

Determinants of Complementary Food Handling Practices in Conflict-Affected Tigray, Ethiopia: A Qualitative Exploration

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Abstract

This study aimed to determine complementary food handling practices among mothers/caregivers of children aged 6–59 months in conflict-affected Tigray, Ethiopia: The role of structural conditions, WASH Insecurity, and health-system factors. This is community-based exploratory qualitative study was conducted from March to April 2026 to explore factors shaping safe food-handling practices among mothers/caregivers of children aged 6–59 months in conflict-affected Tigray, Northern Ethiopia. A total of eleven in-depth interviews (IDIs), three focus group discussions (FGDs), and ten key informant interviews (KIIs) (41 individuals) were conducted with mothers or caregivers.

The purposive sampling technique was used to include study participants based on their potential relevance in delivering a wealth of information. Thematic analysis were used to code and grouped into related families and synthesize the qualitative data. Discussions and interviews were audio-recorded, transcribed into the local language "Tigrigna," then translated into English and thematically coded using ATLAS-ti v.7.5.4 software. Mothers/caregivers actively want to practice proper hygiene of food preparation and handling for children and be completely educated on the risks to prevent cross-contamination. However, they acute lack of clean, safe water, lack the material resources, such as refrigeration, separate kitchens, soap, and affordable fuel, and reducing the time and capacity they can dedicate to meticulous, hygienic infant feeding practices, to put into practice. Therefore, mothers are forced to rely on dangerous proxy-feeding habits, such as storing leftover foods without refrigeration and based on sight and smell to see if food has spoiled and use unclean, unsafe water. The majority of health care providers (HCPs), especially general public health, family health, and health officers, have some knowledge of safe food handling practices, recognize its importance, and provide specific components of safe food handling practices interventions. However, these services are often delivered in a fragmented manner. Complementary food handling practices among mothers/caregivers of young children in conflict-affected Tigray are formed by a complicated matrix of structural, environmental, and socio-political determinants. While mothers/caregivers own baseline knowledge regarding food hygiene, their ability to execute safe practices is systematically constrained by severe WASH insecurity, poverty, and displacement. Handling strategies such as using wood ash for cleaning, relying on ambient-temperature food storage, and avoiding food waste at all costs represent rational adaptations to severe resource scarcity. Addressing food safety in post-conflict and humanitarian settings requires moving beyond individual behavior-change education toward structural enabling strategies that restore the physical, economic, and institutional environments necessary for safe child care.

Introduction

The global burden of foodborne disease presents a persistent and significant public health challenge, resulting in considerable impacts on human morbidity, mortality, and economic productivity in both high- and low-income countries (1, 2). Worldwide, contaminated food containing pathogenic microorganisms or chemical agents accounts for hundreds of millions of preventable illnesses and hundreds of thousands of mortalities annually (1, 3). This epidemiological burden is disproportionately concentrated

in low- and middle-income countries (LMICs), where weak regulatory enforcement, inadequate environmental sanitation, and fragile food supply chains exacerbate exposure risks (2, 4). Consequently, mitigating food safety hazards remains a critical global imperative within broader public health and sustainable development frameworks (1, 4).

Foodborne diseases are one of the most serious public health problems of the contemporary world, causing illness in millions of people every year in both developed and developing areas. Even though the prevalence of foodborne diseases in the world is affected by the role of environmental factors, socio-economic equality, the dynamic nature of the population, and the world's food production systems, the issue regarding the prevalence of foodborne illness in the world tends to be posed by the same four bacteria each year (5). These causative agents include the following four types of bacteria, namely *Salmonella*, *Campylobacter*, *Listeria monocytogenes*, and Shiga toxin-producing *Escherichia coli*.

Food safety practice is vital to minimize food-borne disease and has a huge impact on human health around the world, raising concerns among consumers, producers, and policymakers (6). Food-borne diseases remain a major public health problem globally and are responsible for significant morbidity and mortality (7). Foodborne diseases have a significant global impact, affecting people of all ages, particularly children under the age of 5, who are disproportionately affected in low-income countries (8). Children, particularly those under five years, bear a disproportionate burden of foodborne illness in low- and middle-income countries (LMICs), accounting for approximately 40% of cases in Africa (9).

Despite its small contribution to the world's population, sub-Saharan Africa shows significantly high rates of mortality from foodborne diseases (10). Among the reasons why the region faces the same risks despite the low population contribution is the lack of access to healthcare. This limits the time for diagnosis and consequently worsens the health outcomes. Though, the lack of regulation in the production process of food is also common. Also, the implementation of food safety regulations is not consistent. Additionally, the existence of the free market for food in sub-Saharan Africa is significant. However, the free market for food in the region lacks good hygiene practices (11, 12).

The market lacks the means to cool food. Therefore, the possibility of food being contaminated by foodborne illnesses like *Salmonella* and *Campylobacter* in sub-Saharan Africa exists. Issues related to the clarity of water in sub-Saharan Africa make the problem worse. In Sub-Saharan Africa (SSA), foodborne illnesses are amplified by challenges like unsafe water use, poor hygiene in food production and storage, and climate-related factors that favor pathogen growth, leading to high contamination rates in foods like poultry and vegetable (13).

In Sub-Saharan Africa (SSA), mothers' KAP on safe food handling remains low, with only about 50% adhering to good hygiene practices, directly linked to elevated foodborne illness rates in under-5 children, including 26% malnutrition prevalence in some areas (9).

Vulnerability of infants and young children under five years of age represent an exceptionally vulnerable demographic, bearing nearly one-third of the global mortality burden associated with foodborne

infections despite accounting for a small fraction of the global population (1, 14) .

This heightened vulnerability stems from an immature immune system, developing gut microbiota, and higher physiological food and fluid intake per unit of body weight (15, 16). The risk of foodborne pathogenic micro-organism transmission increases around six months of age, according with the introduction of complementary foods to supplement breast milk (16, 17). Contaminated complementary preparations frequently act as vehicles for enteric pathogens, triggering recurrent diarrheal episodes, environmental enteric dysfunction, nutrient malabsorption, and long-term physical stunting (16, 17).

Regarding the household complementary food handling; the regulatory bodies and commercial food safety initiatives frequently focus on industrial supply chains, the primary nexus of microbial contamination for young children in low- and middle-income countries (LMICs) exists within the households sphere (18, 19). Household food safety encompassing the hygiene practices surrounding the storage, preparation, handling, and feeding of complementary meals serves as the direct frontline defense against pediatric pathogenic micro-organism ingestion (18, 20). Insufficient households practices, such as storing cooked meals at ambient temperatures for long periods, preparing food with unwashed hands, using contaminated water, and utilizing unsterilized utensils, quickly transform complementary foods into unsafe paths for enteric pathogens like *Escherichia coli* and *Salmonella* species (16, 20). Ensuring microbiological safety during household complementary food preparation is therefore as crucial to child survival and development as nutritional adequacy (18, 19).

The Knowledge practices of conventional public health programs often functional on the supposition of that educating mothers/caregivers on hygiene principles will directly induce behavioral change; however, a widespread gap continues between mothers/caregivers' knowledge and actual hygienic practice (21, 22). Rising empirical evidence indicates that while mothers/caregivers frequently own accurate knowledge regarding food safety, they are often unable to translate this knowledge into practice due to the problem of structural and resource constraints (23, 24).

In low-resource settings, structural obstacles such as acute water insecurity, lack of clean cooking fuel, absence of cold storage, inadequate kitchen space, scarcity of clean utensils, and pervasive financial strain reduces standard hygiene protocols practically unfeasible (22, 23). Understanding food handling behaviors thus requires touching beyond individual knowledge models to examine the socio-material conditions governing daily household routines (21, 22).

Conflict

affected settings extremely compounds household-level resource deficits, functioning as an overarching structural determinant that destroys the foundational conditions necessary for food safety and environmental hygiene (25, 26). Violent political instability disrupts municipal water, sanitation, and hygiene (WASH) infrastructure, forces mass population displacement into overcrowded shelters, harshly impedes food supply networks, and dismantles health service delivery (27, 28).

In conflict settings, severe food insecurity forces mothers/caregivers to rely on degraded, substandard constituents, while fuel shortages reduce or delay thorough cooking or water treatment (28, 29). Furthermore, profound psychosocial distress and economic collapse erode mothers/caregivers coping capacities, exposing young children to environments contaminated with pathogenic micro-organisms (25, 29).

In Ethiopia, quantitative studies have evaluated complementary feeding practices and maternal knowledge in stable regional settings, consistently documenting suboptimal food hygiene practices and high burdens of childhood diarrhea (23, 30). In addition, in Ethiopia, similar patterns prevail, with foodborne diseases causing an estimated 5 million cases and 3,300 deaths yearly, driven by inadequate knowledge, attitudes, and practices (KAP) among food handlers (31).

However, existing research overwhelmingly focuses on socio-demographic determinants within non conflict environments, leaving the complex dynamics of food handling during active humanitarian crises under-researched (30, 32). Specifically, in conflict-affected Tigray, severe destruction of WASH infrastructure, health system fragility, widespread displacement, and extreme economic shock have very altered domestic caregiving realities, yet empirical evidence regarding how these structural pressures shape complementary food handling practices remains scant (28, 32).

Quantitative surveys alone cannot capture the lived experiences, adaptive trade-offs, and contextual coping mechanisms mothers/caregivers navigate under extreme hardship; thus, an in-depth qualitative inquiry is required to uncover the complex socio-structural drivers of complementary food safety in this crisis environment (22, 32).

This study aims to qualitatively explore how conflict-related structural conditions, WASH insecurity, household economic resources, social relations, and health-system factors interact to shape complementary food handling practices among mothers/caregivers of children aged 6–59 months in conflict-affected Tigray, Ethiopia.

Methods and materials

Study setting

We were conducting the study in the Eastern and South Eastern zones of Tigray region, Northern Ethiopia. The Eastern and South Eastern zones have a total population of 1,011,212 and 522,534 respectively (33). According to the Tigray Regional Health Bureau, in 2020, the region had a total of 19,324 health care providers (HCPs), including 1,918 health extension workers (HEWs) (34, 35)

In the two zones, the total number of women of reproductive age is around 357,362 (23.3% conversion factors) and total number of under-five children is 236,197 (15.4% conversion factor) (36). The study focused on specific urban areas in both zones of four towns from March 26, 2026 till April 10, 2026. The region invested in primary health care units, achieving a 91.7% coverage rate (37). However, the war-

damaged over 80% of health facilities, leading to a 40% decline in maternal and child health services (37).

These towns found in Eastern and South Eastern zones such as Hawzien, Atsbi E/silasie, Frweyni, E/Hamus, Hagereselam, and Adigudem were included in the study, which were carried out in two zones of the Eastern and South Eastern Tigray area. Edaga Hamus, Frewyni, Hagerselam and Adigudem towns were chosen at random. The total population of Edaga Hamus 25,328, Frewyni 21,012, Hagerselam 23,328, and Adigudem 25,238, while the total number children under five of Edaga Hamus 3,695, Frewyni 2,1012, Hagerselam 2,695, and Adigudem 3,582.

Study design

A community-based exploratory qualitative study was conducted from March to April 2026 to explore factors shaping safe food-handling practices among mothers/caregivers of children aged 6–59 months in conflict-affected Tigray, Northern Ethiopia

Study Participants

We included mothers/caregivers, women's development groups (WDGs), and village health leaders (VHL) of children under five years old in the in-depth interviews (IDIs) and focused group discussions (FGDs). These groups contacted through health extension (HEWs), women's development groups (WDGs), and village health leaders (VHL) in the community.

We selected women with under five children from HEW registers in each kebele who had interacted with HEWs, WDGs, and VHL using random sampling. HEWs collaborate with VHL and WDGs across health posts, communities, and homes in Ethiopia. Key informant interviews (KIIs) were also conducted with specialists from the district health office, directors, nutrition and WASH focal persons or health extension program (HEP) case teams, or environmental health experts in certain towns, and the regional health bureau. Additionally, we chose regional experts and health care providers (HCPs) to implement programs for KIIs based on their extensive knowledge of WASH and nutrition, as well as their capacity for clear communication, which allowed them to offer insightful information about the status of safe food handling practices.

Data collection

We obtained participant information through IDIs, KIIs, and FGDs. To triangulate and validate the data, we included mothers/caregivers, health care providers working in nutrition and WASH focal persons, experts from district and regional health offices.

With the help of HEWs, VHLs, and WDGs in the community at their homes, mothers/caregivers, village health leaders (VHL), and women development groups (WDGs) for FGDs and IDIs were identified. In

order to protect their privacy and reduce background noise, we conducted our interviews with them in private locations, like village health posts or households, after getting their permission.

Directors of district health offices assisted in the selection of experts, supervisors, and health care providers (HCPs) for KII, who was subsequently be interviewed in private rooms at their places of employment. Data saturation, which happens when participant descriptions become repetitive, was used to determine the number of participants. Sampling went on until no new data was found, which would indicate that saturation had been reached (38).

Three FGDs were conducted, one in each town except hagereselam, involving seven participants in two FGDs and six participants in one FGDs of mothers/caregivers, women development groups and village health leaders who have a child of under-five, each session lasting 56–120 minutes. Eleven mothers/caregivers with a child participated in IDIs, averaging 42 minutes per interview. Additionally, ten health care providers (HCPs), directors, experts from four towns and two from Tigray regional health bureau (TRHB) was interviewed for KIIs, averaging 46–70 minutes each.

The primary investigator (KA) and three other PhD students in public health (TT, NB, and GG) who are experienced and trained in qualitative research conducted interviews of FGDs. The four interviewers were paired into two groups: one note-taker and one interviewer. We used interviews and discussion guides to explore experiences, challenges or barriers, socio-ecological determinants and opportunities of safe food handling practices. We were developed semi-structured guides for three groups: mothers/caregivers, women development groups and village health leaders for IDIs and FGDs of children under five, directors, experts, health care providers (HCPs) and regional program implementers working in the nutrition and WASH service units for KIIs. These guides were initially drafted in English and translated into the local language, Tigrigna. FGDs were conducted among mothers/caregivers, women development groups and village health leaders who have a child age under five, each session lasting 56–120 minutes. The place was taken the FGDs interviews in health centers, woreda health office and town municipality and the number of participants seven in two towns whereas six in one town. Furthermore, the interview guide incorporated probing questions. Interviewers actively guided respondents through the questions outlined in the guide, using probing techniques to prompt further explanation of participants' responses. Throughout the interviews, the audio-recorded all sessions, took field notes to document key points, and observed participants' non-verbal cues in-depth.

Trustworthiness

The trustworthiness of the study was ensured using credibility, transferability, and dependability criteria. Credibility was enhanced through triangulation of data sources from different perspectives (women development groups, village health leaders, health care providers, directors, experts and health extension worker supervisors) and prolonged engagement with the data, settings, and complementary safe food handling practices to achieve a deeper understanding of the study context and participants' experiences, challenges and coping mechanisms. Transferability was supported by providing rich and detailed

descriptions of the study setting, participants, and research processes, enabling readers to assess the applicability of the findings to other contexts. Dependability was maintained through a transparent, systematic research process, including data collection guidelines, coding, and analytical decisions, thereby allowing the study procedures to be clearly traced and evaluated. Member checking was conducted by sharing a summary of preliminary transcripts with three experts and one HEW supervisor for feedback. Their comments informed refinement of the full transcripts and were incorporated into the final analysis. The data collectors were trained in tools, interview techniques, participant selection, the concept of reflexivity, and consent procedures. Pre-tested interview guide was used in a similar setting before starting data collection, and revisions were made based on feedback.

During data collection, the team held daily debriefing sessions to address emerging issues and spent extended time with participants to gain deeper insights. Extended the research period to gain an in-depth understanding of the phenomena. Conducted data collection and analysis simultaneously, triangulating findings from interview transcripts with field notes.

Experienced researchers fluent in the local language and culture translated, transcribed, and coded parts of the audio recordings while the primary investigator reviewed their work to ensure accuracy. Emerging findings were discussed among the research team during regular debriefing sessions and were used to refine subsequent probing and areas of inquiry. While conducting participant interviews, creating codes, and organizing these codes into categories, sub-themes, and themes, the research team bracketed their prior experiences and knowledge to enhance the quality of the results.

Data analysis

The FGDs, IDIs, and KIIs were audio-recorded, transcribed verbatim in the local language “Tigrigna”, and then translated into English. Verbatim transcripts of the data saved as an independent MS Word file were imported, stored, managed, and coded using Atlas. ti v.7.5.4 (Scientific Software Development GmbH, Berlin, Germany) qualitative data analysis software. The first author (KA) was conducted the initial coding by thoroughly listening to the audio recordings from the FGDs, IDIs and KIIs, and carefully reviewing all the transcripts to become familiar with the content and to identify initial coding. In addition, linked field notes and investigator memos to the respective files in the software to assist in the analysis.

The first author (KA) was conducted line-by-line coding. We used both process and values coding; that the process coding was used to capture actions and practices described by participants, while values coding was used to identify beliefs, attitudes, and values underlying food handling practices to analyze all the transcripts. Generally, we applied a hybrid approach, inductive and deductive coding methods during the analysis (39).

Process coding and values coding help separate yet complementary functions during the early stages of qualitative data analysis (40). Process coding uses words to track clear actions, routines, and behavioral sequences, such as washing hands, storing leftovers, or shortcutting sanitation routines. Values coding,

on the other hand, separates the internal psychological and social drivers deeply held beliefs, cultural attitudes, and personal priorities; that shape those observable actions (40).

To transition these discrete codes into a broader thematic analysis, we engaged in second phase coding to examine how actions and values intersect (41). Somewhat than analyzing behaviors and beliefs in separation, the integration phase focuses on identifying patterns where specific values consistently trigger, adjust, or conflict with routine practices. For example, a process code like skipping board sanitization during peak hours is cross-analyzed with values codes like valuing speed over regulatory compliance or believing visual cleanliness is sufficient. Grouping these interconnected codes allows abstract patterns to emerge, transforming isolated observation units into meaningful categories that explain both what is occurring and why it happens.

The final synthesis stage, these combined categories are abstracted into overarching narrative themes that structure the study's overall findings (41). Themes are not merely summaries of the code lists; they represent systemic explanations of the phenomenon under study.

A second investigator (TT) independently coded a subset of transcripts, and the researchers compared coding decisions and discussed discrepancies to refine the coding framework and improve consistency in interpretation.

Furthermore, during the write-up, was conducted content analysis to describe the frequency of participants in subcategories. Quotes that best described the various categories and frequently expressed sentiments across several groups was chosen and presented in italics.

Ethics approval

The Institutional Review Board of Mekelle University, College of Health Sciences. The Tigray Health Bureau issued a support letter, and the respective district health offices and kebeles granted permission. We fully explained the study's objectives, risks, and benefits and obtained informed consent from all participants. The college's institutional review board approved the consent form. We prioritized privacy and confidentiality and informed participants about their right to withdraw at any time. We also requested permission to record focus group discussions, in-depth and key informants' interviews.

Results

Socio-demographic characteristics of the respondents

The qualitative study involved 41 participants, of those eleven individuals in IDIs with mothers/caregivers, women development groups and village health leaders who have children under five, three FGD seven participants in two groups and six participants in one group, and addition ally, ten participants; eight from health centers and district health offices, and two from regional health bureau who have experiences in nutrition service, WASH and environmental health experts participated in KIIs.

Among mothers/caregivers, WDGs and VHL participated in IDIs and FGDs who have children under five, about 6 (54.5%) and 12 (60%) were aged between 21 to 31 and years for IDIs and FGDs receptively. Mothers/caregivers, WDGs and VHL participated in IDIs and FGDs who have children under five have attained educational level about 3 (27.3%) of IDIs and 16 (80%) FGDs non educated. About 9 (81.8%) of IDIs and 16 (80%) FGDs were housewives (**Table 1**). Additionally, the healthcare professional, experts, supper visors and program implementer participants, 40% were female, with approximately 40% master of public health and the work experiences of all participants greater than ten years (**Table 2**).

The conceptual framework, which emerged from qualitative data, illustrates the overall relationships among the socio-ecological determinants in safe food handling practices. A higher level of conflict and socioeconomic insecurity narrowed the margins for safe food handling, gender and community structure negatively influences the practices of safe food handling. Conversely, knowledge of food safety constrained by inadequate WASH conditions and mothers/caregivers adapted food-handling practices to severe resource constraints either positive or negative influenced food safety practices such as knowledge and awareness of safe food handling, unsafe water sources and household water contamination, water transport and storage-related recontamination, competing caregiving and domestic workloads, and limited access to soap and cleaning materials, alternative cleaning practices, separation of raw and cooked foods under constrained household space, food preservation and repeated reheating and household leftover management. This framework) provides a guiding structure for implementing safe food handling practices within the healthcare system (Fig 1)

Table 1: Characteristics of mothers/caregivers, women development groups and village health leaders, who participates in IDIs and FGDs Tigray, Northern Ethiopia, 2026

Characteristics	Categories	IDI (Mothers/caregivers, WDGs and VHLs)	FGD (Mothers/caregivers, WDGs and VHLs)
Age of Participants, years	21-31	6	12
	32-42	5	7
	>=43	0	1
Educational status	Not attended school	3	16
	Primary (1–8 th)	3	0
	Secondary(9–12 th)	4	0
	Diploma and above	1	4
Occupational status	Household work	9	16
	Government Employee	2	4
Family Size	1. 2-4	3	12
	2. 5-7	8	8
Number of under five children	1. 1	6	18
	2. > 1	5	2

FGDs: Focused Group Discussion **VHLs:** Village health leaders **IDs:** In-depth interviews

Table 2: Characteristics of key informants participating in the study, Tigray, Northern Ethiopia, 2026

Characteristics	Categories	KIIs (Experts, supervisors, HCP and program implementers)
Age of Participants, years	21-31	0
	32-42	7
	>=43	3
Sex	Male	6
	Female	4
Educational status	Not attended school	NA*
	Primary (1–8 th)	NA*
	Secondary(9–12 th)	NA*
	Diploma	1
	Bachelor's degree	4
	GMPH	4
	MSc	1
Work Experience		0
	1. < 5 years	0
	2. 5-10 years	0
	3. >10 years	10
Profession		1
	1. Family health	2
	2. Health officer	4
	3. MPH	1
	4. MSc	1
	5. E. Health	1
	6. Nurse	1
Current working unit		3
	1. Health Extension. Supervisor	
	2. OR and OPD	2
	3. MCH Expert	2
	4. E. Health Expert	2
	5. Program Implementer	1
		2

KIIs: Key informants **NA*:** Not Applicable, because they are health professionals and program implementers

Themes: Through an analysis of the transcribed interviews, five major themes, encompassing twenty sub-themes emerged. knowledge of food safety was constrained by inadequate WASH conditions, mothers/Caregivers adapted food-handling practices to severe resource constraints, conflict and socioeconomic insecurity narrowed the margins for safe food handling, household gender relations and community structures influenced food-safety practices and health-system and regulatory constraints limited sustained food-safety promotion have emerged from the qualitative data on safe food handling practices (**Table 3**)

Table 3: A list of major themes and sub-themes emerged from the data, Tigray, Northern Ethiopia, 2026.

Major themes	Sub-themes
Conflict and socioeconomic insecurity narrowed the margins for safe food handling	Poverty and increasing costs of food-safety resources
	Food insecurity and avoidance of food waste
	Displacement and overcrowded living conditions
	Psychosocial stress and competing survival priorities
Health-system and regulatory constraints limited sustained food-safety promotion	Fragmented nutrition, WASH and food-safety services
	Health-worker workload and limited institutional capacity
	Inadequate WASH conditions in health facilities
Household gender relations and community structures influenced food-safety practices	Gendered household responsibilities
	Male control over household resources and decisions
	Engagement of religious and community leaders
	Role of HEWs, VHLs and WDGs

Knowledge of food safety was constrained by inadequate WASH conditions	Knowledge and awareness of safe food handling
	Unsafe water sources and household water contamination`
	Water transport and storage-related recontamination
	Competing caregiving and domestic workloads
Mothers/Caregivers adapted food-handling practices to severe resource constraints	Limited access to soap and cleaning materials
	Alternative cleaning practices
	Separation of raw and cooked foods under constrained household space
	Food preservation and repeated reheating
	Household leftover management

1. Conflict and socioeconomic insecurity narrowed the margins for safe food handling

This theme emphasizes how poverty stops people from taking actions they otherwise want to take as an environmental barrier that make hygiene practices impossible. Mothers/caregivers actively wants to practice proper hygiene of food preparation and handling for child and being completely educated on the risks to prevent cross-contamination, but they lack the material resources such as refrigeration, separate kitchens, soap, and affordable fuel to put into practice. This financial desperation alters the mothers are adjust their tolerances for food risks or contamination or food borne diseases from an absolute standard to an adaptive, risk-mitigating practice. Mothers are forced to rely on dangerous proxy-feeding habits, such as storing leftovers foods without refrigeration and based on sight and smell to see if food has spoiled.

Poverty and Increasing Costs of Food-Safety Resources

The after-conflict severe inflation increases the prices of basic needs of foods, fuel (charcoal and firewood) and cleaning materials. Previously, families could afford contracts for milk, diverse diets and cooking fuel. Now they are pushed into severe poverty, forcing trade-offs between buying food and buying sanitation products.

"The economic barrier to food safety is important. A single closed water container or a supply of soap now represents a significant fraction of a family's income, making safe practices financially unviable." **(BSc nurse professional, male, KII)**

"Poverty strips away every tool you need to practice hygiene. We cannot replace cracked water buckets or buy fuel for boiling water. Economic hardship forces us to drop hygiene steps just to keep our children fed." **(30 years old mother, 10th grade, FGDs)**

"Prices for basic goods have multiplied ten times since the conflict started. When money is so tight that you cannot buy enough flour or salt, buying soap, clean buckets, or fuel for boiling water is out of the question. Economic hardship forces us to drop all hygiene precautions just to stay alive." **(37 years old mother, 10th grade, IDIs)**

"We used to buy jerrycans with tight lids and proper washing basins. Now, our income is completely gone, and we cannot afford to replace broken water containers or buy soap. Poverty strips away every ability you have to keep your child's food clean." **(35 years old mother, illiterate, IDIs)**

Food Insecurity and Avoidance of Food Waste

Conflict-induced food scarcity transforms food safety priorities. Preventing child starvation becomes the dominant daily objective, superseding stringent hygiene protocols. Because households cannot risk wasting food, spoiled or poorly stored food is frequently consumed after basic reheating.

"When there is no food in the house, you cannot be picky about cleanliness. If a piece of food falls on the dirty floor, we quickly wipe it off and put it right back into the baby's mouth. We cannot afford to discard a single morsel because we do not know where the next meal will come from." **(35 years old mother, 10th grade, IDIs)**

"When a household experiences severe food insecurity, the discarding contaminated food vanishes. If food drops on the ground or shows early signs of souring, it is still fed to the child because no alternative food exists." **(Family health professional, female, KII)**

"If porridge sits out all day and starts to look questionable, a mother in normal times would throw it away and cook fresh food. But today, throwing away food means the child goes completely hungry. We are forced to serve food that we suspect might be unsafe because the alternative is starvation." **(21 years old mother, 5th grade, IDIs)**

"When there is no food reserve in the house, you cannot afford to be strict about cleanliness. If a piece of food drops onto the dirty ground, we wipe it off with our fingers and put it straight into the baby's mouth because there is no replacement." (26 years old mother, 7th grade, FGDs)

Displacement and Overcrowded Living Conditions

Conflict displaces mass numbers of families who are forced into single rooms for rent or crowded shared shelters. Under these conditions, one room is used as a bedroom, kitchen and living room simultaneously, making pest control, sanitation and hygienic food storage extremely difficult.

"Internally displaced persons (IDPs) or residences who live in severely overcrowded environments with inadequate latrine and no solid waste management. Preparing infant food in dusty, fly-infested communal shelters creates constant exposure to pathogens." (GMPH professional, male, KII)

"We were displaced from our village and now live in a school classroom with four other families. There are thirty people sharing one small room and a single overflowing pit latrine. There is no clean space to prepare complementary food without dust, flies, and human waste contamination nearby." (40 years old mother, 7th grade, IDIs)

"In the collective compound, we cook directly on the dusty ground right next to where people walk. Sanitation facilities are non-existent, and open defecation happens near the compound boundaries. Environmental contamination of infant food happens every single day." (27 years old mother, TVET, FGDs)

"In the collective shelter, we cook on the dusty ground right next to where people sleep and walk. Sanitation facilities are non-existent, and open defecation is common around the camp borders. Keeping food clean in such an overcrowded, unsanitary space is an impossible battle." (35 years old mother, illiterate, IDIs)

Psychosocial stress and competing survival priorities

Fears, displacement, loss of livelihoods and uncertainty of economies in crisis affect food preparation and hygiene practices in households where other pressing issues need to be addressed first. In times when the household needs water, fuel, food etc. instead of practicing food safety all the time, mothers and caregivers of young children and other

"During the conflict there is fear, anxiety, and lack of water, soap carrying baby and clothes to the river... There were fears and anxieties that we might get a lack of peace altogether and at this time safe handling and storage of food is not considered." (35 years old mother, 10th grade, IDI).

"When you live in constant fear for your family's safety and worry about where to find tomorrow's meal, your mind is overwhelmed. You live in survival mode. Remembering to wash your hands four times or sanitize a cooking utensil becomes secondary when you are mentally broken." (30 years old mother, 7th grade, FGDs)

"Fear and trauma exhaust you completely. Mothers are depressed and anxious about their family's safety. When your mental health is so low, you lose the capacity to pay attention to small details like keeping food covers closed or scrubbing utensils thoroughly." (21 years old mother, 5th grade, IDIs).

"When caregivers are in acute survival mode worrying about basic safety, shelter, and missing family members attending to food safety steps like multi-stage handwashing becomes mentally overwhelming." (Family health professional, female, KII)

2. Health-System and Regulatory Constraints Limited Sustained Food-Safety Promotion

The broader institutional ecosystem comprising health facilities, WASH infrastructure, and public policy delivery exhibits severe structural limitations. The conflict led to widespread damage to health centers, stockouts of essential supplies, and overburdened healthcare personnel, severely compromising the health system's capacity to deliver sustained hygiene and complementary food safety education.

Fragmented Nutrition, Water and Sanitation Hygiene (WASH), and Food-Safety Services

Public health programs often function in isolation, treating nutrition education, WASH (Water, Sanitation, and Hygiene) interventions, and food safety as distinct elements rather than as an integrated whole. Health messaging directed at mothers typically emphasizes dietary diversity or feeding frequency but often overlooks the crucial need for clean water and safe hygiene practices required to prepare those meals safely.

"Public health programming remains heavily fragmented. Nutrition interventions distribute infant cereal or supplementary foods without ensuring the beneficiary family has access to safe water or soap to prepare it hygienically." (BSc nurse professional, male, KII)

"At the health center, health workers advise us to feed our children diverse foods like eggs, vegetables, and thick porridge. But they rarely discuss how to prepare those foods safely when we lack clean water and soap. The nutrition advice is disconnected from our daily WASH reality." (26 years old mother, 7th grade, FGDs)

"At the clinic, health workers tell us to feed our children diverse foods like eggs, vegetables, and thick porridge. But they rarely discuss how to safely prepare those foods without clean water or how to store them without refrigeration. The nutrition program is completely disconnected from our daily water and sanitation realities." (35 years old mother, illiterate, IDIs)

"WASH programs give out water purification tablets occasionally, while nutrition programs advise on child feeding, but nobody brings these services together. Advising a mother to prepare complementary food without ensuring she has access to clean water and soap renders the advice practical nonsense." (37 years old mother, 10th grade, IDIs)

Health Worker Workload and Limited Institutional Capacity

Healthcare facilities are facing severe staffing shortages, deteriorating infrastructure, and insufficient educational materials. Health Extension Workers and clinic nurses are inundated with emergency clinical care, trauma management, and acute malnutrition cases, which leaves them with little to no time or resources to provide thorough counseling on complementary food hygiene.

"Health centers are completely crowded with emergency clinical cases and severely malnourished children. The nurses and health extension workers are overworked and only have time to weigh babies and give out food rations, with no time for hygiene counseling." **(30 years old mother, 10th grade, FGDs)**

"The health centers are completely overwhelmed with acute emergency cases and severe malnutrition. The health workers are overworked and understaffed. When you go for a child checkup, they only have time to weigh the baby and give flour; they do not have time to sit down and counsel us on food hygiene details." **(35 years old mother, 10th grade, IDIs)**

"Health Extension Workers lack basic teaching materials, transportation, and regular salaries. Because institutional support has collapsed, routine home visits and community-level food safety demonstrations have virtually stopped." **(27 years old mother, TVET grade, FGDs)**

"Health Extension Workers used to conduct home visits to inspect kitchen hygiene, but now their offices are damaged, they lack transport, and they haven't been paid regularly. Institutional capacity has collapsed, so formal health education regarding safe food handling has virtually stopped." **(21 years old mother, 5th grade, IDIs)**

"Health Extension Workers lack basic educational tools, transport, and continuous supervision. Under these compromised operational conditions, delivering structured, high-quality food safety education becomes virtually impossible." **(GMPH professional, male, KII)**

Inadequate Water and Sanitation Hygiene (WASH) Conditions in Health Facilities

Health facilities themselves frequently lack running water, functional latrines, handwashing stations with soap, or proper medical waste disposal systems. When health centers cannot demonstrate or maintain basic hygiene standards due to damaged infrastructure, it underpins institutional credibility and hinders their ability to act as model environments for mothers learning food safety practices.

"Even when we visit the health center, there is no water in the taps and the latrines are filthy and broken. How can health workers teach us about the importance of handwashing with soap when there is not a single drop of water or soap available for patients in the health facility itself?" **(40 years old mother, 7th grade, IDIs)**

"When we visit the health center, there is no running water in the taps and the latrines are dirty and broken. How can health workers teach us about the importance of handwashing with soap when the health facility itself has no water or soap?" **(35 years old mother, 7th grade, FGDs)**

"The health center should be a clean example for the community, but its own environmental hygiene is degraded due to the war damage. When mothers see that even the clinic lacks basic WASH facilities, it reinforces the belief that safe hygiene is impossible to achieve in our current environment." **(35 years old mother, illiterate, IDIs)**

"A major institutional contradiction is that many primary health centers lack functional running water, clean latrines, or handwashing stations. Health facilities cannot effectively model hygiene behaviors when their own infrastructure is non-functional." **(MSc reproductive health professional, female, KII)**

3. Household gender relations and community structures influenced food-safety practices

Responsibility for safe food handling and complementary feeding is placed on women within broader social, gender and community structures. Although women are responsible for food safety, men hold the power and finances to make decisions regarding the family. In addition, informal community networks and local structures play a key role in shaping practices.

Gendered household responsibilities

Some key informants described household financial decisions, including expenditures on food and hygiene materials, as being influenced by male household members. Participants suggested that engaging men in nutrition and hygiene education could strengthen household-level support for recommended practices.

"Intensely rooted gender norms dictate that child care, water fetching, and food preparation belong solely to women. Men rarely participate in domestic hygiene tasks, leaving mothers overburdened and unsupported." **(BSc Health officer professional, female, KII)**

"All work inside the home—cooking, cleaning, fetching water from miles away, feeding the children—is left entirely on the shoulders of women. Men do not assist with these domestic chores because society views it as shameful for a man to cook or clean infant utensils." **(35 years old mother, 10th grade, IDIs)**

"In our culture, fetching water, gathering wood, cooking, and washing child utensils are seen strictly as women's work. Men do not assist with domestic tasks because society considers it shameful for a man to cook or clean." **(40 years old mother, 4th grade, FGDs)**

"Because men believe child care and food preparation are strictly women's duties, a mother must handle everything alone even when she is sick or completely exhausted. This heavy workload forces women to take shortcuts in washing dishes and preparing meals." **(21 years old mother, 5th grade, IDIs)**

Male Control Over Household Resources and Decisions

Men maintain dominant authority over household finances, determining how money is allocated. Even when mothers possess knowledge of safe food practices, their inability to access cash independently

restricts them from purchasing necessary hygiene items like soap, clean containers, or nutritious supplementary foods.

"Even if a mother understands the importance of buying clean utensils or safe ingredients, she must ask permission from her husband. When men do not understand food hygiene risks, they refuse to allocate funds for these items." **(39 years old mother, 6th grade, FGDs)**

"I know we need soap and a proper covered bucket for storing drinking water, but my husband controls all the money in the household. If I ask him for cash to buy cleaning materials, he says soap is a waste of money and that we should only spend on grain. I have no control over the budget." **(40 years old mother, 7th grade, IDIs)**

"Female caregivers often report wanting to purchase cleaning supplies or safer food items, but they are constrained by male financial control. Hygiene promotion must target male decision-makers to be effective." **(BSc nurse professional, male, KII)**

"Even if a mother wants to buy safer complementary food ingredients or hygiene items, she must ask permission from her husband. When men do not understand the importance of food hygiene, they refuse to allocate funds for these essential supplies." **(35 years old mother, illiterate, IDIs)**

Engagement of religious and community leaders

Health professionals and participants of focus group discussion also described the use of religious leaders, community leaders, village health leaders (VHLs), and women development groups (WDGs) as channels for disseminating nutrition and hygiene messages. Participants viewed these structures as potentially important for extending food-safety messages beyond health facilities and supporting household-level behavior change.

"In traditional society, religious and community leaders hold important influence. When priests and village elders reinforce messaging on sanitation and child care during community gatherings, household compliance increases markedly." **(Family health professional, female, KII)**

"Community elders are essential for driving behavioral change. If elders emphasize clean water storage and proper waste disposal during village meetings, households respond positively and try to keep their kitchens cleaner." **(37 years old mother, 10th grade, FGDs)**

Role of Health Extension Workers (HEWs), Village Health Leaders (VHLs), and Women Development Groups (WDGs)

Local health infrastructure relies heavily on community-level actors like HEWs, VHLs, and WDGs to disseminate health and nutrition education. Prior to the conflict, these networks served as the primary delivery channel for food hygiene education. However, the destruction of these networks during the war severely weakened community-level health promotion.

"Before to the war, local health leaders regularly inspected household kitchens and held practical demonstrations on infant food preparation. Restoring these community-level health platforms is vital for reviving safe practices." (MSc reproductive health professional, female, KII)

"Before the war, Health Extension Workers and Women Development Group leaders visited our homes regularly to teach us about child nutrition and hygiene. They checked our kitchens and water containers. Their presence kept us accountable and knowledgeable about safe practices." (21 years old mother, 5th grade, IDIs)

"The Women Development Groups used to hold weekly meetings where we shared experiences on how to prepare clean porridge for our infants. But during the conflict, these networks collapsed completely. Without their ongoing support and guidance, community food hygiene awareness has declined." (40 years old mother, 7th grade, IDIs)

"The Women Development Groups used to hold weekly meetings where mothers shared advice on safe complementary feeding. Since these networks collapsed during the conflict, mothers no longer receive regular guidance or support." (30 years old mother, 10th grade, FGDs)

4. Knowledge of food safety was constrained by inadequate WASH conditions

Findings under this theme the striking discrepancies between the mother's conceptual comprehension of safe complementary feeding and the physical infrastructure damage that stops safe food handling practices. Whereas, mothers demonstrate high literacy regarding exclusive breastfeeding up to 6 months, and after introducing different cereals, their environment presents acute health hazards.

Public distribution of water sources has been disrupted or is failing, driving a dependency on highly contaminated well water and informal water vendors. The process of transporting and storing water that establishes critical vector sources for contamination or introduces severe contamination check points, rendering household food safety and handling practice nearly impossible despite high maternal motivation.

Knowledge and awareness of safe food handling

There was awareness of practices recommended to ensure food safety. These included hand washing, food contact surfaces cleaned and food prepared safely to prevent contamination. However, caregivers described how lack of access to safe water and adequate household WASH facilities made practice difficult to implement.

"Caregivers are fully aware that feeding equipment needs thorough washing and that raw water is dangerous for young children. However, in emergency conditions, knowledge alone cannot overcome the complete absence of clean water points in the locality." (GMPH professional, male, KII)

"We know very well that we must wash our hands with soap before preparing porridge for the baby and clean the feeding bowl thoroughly. The health extension workers taught us this repeatedly. But what can you

do when you don't even have a cup of clean water in the house, let alone soap? Knowing what is right does not fill the jerrycan with clean water." **(35 years old mother, 10th grade, IDIs)**

"Every mother can explain that unhygienic feeding causes illness. The problem is not lack of information. The problem is that we are forced to feed our children using water from open rivers because the clean pumps were destroyed." **(39 years old mother, 6th grade, FGDs)**

"I know that feeding a child cold or uncovered food can make them sick with diarrhea. We understand the rules of hygiene. But when there is no firewood to reheat the food or clean water to wash the plate again, you are forced to feed the child what is available, praying that God protects them." **(21 years old mother, 5th grade, IDIs)**

Unsafe Water Sources and Household Water Contamination

Due to destroyed or non-functional municipal and urban water supply schemes, households are forced to rely on unprotected, contaminated water sources such as open rivers, unprotected springs, and shallow hand-dug wells. Mothers/caregivers recognize that these water sources are unsafe, yet they must use them for food preparation and utensil washing, directly introducing biological pathogens into complementary foods.

"The water tap in our village was destroyed during the fighting and has not been repaired since. Now, we all collect water from the local river where animals drink and people wash clothes. Even though I know this water causes sickness, I have no choice but to use it to mix the child's porridge and wash the feeding cups." **(40 years old mother, 7th grade, IDIs)**

"We fetch water from shallow hand-dug pits near the riverbank. When you scoop it, you can see dirt and larvae. Without water treatment chemicals or fuel to boil it every time, this contaminated water goes straight into the child's food." **(39 years old mother, 10th grade, FGDs)**

"Mothers are mixing infant formula and cooking porridge using water collected from surface runoff and unprotected streams. Even when caregivers attempt to keep the cooking area clean, the raw water is unsafe." **(BSc nurse professional, male, KII)**

"We bring water from open ponds. It looks cloudy and dirty, but it is the only source near us. When I prepare complementary food using this water, I know it is contaminated from the source. Water treatment chemicals or chlorine are nowhere to be found in our community." **(35 years old mother, illiterate, IDIs)**

Water Transport and Storage-Related Recontamination

Even when water is collected from relatively safer or protected points, jerrycans or storing it in household containers presents substantial risks of recontamination. Unsanitary storage vessels, open containers, and poor handling during transport negate initial water purity. At home, wide-mouthed storage containers lack proper lids, and multi-use dipping utensils transfer bacteria directly into household water stocks.

"At the household level, wide-mouthed storage containers are ubiquitous, and families lack specialized narrow-necked vessels or dispensable taps. Direct dipping with dirty cups rapidly decontaminates whatever water was brought home." **(Family health professional, female, KII)**

"Carrying water from two hours away means the jerrycans are handled repeatedly. We do not have proper lids, so we stuff leaves or rags into the top to keep it from splashing out. By the time the water reaches the kitchen, dust and dirt have settled inside it. Then we dip dirty cups into the container throughout the day to scoop water for cooking." **(37 years old mother, 10th grade, IDIs)**

"At home, we store our water in wide clay pots. Because we lack containers with tap spigots, everyone dips a small plastic cup into the main pot throughout the day. Family members put their hands near the water, spreading germs into the cooking supply." **(30 years old mother, 10th grade, FGDs)**

"Even if you manage to fetch clean water, storing it safely at home is impossible. We do not have narrow-necked water containers with spigots. Everyone in the household uses a small bowl to dip into the main water pot, transferring germs from their hands straight into the drinking and cooking water." **(35 years old mother, 10th grade, IDIs)**

Competing Caregiving and Domestic Workloads

Mothers bear an overwhelming burden of domestic chores, including traveling extreme distances for water and firewood, searching for food, and managing household labor without assistance. This time poverty leaves virtually no margin for rigorous food safety routines, such as washing hands at every critical moment or thoroughly cleaning cooking spaces before preparing meals.

"Caregiving under crisis conditions is a continuous struggle. When a mother must choose between spending an hour scrubbing dishes with limited water or searching for food to feed her starving household especially children, food procurement takes priority." **(GMPH professional, male, KII)**

"My day starts before dawn. I walk for hours to fetch water, search for firewood, grind grain by hand, and take care of three small children alone. By the time I sit down to feed the infant, I am completely exhausted. I simply do not have the time or energy to scrub every bowl three times or wash my hands at every single step." **(21 years old mother, 5th grade, IDIs)**

"When you are managing five children alone while struggling to secure a single meal, keeping a perfectly sanitary kitchen becomes impossible. You rush to cook whatever food you have before the fire dies out, skipping handwashing steps because ten other tasks are waiting." **(24 years old mother, 10th grade, FGDs)**

"When you are struggling to survive and spending the entire day looking for food for your family, keeping the kitchen pristine becomes secondary. Time is limited. You rush to cook whatever little you have so the child

does not cry from hunger, skipping hygiene steps because there are ten other tasks waiting for you." **(40 years old mother, 7th grade, IDIs)**

5. Mothers/Caregivers adapted food-handling practices to severe resource constraints

Mothers or care givers are forced to improve and adjust physical space and heating hygiene principles to establish basic protection against pathogenic micro-organism transmission under war time inflation and reduction of resources.

Limited access to soap and cleaning materials

Adapting food-handling practices when lack of access to soap, fuel, refrigeration, suitable utensils and/or food-preparation space results in mothers/caregivers using boiling/reheating or other alternatives in order to try to maintain some aspect of food-handling practice when not able to follow standard cleaning and storage practices using available. These practices reflected caregivers' efforts to reduce food-safety risks within severe resource constraints rather than a simple lack of knowledge.

"A single bar of soap now costs more than what we can afford for a day's food. How can I buy soap for washing hands when my children have nothing to eat? Soap has become a luxury item that only wealthy people can buy. We clean our hands and dishes using water alone." **(37 years old mother, 10th grade, IDIs)**

"A single bar of soap now costs more than what we spend on food for a day. When forced to choose between buying grain to feed the family or buying soap to wash plates, food always wins. We rinse everything with plain water." **(30 years old mother, 10th grade, FGDs)**

"We know plain water does not remove grease or germ dirt from feeding bottles and bowls, but we have no detergent. We wash the baby's feeding equipment using only cold water because we cannot afford soap or fuel to heat water for washing every day." **(35 years old mother, illiterate, IDIs)**

"Commercial soap and cleaning agents are essentially absent in poor households due to cost and supply chain blockades. Washing utensils or hands with plain cold water fails to remove fats and bacteria, leaving feeding equipment contaminated." **(MSc reproductive health professional, female, KII)**

Alternative Cleaning Practices

To cope with the absence or unaffordability of commercial soap, mothers adapt by using alternative sanitation techniques. These include washing utensils solely with water, heating or scalding cookware over a fire, repeatedly rinsing dishes, or utilizing clean wood ash as an abrasive cleaning agent.

"Since we cannot purchase soap, we use wood ash from the hearth mixed with a bit of water to scrub the cooking pots and plates. Sometimes, if the grease is stubborn, we use coarse river sand to rub the surface clean, and then rinse it off with river water." **(35 years old mother, 10th grade, IDIs)**

"Since we cannot afford soap, we scoop wood ash from the hearth, mix it with a little water, and use it to scrub grease off the cooking plates. It takes off the dirt, but it is not the same as proper soap." (35 years old mother, 7th grade, FGDs)

"We wipe the child's bowl and spoon with a cloth that we reuse repeatedly because we do not have multiple cleaning rags or paper towels. That same cloth is used to wipe table surfaces, the floor, and dirty hands, so it probably spreads dirty germs back onto the child's plate." (21 years old mother, 5th grade, IDIs)

"In place of soap, caregivers' resort to scrubbing cooking utensils with wood ash or river sand. While ash has some abrasive utility, using contaminated river sand or dirty rags often reintroduces bacteria back onto infant plates." (Family health professional, female, KII)

Separation of Raw and Cooked Foods Under Constrained Household Space

While mothers/caregivers generally understand that cross-contamination between raw (uncooked) and cooked items spreads illness, adhering to strict physical separation is difficult. Due to overcrowding and single-room living quarters, mothers' resort to improvised adaptations like thoroughly re-washing shared cutting boards/knives or wrapping raw vegetables tightly in plastic bags.

"Separating raw and cooked food requires multiple tables, cutting boards, and clean dishes that we do not own. Everything sits side-by-side on the dusty floor, where flies and family members constantly pass by." (27 years old mother, 8th grade, FGDs)

We live in a single room where we sleep, cook, and store everything. There is no separate kitchen or counter. I prepare the raw vegetables on the same grass mat where I place the cooked baby porridge, and the chickens walk right through the space while I am cooking." (40 years old mother, 7th grade, IDIs)

"Separating raw meat or raw grains from cooked food requires space and extra containers that we simply do not have. Everything sits side by side on the floor. Knives and cutting surfaces are used for cutting raw items and then immediately used to serve the child's food without being properly washed in between." (37 years old mother, 10th grade, IDIs)

"Mothers lack dedicated kitchen counters or multiple cutting boards. The same floor space and utensils are used for raw items and cooked baby food without e sanitization." (MSc reproductive health professional, female, KII)

Food Preservation and Repeated Reheating

This strand of findings highlights; lack of refrigeration forces mothers to rely on thermal preservation. Foods prepared in the morning or kept overnight are repeatedly reheated over fire before consumption. However, the duration and thoroughness of reheating are usually estimated by sight or practice rather than formal temperature standards, and fuel costs often limit proper heating.

"Fuelwood is extremely scarce and dangerous to collect. Therefore, I cook porridge once in the morning and keep it in the pot to feed the baby throughout the day—for lunch and dinner. We do not have a refrigerator to keep it cold, nor do we have enough wood to boil and reheat it thoroughly before every single feeding." (35 years old mother, illiterate, IDIs)

"Because fuelwood is extraordinarily scarce and expensive, mothers cannot afford fires for multiple times a day. They prepare a single batch of complementary porridge in the morning to serve throughout the entire day." (BSc nurse professional, male, KII)

"Fuelwood is dangerous and difficult to collect, so we cannot light the fire multiple times a day. I cook porridge once in the morning and serve it for lunch and dinner. We have no refrigerator to keep it cool, nor wood to boil it again before feeding." (23 years old mother, 10th grade, FGDs)

"Sometimes the leftover porridge smells slightly sour by evening, but we cannot afford to throw it away. I just warm it slightly over a few embers—not bringing it to a boiling point—and give it to the child because we cannot burn our limited firewood to boil it again." (35 years old mother, 10th grade, IDIs)

Household Leftover Management

Typically, leftover infant foods are discarded to prevent bacterial growth. In extreme food insecurity situations though, the alternative is not acceptable. Mothers can safely re-heating leftovers, giving leftovers exclusively to adults, or consuming the leftover food themselves while preparing fresh portions for infants when possible.

"Severe food scarcity means that discarding unused complementary food is socioeconomically impossible. Leftovers sit loosely covered for hours, exposed to flies, but are continuously fed to infants to avoid wasting calories." (BSc health officer professional, female, KII)

"In our house, throwing away even a single spoonful of porridge is considered a severe waste and a sin during these tough times. If the baby does not finish their portion, we leave the bowl covered with a piece of cloth on the shelf until the child cries for food again hours later." (21 years old mother, 5th grade, IDIs)

"In our current situation, throwing away even half a spoon of porridge is considered a severe waste. If the baby does not finish their bowl, we cover it with a cloth and save it for later, even if it sits out for hours." (37 years old mother, 10th grade, FGDs)

"Flies are everywhere, especially around stored food. We try to cover the leftover bowls with wooden plates or baskets, but insects still crawl inside. Yet, because food is so precious, we just scoop off the top layer and feed the rest to the infant later in the day." (40 years old mother, 7th grade, IDIs)

Discussion

This study exploring the knowledge of food safety was constrained by inadequate WASH conditions, mothers/Caregivers adapted food-handling practices to severe resource constraints, household gender relations and community structures influenced food-safety practices, and health-system and regulatory constraints limited sustained food-safety promotion in northern Ethiopia following the Ethiopian government prioritized of food safety as Ethiopia National Food Safety Strategy (42), While previous qualitative research on safe food handling focused solely on barriers to its practices (43).

Similarly this study took a broader approach by exploring the knowledge of food safety was constrained by inadequate WASH conditions, mothers/caregivers adapted food-handling practices to severe resource constraints, conflict and socioeconomic insecurity narrowed the margins for safe food handling, household gender relations and community structures influenced food-safety practices and health-system and regulatory constraints limited sustained food-safety promotion related to safe food handling practices from the perspectives of various participants.

The study identified major themes related to safe food handling practices, including knowledge of food safety was constrained by inadequate WASH conditions (knowledge and awareness of safe food handling, unsafe water sources and household water contamination, water transport and storage-related recontamination and competing caregiving and domestic workloads and mothers/caregivers adapted food-handling practices to severe resource constraints (limited access to soap and cleaning materials, alternative cleaning practices, separation of raw and cooked foods under constrained household space, food preservation and repeated reheating and household leftover management). Participants also explored perceived conflict and socioeconomic insecurity narrowed the margins for safe food handling, such as poverty and increasing costs of food-safety resources, food insecurity and avoidance of food waste, displacement and overcrowded living conditions and psychosocial stress & competing survival priorities). Additionally, they noted perceived household gender relations and community structures influenced food-safety practices, such as gendered household responsibilities, male control over household resources and decisions, engagement of religious & community leaders and role of HEWs, VHLs and WDG. Finally, the participants recognize health-system and regulatory constraints limited sustained food-safety promotion for instance; fragmented nutrition, WASH & food-safety services, health-worker workload & limited institutional capacity and inadequate WASH conditions in health facilities.

Conflict and Socioeconomic Insecurity Narrowed the Margins for Safe Food Handling

This theme examines how macro-level conflict, economic collapse, displacement, and severe trauma restrict the practical choices available to mothers. Armed conflict in Tigray disrupted local food systems, inflated living costs, displaced communities, and caused widespread psychosocial stress. These structural shocks eliminated the economic and emotional margins needed to maintain safe food practices, leaving families vulnerable to health risks.

The findings demonstrate that food safety is deeply tied to household socioeconomic stability and mental well-being. When war destroys livelihoods, inflates prices, and causes severe psychological

trauma, adherence to hygiene protocols becomes secondary to basic survival. This theme shifts attention from individual practices to the broader geopolitical and structural drivers of malnutrition and disease.

Poverty and increasing costs of food-safety resources indicated that extreme inflation, loss of livelihoods, and economic barrier made essential hygiene tools such as clean water containers, soap, fuel, and covered feeding utensils unaffordable for most households. This result consistent with empirical research (44-46), who recognized that armed conflict extremely increases food and non-food costs, uncovering households of purchasing power for preventative health resources. The consistency is determined by basic macroeconomic shocks in conflicted zones, where disrupted supply chains drive up the prices of imported commodities like soap. Similarly, studies (47, 48) showed that humanitarian price-stabilization interventions and cash-transfer programs can preserve household purchasing power for essential health supplies during crises. This variation highlights the complete institutional isolation of Tigray, where banking blockades and restricted humanitarian access prevented cash transfers from mitigating local economic increment. This theoretically supports the political economy of Health framework, showing how macro-level conflict policies directly damage micro-level household health protection. Programmatically, humanitarian responses in active conflict settings must deliver direct, non-cash distributions of hygiene and food-preparation kits.

Regarding food insecurity and avoidance of food waste findings revealed that extreme household food insecurity forced mothers/caregivers to alter food preparation, often diluting complementary foods with unsafe water to stretch limited supplies or serving undercooked meals to conserve fuel. This finding is supported by studies from (49-51), which established that extreme food deficits drive coping behaviors that directly undermine food safety protocols. These findings are consistent because extreme hunger fundamentally reshapes household priorities toward maximizing volume rather than quality or sanitation. In difference, interventions evaluated (52-54) found that food-insecure mothers maintained safe preparation techniques when provided with specialized fortified blended foods. This divergence exists because specialized food distribution in those programs was continuous and paired with fuel support, whereas caregivers in Tigray faced severe, unmitigated food shortages. This validates Maslow's Hierarchy of Needs, where basic physiological survival needs completely hide safety and preventative hygiene needs. Emergency food aid must ensure that ration packages include easy-to-prepare, fuel-efficient foods to prevent unsafe preparation practices.

Findings from displacement and overcrowded conditions showed that; displacement into overcrowded collective centers, damaged public buildings, or host family homes bare caregivers of basic domestic infrastructure, forcing communal, highly unsanitary food handling. This finding is consistent with literature (48, 55), who documented that displacement camps foster severe environmental health hazards, rapid pathogen transmission, and compromised infant feeding hygiene. The consistency across emergency settings is explained by the loss of domestic privacy, shared sanitation facilities, and high population density, which together break down individual hygiene controls. Conversely, evaluations of organized refugee camps (46, 51, 56) demonstrated that structured humanitarian camp management

can maintain acceptable hygiene and infant feeding safety standards. This inconsistency underscores the difference between planned refugee camps with institutional support and informal internal displaced peoples (IDP) settlements in Tigray, which lacked basic water, sanitation, and shelter structures. This dynamic theory fits structural violence theory, where displaced populations are exposed to preventable health risks due to systemic societal collapse. Internal displaced peoples (IDP) answers must prioritize decongesting housing places though founding devoted, clean communal kitchens for infant food preparation.

Psychosocial stress and competing survival priorities showed that psychological trauma of war, active safety pressures, and loss of livelihoods produced severe mental suffering among caregivers, reducing their expressive and mental capacity to prioritize food hygiene. This finding is supported research (50, 55, 56), which established that war-related psychological trauma directly impairs caregiving practices, maternal-infant interactions, and domestic health routines. The alignment reflects the physiological reality of chronic stress, which depletes executive functioning and limits an individual's capacity to maintain complex daily preventative behaviors. In contrast, psychological studies in disaster contexts (45, 47, 57) suggested that maternal caregiving resilience often protects infants from environmental hazards despite high mental stress. This difference is explained by the duration and intensity of the exposure: chronic, multi-year conflict combined with total economic collapse overwhelms baseline psychological resilience mechanisms. Theoretically, this validates the Stress-Function Model, proving that structural trauma cascades down to compromise domestic health behaviors. Programmatically, child health and nutrition interventions in conflict zones must integrate Mental Health and Psychosocial Support (MHPSS) for caregivers.

Health-System and Regulatory Constraints Limited Sustained Food-Safety Promotion

Findings based on fragmented nutrition, WASH, and food-safety services public health programming in Tigray suffered from structural fragmentation, with nutrition, WASH, and food safety operating in sectoral silos without interconnected service delivery at the primary care level. This finding is consistent with global health systems analyses (58, 59), which identified institutional fragmentation between health, sanitation, and agricultural ministries as a major structural barrier to integrated disease prevention. The alignment across these studies is driven by inflexible administrative and funding silos, where WASH activities focus on water hardware while nutrition programs focus exclusively on nutrient intake, overlooking microbiological food safety. On the other hand, integrated programmatic evaluations (52, 60) demonstrated that combining WASH, nutrition, and food safety into a single delivery package produces synergistic health gains and improved resource efficiency. This contrast highlights an operational failure in crisis management: emergency responses often default to narrow, single-sector interventions rather than holistic packages. Theoretically, this finding reflects systems theory, proving that uncoordinated sub-system components lead to sub-optimal system wide outcomes. Policy-makers

must establish integrated "WASH-Nutrition-Food Safety" operational frameworks across humanitarian and development agendas.

Health-worker workload and limited institutional capacity results indicated that primary healthcare staff faced acute burn-out, unpaid salaries, and extreme heavy workloads, forcing them to prioritize urgent curative care while neglecting preventative food safety counseling. This finding matches health workforce research in crisis contexts (56, 61, 62), which indicated that extreme health worker shortages and infrastructure damage force staff into emergency triage, sidelining preventative health promotion. The consistency lies in human resource limitations: under high patient volumes and severe material shortages, healthcare workers must focus on immediate life-saving clinical tasks over routine counseling. Conversely, health system studies (52, 63) showed that task-shifting preventative counseling to community-level volunteer cadres can maintain effective health promotion even when clinical staff are overloaded. This difference arises because the conflict in Tigray disrupted community-level support structures, leaving remaining facility-based staff overwhelmed. Theoretically, this reflects the health care trilemma, where access, quality, and cost cannot be balanced without adequate institutional capacity. Health sector reconstruction must invest in health workforce retention packages, staff welfare, and structured task-shifting models for preventative care.

Results from inadequate WASH conditions in health facilities revealed that health facilities themselves lacked clean water supply, functional handwashing stations, and proper waste management systems, severely impairing their ability to model safe hygiene practices to visiting caregivers. This finding is consistent with empirical surveys (59, 64), which reported that widespread WASH deficits in primary healthcare centers across low-income countries undermine infection prevention and lower public trust in health services. The consistency across literature highlights a systematic underfunding of basic environmental health infrastructure within primary health networks. In contrast, health facility evaluations (56, 58, 65) demonstrated that health centers equipped with reliable water points and sanitation amenities serve as effective demonstration sites that successfully reinforce maternal hygiene practices. This contradiction underscores the physical impact of conflict, as targeted destruction of health facility water systems reduced these centers to high-risk environments for healthcare-associated infections. Theoretically, this aligns with Institutional Theory, proving that healthcare facilities cannot successfully promote behaviors that they fail to demonstrate organizationally. Programmatically, institutional rehabilitation must prioritize restoring reliable, heavy-duty WASH infrastructure in all primary healthcare facilities.

Household Gender Relations and Community Structures Influenced Food Safety Practices

Gendered household responsibilities findings revealed that women were exclusively responsible for domestic food preparation, water collection, and child feeding, yet their heavy domestic workload was under-supported by male partners. This finding aligns with gender studies in sub-Saharan Africa (66, 67), indicated that rigid gender roles assign total domestic and hygiene labor to women while denying them equal support. The consistency is explained by patriarchal cultural frameworks that classify domestic

hygiene as strictly female work, irrespective of maternal physical exhaustion or external crises. Conversely, post-conflict gender evaluations (57, 63, 68) observed that extreme crises can force a restructuring of household gender roles, leading men to assist with domestic labor like water hauling and childcare. This contrast highlights the structural resilience of traditional gender norms in rural Tigray, where conflict intensified women's domestic burdens without shifting traditional task allocations. Theoretically, this finding aligns with Social Gender Theories, demonstrating how entrenched gender roles persist even when structural shocks make those roles unsustainable for women's health. Programmatically, community hygiene campaigns must explicitly challenge traditional gender division of labor to encourage male participation in domestic water and sanitation tasks.

Male control over household resources and decisions showed that; while mothers were tasked with food preparation, male household heads held control over financial assets, deciding whether to spend money on soap, clean water containers, or nutritious foods. This finding is consistent with literature (67) which showed that limited female financial autonomy directly correlates with lower spending on household sanitation commodities and child healthcare. The alignment across these studies stems from household bargaining dynamics; when men do not perform daily food preparation, they often underestimate the financial cost of hygiene supplies and deprioritize them in budget decisions. On the other hand, research on cash transfers (47, 51, 68) showed that targeting financial assistance directly to women reliably increases household expenditures on soap, varied food, and health items. This contradiction illustrates how targeted economic empowerment can bypass traditional household financial control mechanisms. Theoretically, this validates the Intra-Household Bargaining Model, demonstrating that health expenditures depend on who controls household capital. Programmatically, food safety and hygiene intervention programs must design female-targeted resource transfers while delivering gender-transformative budgeting education to men.

Findings from engagement of religious and community leaders revealed that religious leaders and traditional elders played an influential role in shaping community trust, hygiene perceptions, and emergency health compliance during the conflict. This finding aligns with community health studies in Ethiopia (63, 66, 69) which highlighted that faith leaders serve as crucial gatekeepers for promoting public health norms in rural agrarian societies. The consistency occurs because in times of crisis and institutional collapse, communities turn to established faith institutions and traditional elders for guidance and moral authority. Conversely, evaluations (56, 70) indicated that religious leaders can sometimes reinforce fatalistic health beliefs or resist scientific hygiene messaging, thereby delaying medical care seeking. This difference is explained by proactive health system outreach; when community leaders are trained and integrated into health messaging, they become effective advocates for public health rather than sources of resistance. Theoretically, this aligns with Social Capital Theory, proving that informal social networks dictate the adoption of health behaviors. Programmatically, public health agencies should systematically engage and train religious and traditional leaders to advocate for safe food handling and hygiene practices.

Role of health extension workers (HEWs), village health leaders (VHLs) and women development groups (WDGs) findings showed that from grassroots health cadres specifically health extension workers (HEWs), voluntary health leaders (VHLs), and women's development groups (WDGs)—served as the primary channel for hygiene education, though their operational capacity was eroded by war. This finding is strongly supported (51, 61, 69), who documented that Ethiopia's Health Extension Program and its female community networks are pivotal drivers of rural behavioral change. The agreement across literature reflects the power of peer-led, community-anchored health promotion in overcoming geographical and cultural barriers to health messaging. In contrast, studies (62, 64, 70) noted that grassroots community networks often become inactive or ineffective during active conflict due to displacement, lack of financial incentives, and loss of institutional oversight. This discrepancy is attributable to variations in cadre resilience: despite severe resource constraints and unpaid status, local health cadres in Tigray maintained informal support networks due to strong community solidarity. Theoretically, this highlights the Diffusion of Innovations Theory, showing how trusted local change agents facilitate normative behavioral adoption. Programmatically, post-conflict health sector recovery must prioritize re-equipping, retraining, and financially supporting HEWs, VHLs, and WDGs.

Knowledge of Food Safety Was Constrained by Inadequate WASH Conditions

Knowledge and awareness of safe food handling vs. environmental reality; the findings of this study demonstrate that mothers and caregivers in conflict-affected Tigray possessed baseline awareness regarding basic hygiene rules, such as washing hands before feeding and keeping utensils clean. However, this cognitive awareness rarely translated into safe food handling practices due to acute environmental constraints. This observed knowledge gap aligns with findings from (60, 65, 71) in sub-Saharan African settings, and in fragile environments, all of which established that individual health literacy is insufficient to maintain hygiene when structural support is lacking. This consistency occurs because cognitive knowledge operates merely as an enabling factor, whereas physical access to water and sanitation acts as the binding constraint in low-resource settings. Conversely, early intervention trials (17, 72, 73) reported that educational interventions alone led to marked improvements in domestic hygiene practices regardless of baseline infrastructure. These contradictions arise because those evaluation studies were conducted in stable rural contexts where basic baseline infrastructure was functional and market access to sanitation supplies was uninterrupted, unlike the complete structural breakdown documented in war-affected Tigray. Theoretically, this finding highlights the structural limits of the Health Belief Model, confirming that perceived threat and self-efficacy are rendered ineffective without environmental enabling factors as outlined in the Socio Ecological Model (SEM). Programmatically, public health strategies in humanitarian settings must pivot away from standalone behavioral change communication (BCC) toward structural WASH rehabilitation integrated with infant feeding programs.

Results from unsafe water sources and household water contamination indicated that mothers/caregivers heavily depend on unprotected rivers, open wells, and unimproved surface water due to the widespread destruction of community water infrastructure during the conflict. This finding is

consistent with studies (74, 75), which reported that source water contamination is a primary vehicle for diarrheal pathogens entering the domestic domain in low-income settings. The alignment across these studies is explained by the fundamental microbiological reality that unimproved surface water carries high fecal coliform loads, making domestic contamination inevitable regardless of handwashing frequency. In contrast, research (76, 77) found that household water treatment (HWT) and maternal vigilance could effectively mitigate source-level contamination, maintaining clean complementary food preparation. This divergence is attributable to the fact that caregivers in those comparative studies had continuous access to point-of-use water treatment products (such as chlorine tablets or boiling fuel), commodities that were completely unavailable or economically out of reach in blockaded Tigray. This situation illustrates Sen's Capabilities Approach, proving that structural deprivation of basic infrastructure strips individuals of the capability to achieve health agency. Programmatically, emergency relief must prioritize the distribution of point-of-use water treatment chemicals alongside urgent repair of solar-powered water supply schemes.

Findings based on water transport and storage-related recontamination revealed that; even when water was fetched from relatively clean points, severe recontamination occurred during transit in unsealed containers and storage within open wide-mouthed household containers. This finding is strongly supported (78, 79), who documented rapid microbial decay between point-of-collection and point-of-use due to narrow-necked container shortages and frequent hand-immersion during scooping. These results are consistent because domestic water storage in unsealed vessels under warm ambient temperatures creates ideal conditions for bacterial proliferation, especially when hand hygiene is compromised. Conversely, studies (20, 80) observed minimal post-collection contamination when households utilized modified narrow-necked containers or vessels fitted with dispensing taps. The difference in findings stems from the availability of standardized public health hardware; in conflict zones, asset destruction forces households to use degraded, hard-to-clean storage containers. Theoretically, this recontamination dynamic reinforces Resource Dependence Theory, where external material scarcity directly shapes domestic micro-risk environments. Programmatically, humanitarian hygiene kits must explicitly include narrow-mouthed, tap-fitted water containers alongside targeted messaging on safe storage practices.

Competing Caregiving and Domestic Workloads findings indicate that mothers reported extreme time poverty driven by the double burden of prolonged water hauling over long distances and arduous domestic chores, which left minimal time for thorough food hygiene routines. This finding is highly consistent with literature (66, 67, 81), which highlighted that excessive maternal labor demands directly trade off against child feeding care and sanitation adherence in rural sub-Saharan Africa. The consistency lies in the fixed nature of daily temporal budgets; when fetching water and fuel consumes several hours daily, meticulous multi-step food preparation hygiene is inevitably truncated. On the other hand, research (51, 57, 68) indicated that domestic workload does not significantly reduce feeding hygiene when secondary caregivers (e.g., older siblings or grandmothers) or extended social support networks step in to share household duties. This discrepancy exists because acute conflict and population displacement fragmented traditional extended family networks in Tigray, isolating primary mothers and intensifying their individual work burden. Theoretically, this validates Time Allocation

Theory in maternal-child health, showing that structural labor burdens create severe trade-offs against preventative hygiene tasks. Programmatically, interventions should incorporate labor-saving technologies, such as close-proximity communal water kiosks and fuel-efficient stoves, to reduce maternal time poverty.

Mothers/Caregivers Adapted Food-Handling Practices to Severe Resource Constraints

Limited access to soap and cleaning materials showed that lack or extreme cost of commercial soap forced mothers/caregivers to skip handwashing and utensil sanitation during complementary food preparation. This finding is consistent with observational evidence (51, 82, 83), who established those financial barriers to purchasing soap directly predict low handwashing compliance at critical feeding times. These findings align because commercial hygiene products are price-sensitive market commodities; when economic collapse occurs, soap is quickly displaced by essential food items in household budgets. On the other hand, studies (17, 77) argued that soap availability is not a primary driver, as maternal health beliefs and emotional disgust drivers can sustain handwashing even under severe economic constraints. This divergence is explained by the difference between relative poverty in stable markets and the absolute market blockade experienced in Tigray, where soap was physically absent from local markets regardless of motivation. From a theoretical perspective, this highlights the principles of Behavioral Economics, where immediate financial constraints eliminate non-food expenditures regardless of health utility. Humanitarian aid must treat soap as an essential non-food item (NFI) distributed systematically alongside food rations.

Alternative cleaning practices revealed that in response to soap shortages, caregivers adapted by using traditional substitutes such as wood ash, sand, and plant leaves to scrub feeding utensils and wash hands. This adaptive practice is widely supported (20, 80, 83), who documented that resource-poor households routinely rely on abrasive alkaline materials like wood ash to clean organic residues from cooking surfaces. The consistency across these studies reflects the universal human tendency to improvise hygiene solutions using locally available abrasive agents when formal commodities fail. However, clinical and microbiological assessments (74, 84) proved that traditional cleaning agents like sand or plant leaves often introduce secondary microbial pathogens or cause mechanical skin damage, failing to provide the chemical surfactant action of soap. This contradiction highlights a conflict between subjective mothers/caregiver perceptions of physical cleanliness and objective microbiological safety. This behavior similar with protection motivation theory, where individuals execute coping behaviors based on available options, even if those actions carry secondary risks. Public health interventions should rigorously evaluate and provide clear guidelines on the safest local cleansing alternatives (such as sifted wood ash solution) when commercial soap supply chains are entirely severed.

Separation of raw and cooked foods under constrained household space indicated that single-room dwellings in displaced or damaged housing forced caregivers to prepare raw foods, store cooked food, and feed children in the same restricted physical space or house, leading to cross-contamination. This structural challenge is consistent with research (51, 84), which supported that domestic place crowding

in low-income settlements makes the physical separation of raw animal products and infant food nearly impossible. The alignment occurs because physical space is an absolute spatial constraint; high household density increases path-surface contact frequencies between raw items and child feeding utensils. In contrast, behavioral studies (65, 85) argued that spatial constraints can be overcome through procedural hygiene, such as using elevated surfaces or covering prepared food dishes. These differences arise because those studies examined settled rural homes with dedicated kitchen spaces, whereas displaced populations in conflict zones lack elevated counters, tables, or adequate food storage furniture. This situation fits Spatial Determinants of Health Frameworks, illustrating how physical living environments command domestic sanitary boundaries. Emergency shelter designs and post-conflict housing reconstruction must incorporate dedicated, elevated food preparation modules for vulnerable households.

Findings from food preservation and repeated reheating showed that complementary food at ambient room temperatures and served it cold or after minimal reheating. This practice is consistent with findings (86, 87) who identified ambient-temperature storage of high-moisture food as a major vector for bacterial growth and infant diarrheal disease in low-resource settings. The consistency stems from basic food microbiology: warm ambient temperatures combined with high carbohydrate complementary food matrices foster rapid logarithmic bacterial growth within hours. In contrast, evaluations (51, 88) showed that mothers/caregivers can maintain food safety by preparing small, single-use food portions for each meal, eliminating the need for storage and reheating. This discrepancy is explained by fuel and time availability; single-meal preparation requires multiple daily cooking fires, a strategy that is unfeasible for fuel-deprived mothers/caregivers in conflict settings. This finding reflects risk trade-off theory, where mothers/caregivers accept the latent microbial risk of stored food to prevent the immediate crisis of fuel exhaustion and severe starvation. Nutrition programs must distribute energy-dense, ready-to-use complementary foods (RUTF) that require no post preparation storage or reheating fuel.

Household leftover management revealed that mothers/caregivers routinely retained leftover complementary food for subsequent feedings to prevent food waste, even when signs of spoilage were suspect. This finding strongly correlates with evidence (49, 64), which observed that severe food insecurity creates a culture of absolute waste avoidance, forcing mothers/caregivers to feed infants' stale leftovers. The agreement across literature is rooted in economic survival logic: in acute starvation conditions, wasting calories is perceived as a greater threat to child survival than potential foodborne illness. On the other hand, health education trials (72, 73, 89) demonstrated that mothers educated on bacterial contamination routinely discard leftovers exceeding two hours of ambient storage. This contradiction is explained by the economic backdrop: behavioral compliance with waste-disposal guidelines occurs only when food supplies are secure and replaceable, a condition absent in Tigray. This behavior is best understood through scarcity mindset theory, where acute resource scarcity forces decision-makers to prioritize immediate survival needs over long-term preventative health risks. Food security initiatives must pair complementary food distribution with clear guidance on safe, short-term preservation techniques like fermentation.

Study limitations and strengths

This study in Tigray northern Ethiopia explores safe food handling practices from multiple perspectives, including front-line health care providers, experts, supervisors and program implementers in urban and semi-urban areas. The findings significantly contribute to developing locally appropriate programs to increase knowledge and practices of safe food handling. However, due to resource constraints, our study did not explore the perspectives of husbands, religious leaders, and government partners, emphasizing the need for further research, and the health extension workers, women development groups and village health leaders used as participants in the interview and nominates the mother of the child may be creates bias. We held open discussions and regular meetings among the researchers to maintain trustworthiness. However, because the naming of the practices is insufficient to the community, some mothers/care givers may have confused safe food handling practices with nutrition, potentially leading to exaggerated responses.

Conclusions

Complementary food handling practices among mothers/caregivers of young children in conflict-affected Tigray are shaped by a complicated matrix of structural, environmental, and socio-political determinants. While mothers/caregivers own baseline knowledge regarding food hygiene, their ability to execute safe practices is systematically constrained by severe WASH insecurity, destruction of infrastructure, poverty, and displacement. Handling strategies such as using wood ash for cleaning, relying on ambient-temperature food storage, and avoiding food waste at all costs represent rational adaptations to severe resource scarcity, despite introducing significant microbiological risks. Furthermore, rooted male-controlled gender dynamics and a fragmented health system under severe operational strain exacerbate these challenges. Addressing food safety in post-conflict and humanitarian settings requires moving beyond individual behavior-change education toward structural enabling strategies that restore the physical, economic, and institutional environments necessary for safe child care.

Recommendations

Federal Ministries & Regional Government Bodies (Tigray Regional Health Bureau, Ministry of Water and Energy)

- **Rebuild & Restore Infrastructure:** Prioritize the emergency rehabilitation of municipal water points
- **Restore Institutional Capacity:** Re-equip primary health care facilities, repair damaged health posts, and ensure all health centers are provisioned with continuous running water, sanitation systems, and hygiene supplies.
- **Support the Health Workforce:** Re-mobilize, incentivize, and train Health Extension Workers (HEWs), Health care providers (HCPs), Women's Development Groups (WDGs) and village health leaders (VHLS) to resume community outreach, home visits, and food safety demonstrations.

International Humanitarian & Non-Governmental Organizations

- **Deliver Integrated WASH-Nutrition-Food safety Programs:** Eliminate vertical service silos by systematically bundling food safety messaging and hygiene supplies (soap, clean water containers, water treatment) directly into Infant and Young Child Feeding (IYCF) and Community-Based Management of Acute Malnutrition (CMAM) programs.
- **Provide Targeted Material Support:** Distribute specialized complementary food safety kits containing narrow-necked closed water storage containers with spigots, covered food storage containers, fuel-efficient cooking stoves, and soap or validated local substitutes.
- **Embed Psychosocial & Economic Support:** Integrate Mental Health and Psychosocial Support (MHPSS) services into maternal nutrition interventions, while scaling up cash-based assistance directly targeted to female caregivers to reduce economic barriers to hygiene inputs.

Community Leadership & Local Institutions

- **Engage Men in Child Hygiene:** Implement gender-transformative community dialogues led by local leaders to encourage male partners to share domestic burdens (water/firewood retrieval) and prioritize household cash allocation toward child health and hygiene assets.
- **Mobilize Faith-Based Institutions:** Partner with religious and traditional community leaders to promote hygienic food handling practices, water protection, and community support networks for vulnerable caregivers.

Academic & Research Institutions

- **Conduct Microbiological Validation Studies:** Research the real-world microbiological efficacy and safety of indigenous adaptive practices (e.g., wood ash washing, localized heating methods) in resource-scarce environments.
- **Evaluate Structural Interventions:** Implementation research should focus on assessing the cost-effectiveness and impact of bundled structural interventions (cash + WASH kit + community messaging) on child diarrheal morbidity and nutritional status in protracted crises.

Abbreviations

FGDs

Focus Group Discussion

HCPs

Health Care Provider

HEWs

Health Extension Workers

IDs

In-depth Interviews

KAP

Knowledge, Attitude, Practice

KIIs

Key informant interviews

LMICs

Low Middle-Income Countries

SSA

Sub-Saharan Africa

VHL

Village Health Leaders

WASH

Water, Sanitation and Hygiene

WDGs

Women Development Groups

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I confirm that all methods were performed in accordance with the relevant guidelines. This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. This was given by Institutional Review Board of Mekelle University, College of Health Sciences (**reference: MU-IRB 2764/2026**) granted ethical approval. The Tigray Health Bureau issued a support letter, and the respective district health offices granted permission and obtained informed consent from the participants.

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Conceptualization: Kahsay Amare Gebremedhin, Gebretsadik Berhe, Girmatsion Fisseha, Shifare Berhe . Data curation: Kahsay Amare Gebremedhin. Formal analysis: Kahsay Amare Gebremedhin, Gebretsadik Berhe. Funding acquisition: Kahsay Amare Gebremedhin. Investigation: Kahsay Amare Gebremedhin, Gebretsadik Berhe. Methodology: Kahsay Amare Gebremedhin, Gebretsadik Berhe, Girmatsion Fisseha,

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Data Availability and Materials

All data generated or analyzed during this study are included in this published article

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Figures

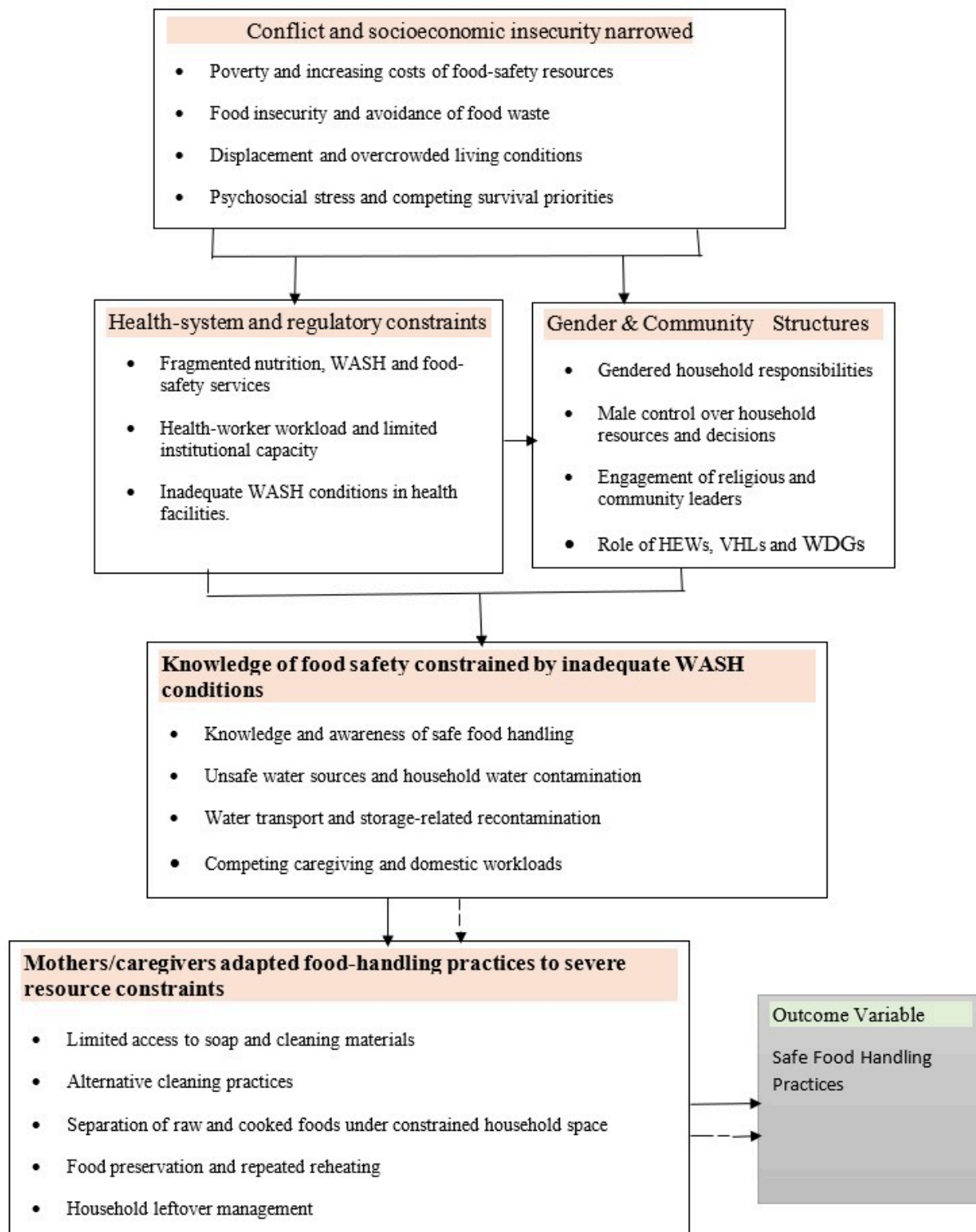


Figure 1

Framework of conflict and socioeconomic insecurity narrowed, health-system and regulatory constraints, gender & community structures, knowledge of food safety constrained by inadequate WASH conditions and mothers/caregivers adapted food-handling practices to severe resource constraints of safe food handling practices in Tigray Ethiopia.

Note:The broken lines represent a negative influence on safe food handling practices, while the solid lines indicate a positive influence.