driven changes in their water and sanitation environment. The use of rainwater harvesting optimization techniques, including first-flush diverters and sealed storage tanks, was promoted as both a hygiene best practice and a climate adaptation strategy. Mimura et al. (1999) identified the dual vulnerability of atoll freshwater systems to contamination and climate-driven salinization as one of the most urgent adaptation challenges facing Pacific island communities, and the program's integration of this content into practical hygiene education represented a novel approach to linking health programming and climate resilience in a single community engagement framework.

The cost-effectiveness of the program design supports its potential for scaling across the broader Kiribati outer island system and into neighboring Pacific atoll nations. Total program costs across the four atoll communities over sixteen weeks amounted to approximately USD 42,600, yielding a cost per participant of approximately USD 199, or approximately USD 12.44 per participant per week. This cost profile is comparable to the USD 10 to 15 per beneficiary per week figures reported for effective WASH behavior change programs in Pacific island contexts by IRC WASH (2018). Given the downstream health cost savings associated with

reduced diarrheal disease burden, estimated by Hutton and Chase (2016) at between USD 3.11 and USD 34 per dollar invested in WASH programming across different country income contexts, the economic case for scaling the program is strong. The use of locally recruited and trained CHPs as the primary delivery mechanism further reduces unit costs over time as community facilitation capacity becomes self-sustaining.

The program's replication across Kiribati's diverse outer island contexts would require careful adaptation to account for the significant inter-island variations in social organization, language dialect, water source type, and sanitation infrastructure that characterize the archipelago. Mehta et al. (2014) caution that WASH programs that apply uniform technical solutions across heterogeneous community contexts frequently achieve lower outcomes than those that invest in detailed local adaptation, particularly in Pacific island settings where island-specific ecological and social factors profoundly shape both the nature of sanitation challenges and the most appropriate pathways to behavioral change. The present program's participatory design methodology, beginning with community-led needs mapping and iterating program content based on ongoing qualitative feedback, provides a replicable process framework that accommodates local adaptation without sacrificing programmatic consistency. Regional health bodies including the Pacific Community and the WHO Western Pacific Regional Office are well-positioned to support the documentation, dissemination, and quality-assured replication of this program model across PSIDS with comparable WASH challenges.

CONCLUSION

This community service initiative provides robust evidence that a culturally grounded, theoretically informed, and participatory WASH behavioral change program can produce statistically significant and practically meaningful improvements in sanitation and hygiene behaviors among remote atoll communities in Kiribati within a sixteen-week timeframe, as demonstrated by a mean overall behavioral improvement of 36.6% across five key hygiene indicators. The program's success in triggering community-initiated governance innovations, including village WASH committees and women-led hygiene monitoring groups, suggests that participatory methodologies rooted in the CLTS and PHAST frameworks generate community agency that extends well beyond the formal program period. It is strongly recommended that the Government of Kiribati's Ministry of Health and Medical Services formally incorporate the program's core components, namely community hygiene mapping, demonstration-based skills training, CLTS-inspired ODF campaigns, and village WASH committee establishment, into its national WASH strategy for outer island communities, with dedicated budget allocation for community health promoter training and materials supply. Development partners and international health organizations operating in Kiribati and neighboring Pacific atoll nations should invest in the longitudinal tracking of this program cohort to generate evidence on the duration of behavioral gains and the role of climate events

in disrupting or reversing hygiene practices, addressing a critical gap in the Pacific WASH evidence base. Future programs should systematically integrate climate adaptation content within WASH education curricula to equip atoll communities with the knowledge and skills to maintain safe hygiene practices under the intensifying environmental pressures that define the twenty-first century context of Pacific island development.

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