



Impact of a mass-media consumer awareness campaign on food safety behavior and behavioral determinants among women in Dire Dawa and Harar, Ethiopia

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ABSTRACT

Food safety is a pressing public health challenge in urban informal markets in Sub-Saharan Africa. This study assessed the potential effectiveness of a nine-months food safety multi-media behavior change campaign implemented in Dire Dawa and Harar, Ethiopia (June 2022–February 2023) that aimed to encourage women to choose intact (safe) tomatoes at markets and safely prepare at households. Campaign channels included door-to-door household visits by health extension workers, TV and radio advertisements, billboards, and social media posts. Consumer panel surveys assessed self-reported food safety behavior and related behavioral determinants (i.e., intentions, knowledge, attitudes, norms and agency) pre-and-post campaign, 12 months apart. The sample included 765 consumers at endline with an attrition rate of 28.5%. Mixed-effects linear and ordered logistic models estimated changes associated with prompted recall. Campaign recall was high with 78.3% recalling a minimum of one channel. Recall was associated with higher access to safe food purchasing (aOR 1.994) and preparation (aOR 1.654) information. Door-to-door visits, radio, and TV advert recall were associated with safer buying behavior recall (0.520, 0.515, 0.515 unit increases resp.). Prompted recall was associated with a 0.921 unit increase in safe household food preparation scores, where door-to-door visits and billboard showed the strongest association. Recall increased odds of higher intent to buy intact tomatoes (aOR1.409); printed media recall related to a 1.314 unit increase in knowledge scores. Finally, recall was associated with higher perceived health benefits (aOR 1.546), social descriptive norms (aOR 1.458), and self-efficacy (aOR 2.5) regarding safe tomato practices. In conclusion, a mass media behavior change campaign has potential to empower consumers to choose safer food in informal markets. Door-to-door visits, TV, radio and print media were notably more effective than social media channels. Beyond enhancing consumer knowledge and behavior, broader efforts are vital for enhancing food safety in urban informal markets, including ensuring the availability and affordability of intact, clean tomatoes by engaging and motivating actors within the tomato value chain.

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1. Introduction

Foodborne diseases rank among the leading contributors to the global burden of disease (Pires et al., 2021). Unsafe food harms individual nutritional and health status, elevating morbidity and mortality (Chan, 2014), and foodborne disease burdens economies and healthcare systems, exacerbating inequality and hampering overall human development. Food safety plays a critical role in shaping healthy food systems, impacting food and nutrition security (Nordhagen et al., 2022; Unnevehr, 2015). Despite increased awareness, its significance is undervalued compared to its massive public health, economic, and societal impact (Grace et al., 2019).

Food safety is a particular pressing challenge in low- and middle-income countries where the annual estimated costs of \$115 billion dollars are attributed to food hazards and foodborne disease (Henson, Jaffee, & Wang, 2023). Sub-Saharan Africa bears the biggest burden (Pires et al., 2021) with per capita economic costs of unsafe food consumption estimated to be double the global average. Despite challenges in accurately estimating the economic burden of foodborne disease in Sub-Saharan Africa due to limited surveillance and data availability, the morbidity and mortality-related costs (e.g. loss of human capital and productivity due to disease, hospitalization) range between \$20 and 40 billion dollars, annually (Grace et al., 2018). Food insecurity, poverty, and malnutrition, particularly among economically disadvantaged groups, increase the risk of consuming contaminated food, leading to cycles of disease and malnutrition (Jaffee, Henson, Unnevehr, Grace, & Cassou, 2019). Food hazards disproportionately affect young children, the elderly, and pregnant and lactating women (World Health Organization, 2015). Children under five years old not only carry 40% of the FBD burden in terms of Disability Adjusted Life Years (DALYs), but also endure the most severe long-term consequences from these diseases (Havelaar et al., 2015, 2022).

Exposure to biological hazards associated with foodborne disease, primarily microbial and parasitic pathogens, relate to human (in)actions (Grace et al., 2018; Havelaar et al., 2015), but incidence is expected to rise due to evolving food systems, urbanization, globalization, population growth, climate change, and shifting dietary patterns (King et al., 2017). Food value chains have become increasingly complex and lengthier with more steps and actors involved in supplying food to meet consumer demand. In Sub-Saharan Africa and South-Asia, up to 90% of foods are sold through informal outlets (Henson, Jaffee, & Wang, 2023). Despite the importance for daily food needs, informal markets also supply high-risk items including fruits and vegetables which contribute significantly to foodborne disease in Sub-Saharan Africa (Aworh, 2021; Grace, 2015).

Food safety responsibility spans the entire chain, including consumers who influence choices in buying, storing, and preparing food, especially in informal markets (Jaffee, Henson, Unnevehr, Grace, & Cassou, 2019). Consumer decisions often centralize food affordability, availability, convenience, and taste (Raaijmakers, Snoek, Maziya-Dixon, & Achterbosch, 2018) and trust in vendors, branding, and certification (Wertheim & Spaargaren, 2016). However, recent studies noted increased consumer concern about food safety in low- and middle-income countries (Amenu et al., 2023; Liguori et al., 2022). Several studies highlight that consumers feel increasingly knowledgeable about preventing foodborne disease (Fischer et al., 2006; Odeyemi et al., 2019), although consumer food safety awareness in Sub-Saharan Africa remains low relative to Asia (Ortega & Tschirley, 2017). Consumer awareness, if translated into safer buying behaviors, could potentially leverage food safety improvements upstream the value chain (a “pull approach”). However, limited evidence exists on consumers’ food safety concerns, beliefs, and behavior (Henson, Jaffee, & Wang, 2023; Ortega & Tschirley, 2017) and the effectiveness of consumer-focused food safety interventions (Amenu et al., 2023; Dione et al., 2021; Global Alliance for Improved Nutrition, 2020).

This study was carried out as part of a larger project concentrating on

tomato value chains in Ethiopia, considering tomatoes being a high-risk product frequently consumed raw and widely integrated into daily diets (Amenu et al., 2021, 2023; Brascesco et al., 2019). Recent evidence in Ethiopia indicated that the annual burden from vegetable-related foodborne disease equals that of beef and dairy, estimated at 24,000 DALYs or 400,000 cases (Gazu et al., 2023; Havelaar et al., 2022). Due to mishandling and overpacking during transportation, post-harvest tomato damage (up to 40%) increases the risk of pathogen contamination, aside from significant economic losses (Emana et al., 2017; Gemedat et al., 2023). Informal markets amplify foodborne disease risks through unhygienic market conditions and vendor practices (Birke & Zawide, 2019; Gemedat et al., 2023). As part of a larger project¹ we assessed a mass-media campaign targeting urban women with children under ten in Eastern Ethiopia, aimed at encouraging safer choices when purchasing tomatoes at informal markets and during household food preparation to inform the implementation and scaling up of food safety interventions in the context of Sub-Saharan Africa.

In this study, we estimated associations between campaign recall and (intact) tomato buying and safe household preparation behavior as well as their behavioral determinants. We also tested the relative effectiveness of the five campaign channels and whether the campaign reached its intended population.

2. Materials and methods

2.1. Study area

The consumer campaign ran in informal markets of Dire Dawa and Harar, in Eastern Ethiopia, 500 km from the capital, Addis Ababa. Dire Dawa holds an estimated population of 333,000, while Harar, the ancient capital of the Harari region, is a rapidly growing with around 153,000 residents. Both cities span a range of religious, ethnic, and linguistic groups. Tomato value chains in this area lack proper organization, infrastructure oversight, and regulation, leading to generally limited capacity and motivation among stakeholders to improve food safety (Gemedat et al., 2023; Henson, Jaffee, & Wang, 2023; Roesel & Grace, 2014). Poor sanitation, recurring droughts, water scarcity, poverty, and food insecurity further compound food safety risks (Bardosh et al., 2020). For instance, among children under five, food-borne diarrhea has risen to 12% in recent years (CSA & ICF., 2016).

2.2. The “abo! Let’s eat the intact ones” consumer campaign

2.2.1. Aim

The locally-contextualized mass-media behavior change communication campaign, “Abo! Eat the Intact Ones” (in Amharic: አቦ ለሆሽው ርብላ), shortly ‘Abo!’ campaign, was developed by Wageningen Economic Research in collaboration with media agency Cactus, Addis Ababa. The word “Abo” serves as a popular conversational icebreaker – similar to “hey” - in the region where the campaign was implemented, and is commonly used to seek attention from a person with whom the conversation is made. Built on behavioral theories including the Theory of Planned Behavior (Ajzen, 1991) and Elaboration Likelihood Model (Petty & Cacioppo, 1986), the campaign aimed to boost consumer demand for safe, intact tomatoes in Dire Dawa and Harar’s informal markets, and enhancing safe household tomato preparation practices.

2.2.2. Target group

The main target audience was women with children below ten years residing in Dire Dawa and Harar, from lower- and middle-income households, who regularly bought tomatoes at informal markets. These groups were assumed to have a relatively higher exposure to foodborne hazards and foodborne disease impact (Gazu et al., 2021).

¹ Conceptual framework Pull-Push Project.

2.2.3. Campaign messages

Campaign content was based on insights from previous tomato vendor surveys (Gemedo et al., 2021), expert meetings, stakeholder interviews (e.g., with government officials, agriculture extension workers, trade experts, health professionals, value chain actors) and consumer focus group discussions in Dire Dawa and Harar (Amenu et al., 2021; Gazu et al., 2021). Key messages (Supplementary Tables A1 and A2) focused on tomato buying behavior at the market and household tomato preparation behavior, and were inspired by the World Health Organization's "Five keys to safer food" (2006). Considering the region's multi-ethnic, -religious, and -lingual population, locally-contextualized and tailored materials were disseminated in Amharic, Afaan Oromo, Af Somali, and Harari. Messages focused on evoking positive emotions emphasizing benefits of purchasing and preparing safe tomatoes for consumers' and their families' health, rather than risks.

2.2.4. Campaign channels

The campaign was broadcast through multiple media outlets² from June 2022 to February 2023. Channels included: 452 radio adverts at local radio stations *Dire Dawa FM*, *Harar FM*, and *Haramaya Fana FM*; 264 TV spots at local TV stations *Dire Dawa TV* and *Harar TV*; and two prominent billboards (Fig. A1). From June to November 2022, 30 digital Facebook posts reached on average 1,361,999 views per month. In July and August, 30 teams of trained health and nutrition extension workers visited 4993 and 2601 households door-to-door in Dire Dawa and Harar reaching 19,104 and 5873 women respectively, to raise awareness on buying and preparing practices through tutorials and display of 8000 posters with campaign messages on walls near visited households.

2.3. Study design & sampling

To evaluate campaign impact, we conducted a prospective two-wave panel survey with data collected before (February–March 2022) and after the campaign (January–February 2023). Data were collected at tomato outlets in Dire Dawa and Harar. We sampled consumers from a prior vendor survey's sampling frame that included 83 and 50 tomato outlets in Dire Dawa and Harar, respectively, drawn from a census identifying 848 and 518 outlets in Dire Dawa and Harar (Gemedo et al., 2023). A two-stage, non-stratified simple random strategy was applied to reach a sample size of 500 women in each city, totaling 1100, similar to other evaluation studies and considering a modest effect size (0.20) on food safety behavior (Patil et al., 2004; Snyder et al., 2009). We first randomly selected 25 out of 83 outlets in Dire Dawa and 25 out of 50 in Harar, including a mix of tomato retailers, stalls in the vicinity of a food market, and street vendors aiming for a representative consumer-visited sample. After identifying the 50 outlets via GPS coordinates, enumerators stationed near outlets to invite every third eligible tomato-buying consumer: aged 18+ years; permanent resident in Dire Dawa or Harar without intention to move; purchasing tomatoes at least bi-weekly. A maximum of 22 consumers were interviewed per outlet.

At baseline, 1103 women participated. Four respondents were excluded due to unreliable data, 11 women did not consent or complete the survey, and 18 cases were removed as they were duplicates from interviews at other outlets, resulting in a baseline sample of 1070. Post-campaign, all baseline respondents were invited for a follow-up survey. From 769 women agreeing to participate, four duplicates were removed, resulting in an analytical sample of 765 respondents with complete data for both assessments. The final sample included 386 (51%) women from Harar and 379 (49%) from Dire Dawa. The campaign's target audience - mother of at least one child below ten - was represented by 337 (44%) women. The attrition rate was 28.5% due to incorrect phone numbers (17.85%), refusal without specifying a reason (12.5%), partner refusal

(4.6%), non-functional numbers (52.6%), or not answering after three calls (2.6%).

2.4. Survey & procedures

Survey items were inspired by prior consumer food safety studies (Abbot et al., 2009; Asiegbe et al., 2016; C Byrd-Bredbenner et al., 2007; Byrd-Bredbenner et al., 2007a,b; Davis, 1989; Kendall et al., 2004; Odeyemi et al., 2019) and aligned with the campaign's key messages and the Integrated Behavioral Model's components (Montano & Kasprzyk, 2015). This behavioral theory suggests that behavior depends on intentions to follow best practices, knowledge, and contextual factors such as food availability and affordability (Montano & Kasprzyk, 2015). Intentions stem from attitudes, social norms, and agency. Considering women's pivotal roles in household food purchasing and preparation, as well as market vending, we also considered autonomy in decision-making as potentially impacting behaviors (Grace et al., 2018). The survey covered self-reported behavior, intentions, knowledge, attitudes (i.e., risk perception and perceived benefits), social descriptive norms, agency (decision-making autonomy), socio-economic and demographic indicators (highlighted blue in Fig. 1). At endline we assessed campaign recall and appraisal.

Surveys were translated from English to Amharic and Afaan Oromo and programmed in KoboCollect on tablets. The baseline survey underwent thorough pretesting in Harar during enumerator training. Baseline surveys were conducted in-person near sampled tomato outlets by ten trained enumerators. At endline, nine trained enumerators contacted consumers by phone (maximum of three attempts), and invited them for an in-person follow-up interview at a central market location. Consumers unable to attend were interviewed via phone (n = 40, 5.2%). The campaign's goals were not disclosed until after completing surveys. Interviews lasted between 30 and 60 min.

2.5. Measures

2.5.1. Primary outcome

Primary outcomes included self-reported tomato buying and preparation behavior. Items were inspired by previous studies on consumer food safety behaviors and aligned to the World Health Organization's "Five Keys to Safer Food" and campaign key messages (Abbot et al., 2009; Byrd-Bredbenner et al., 2007; WHO, 2016). Rated on a five-point Likert scale (1 'never' to 5 'always'), five items assessed safe tomato buying practices covering frequency of: buying intact, slightly bruised, or damaged tomatoes, floor-displayed tomatoes; and discussing tomato quality and affordability with vendors. Ten items assessed household tomato handling and preparation covering frequency of: tomato use; handwashing; separating damaged and intact tomatoes; storing prepared dishes; and using clean materials. An eleventh item indicated reheating or chilling prepared tomato dishes if not immediately consumed (1 'yes'). Total behavior scores summed buying (max. 25 points) and preparation behavior (max. 51 points).

2.5.2. Secondary outcomes

Secondary outcomes included the behavioral determinants of interest. The development of items was inspired by studies on behavioral determinants of food safety behaviors (Asiegbe et al., 2016; Byrd-Bredbenner et al., 2007a,b). Intentions to buy or cook with intact tomatoes were measured on a five-point Likert scale (1 'never' to 5 'always'). Knowledge was assessed with four true-false and three multiple-choice questions on safe tomato buying, and two true-false and three multiple-choice questions on safe tomato preparation. Correct responses were scored '1,' incorrect or 'don't know' as '0.' Scores were summed for preparation (max. 5) and buying knowledge (max. 7). Risk perceptions including concern and worry about the safety of tomatoes consumed at home, perceived health benefits of buying and preparing intact tomatoes, and social perceived descriptive norms (i.e., extent to

² Campaign materials available via: <https://www.ilri.org/pull-push-project-Implementing-food-safety-consumer-campaigns>.

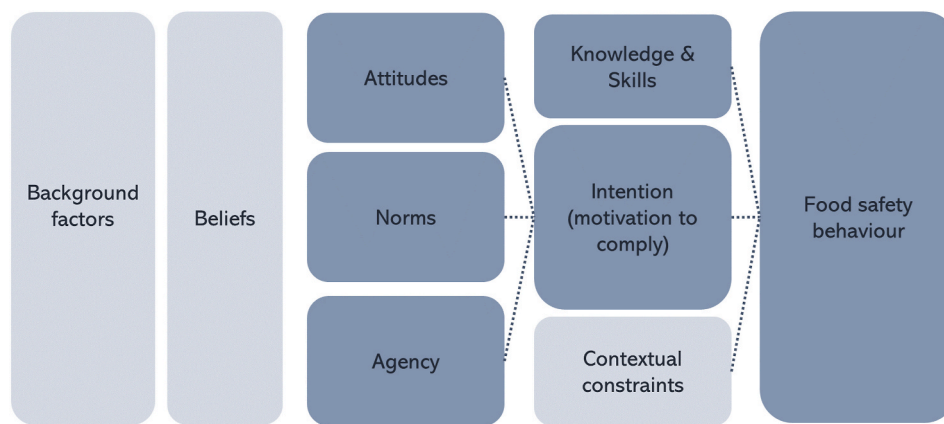


Fig. 1. Conceptual framework - Integrated Behavioral Model.

which consumers believed others followed food safety behaviors) were also measured on five-point Likert scales from 'not safe at all/very detrimental/never' (1) to 'very safe/beneficial/always' (5). Decision-making autonomy regarding routine food purchasing and preparation was derived from items from the Women's Empowerment in Agriculture Index (WEIA) (Alkire et al., 2013) and scored as: 'none to a little input' (0), 'some input' (1), or 'input into most/all decisions' (2). Don't know responses were coded as missing and items were reversed when necessary.

2.5.3. Campaign recall

Both unprompted and prompted campaign recall were assessed as unprompted recall relies on memory and indicates successful message delivery, whereas prompted recall using cues best represents campaign-attributed recall (Charlesworth et al., 2023). Unprompted recall was assessed asking if consumers recalled any message about food safety since baseline and what this message entailed. Prompted recall concerned asking consumers' recall of each of the five campaign channels (i. e. radio, TV, print media, Facebook, or door-to-door visit) using audio and images as prompts. 'Recall' was coded as 1, while all other responses including 'no recall', 'unsure' or 'don't know' were coded as 0. Campaign appraisal concerned trust in received information, frequency of discussing the campaign with others, and extent to which consumers felt able to access information on safe food buying and preparation, measured on five-point Likert scales.

2.5.4. Covariates

Time-invariant (baseline) factors included: age in completed years, marital status (married, separated/widowed/divorced, never married), educational attainment (no [formal], primary, secondary, or above secondary), occupation (agriculture, skilled salaried, unskilled salaried, self-employed, unemployed or student), whether the consumer headed the household ('yes' coded 1, 'otherwise' 0), household size, and number of children below ten. We excluded the latter from analyses due to multicollinearity with household size. To capture market price changes since baseline (Rice et al., 2022), we asked about perceptions of tomato price shifts at endline.

Time-variant factors (base- and endline) included the MacArthur Scale of Subjective Social Status (Adler et al., 2000) where consumers were asked to rank themselves on a ten-rung ladder, and monthly household food expenditure in Ethiopian Birr (ETB), categorized into less than 2000ETB, between 2000 and 3000ETB, or more than 3000ETB

per month.³ Perceived household food security was measured using one item from the Household Hunger Scale (Ballard et al., 2011), 'in the previous 9 months, was there any time that you ran out of food and were not able to buy more?' ('yes' 1, 'no' 0). 'Don't know/don't want to say' responses were coded as missing.

2.6. Analyses

Data were downloaded from KoboToolbox. Frequencies and means summarized sample characteristics and campaign recall. Bivariate analyses (see Supplementary Table A2) tested differences between recall and no recall groups (between-subjects), and between base- and endline (within-subjects) and the primary and secondary outcomes using Wilcoxon signed-rank test for non-normally distributed paired data, *t*-test for normally distributed continuous data, and paired *t*-tests or McNemar's tests for within-subject nominal data in base- and endline comparisons. Unadjusted differences over time between recall groups were estimated using differences-in-difference scores.

A series of mixed models estimated within-subject changes for prompted recall, with time and covariates included as fixed-effects, and outlets and individuals as random-effects to allow for nesting of consumers within outlets and assess variability across outlets and between subjects (Rabe-Hesketh & Skrondal, 2008). Linear regression mixed models estimated relationships between recall and total behavior scores and squared root knowledge scores due to heteroscedasticity of residuals. Recall's impact on behavioral determinants was evaluated using ordered logistic mixed models. Binary logistic regressions were estimated for decision-making autonomy and perceived benefits, for which we dichotomized decision-making input (merging categories 'none' to 'some input' representing 'low input' (0), and 'most' or 'all input' representing 'high input' (1) and perceived benefits (merging 'very detrimental' with 'somewhat detrimental' as 'low perceived benefits' (0), and 'very beneficial' indicating 'high perceived benefits' (1)), to address heteroskedasticity and ceiling effects. Models were adjusted for the covariates: age, marital status, occupation, educational attainment, household head, household size, perceived price changes, food insecurity, SSS, and monthly food expenditure. Impact of the media channels was estimated using dummy variables for radio, TV, Billboard, door-to-door visit, and social media recall. Robustness tests included these dummies separately (output not shown). To determine the campaign's reach to its intended audience, sensitivity analyses considered only women with children below ten ($n = 337$) (available upon request).

³ Exchange rates ETB-USD March 2022: 1 = 0.019; and February 2023 1 = 0.019.

Robust variance-covariance estimation (vce) was employed to enhance the reliability of parameter estimates. Models showed minimum variability of observed effects between subjects (close to, or zero). Full models are reported in the Appendix (Tables A4-12). Statistical analyses were conducted with Stata v.16 (StataCorp, 2019). Significance was set at $p < 0.05$.

2.7. Ethics

Ethics approval for this study was obtained from ILRI's Institutional Research Ethics Committee (IREC, ILRI-IREC2021-63). Respondents provided written, or if refused, audio-recorded verbal consent. They received a financial compensation at both times, covering time and transport costs.

3. Results

3.1. Sample statistics

Table 1 outlines time-invariant (measured at baseline) and time-varying variables (measured at both timepoints) and differences between those recalling or not recalling the campaign. Consumers averaged 31 years old, with 65% married and primarily self-employed (e.g., trading, small business). The majority had no (25.6%) or primary (42.5%) formal education. One-third were household head, with households averaging 4.5 persons. Mean social subjective status was 3.9 at baseline, reaching 4 at endline and although stable over time, one in two consumers reportedly ran out of food at least once. Monthly food expenditure significantly increased over time, with 43.5% spending over 3000 ETB, equivalent to 58.2USD, at baseline, reaching 56.5% at endline. At endline, 92.2% observed at least a doubling of tomato prices

Table 1

Socio-economic and demographic characteristics pre-and post-campaign and differences between recall and no recall at endline.

	Baseline (n = 765)	Endline (n = 765)	p-value	Recall (n = 599)	No recall (n = 166)	p-value
	n (%) or mean \pm SD					
Mean Age	31.5 \pm 11.6	32.3 \pm 11.5	0.176	31.6 \pm 10.9	34.9 \pm 13	0.001
City						
Harar	384 (50.2)			337 (87.8)	47 (12.2)	<0.001
Dire Dawa	381 (49.8)			262 (68.8)	119 (31.2)	
Marital status						
Married	501 (65.5)			390 (77.8)	111 (22.2)	0.735
Divorced, separated or widowed	143 (18.7)			111 (77.6)	32 (22.4)	
Never married	121 (15.8)			98 (81)	23 (19)	
Education attainment						
No (formal) education	196 (25.6)			149 (76)	47 (24)	0.004
Primary education	325 (42.5)			248 (76.3)	77 (23.7)	
Secondary education	136 (17.8)			103 (75.7)	33 (24.3)	
Secondary education or higher	108 (14.1)			99 (91.7)	9 (8.3)	
Occupation						
Agriculture/livestock	13 (1.7)			11 (84.6)	2 (15.4)	0.022
Self-employed	413 (54)			321 (77.7)	92 (22.3)	
Skilled salary	60 (7.8)			55 (91.7)	5 (8.3)	
Unskilled salary	46 (6.0)			39 (84.8)	7 (15.2)	
Unemployed/retired	163 (21.3)			116 (71.2)	47 (28.8)	
Student	70 (9.2)			57 (81.4)	13 (18.6)	
Head of household						
Women-headed	241 (31.5)			185 (76.8)	56 (23.2)	0.484
Not Women-headed	524 (68.5)			414 (79)	110 (21)	
Household size	4.5 \pm 2.0			4.4 \pm 1.99	4.8 \pm 2.09	0.038
No. children <10 yrs	0.9 \pm 1.4			0.9 \pm 1.4	1 \pm 1.3	0.408
Children <10 years						
None	337 (44.1)			342 (79.9)	86 (20.1)	0.225
At least one	428 (55.9)			257 (76.3)	80 (23.7)	
Household food security						
Food secure	426 (49.5)	434 (50.5)	0.680	345 (79.5)	89 (20.5)	0.360
Food-insecure	339 (50.6)	331(49.4)		254 (76.7)	77 (23.3)	
Mean social subjective status	3.93 \pm 1.66	4.07 \pm 1.51	0.088	4.08 \pm 1.5	4.01 \pm 1.5	0.608
Monthly food expenditure*						
<2000 ETB	117 (61.6)	73 (38.4)	<0.001	54 (74)	19 (26)	0.593
2000–3000 ETB	196 (57.8)	143 (42.2)		111 (77.6)	32 (22.4)	
>3000 ETB	387 (43.5)	503 (56.5)		398 (79.1)	105 (20.9)	
Perceived change in tomato price						
No change		60 (7.8)		54 (90)	6 (10)	0.060
doubled		575 (75.2)		449 (78.1)	126 (21.9)	
Tripled		83 (10.9)		59 (71.1)	24 (28.9)	
quadrupled		47 (6.1)		37 (78.7)	10 (21.3)	
Tomato buying frequency						
Bi-weekly	100 (60.2)	66 (39.8)	<0.001	56 (84.9)	10 (15.2)	0.003
Weekly	161 (42.3)	220 (57.7)		175 (79.6)	45 (20.5)	
2–3 times/week	293 (52.7)	262 (47.2)		213 (81.3)	49 (18.7)	
4–6 times/week	91 (72.8)	34 (27.2)		30 (88.2)	4 (11.8)	
Daily	120 (39.6)	183 (60.4)		125 (68.3)	58 (31.7)	
Outlet choice						
Rank 1	Price (58.2)	Safety (66.1)				
Rank 2	Quality (58)	Quality(60.1)				
Rank 3	Appearance (24.8)	Price(34.4)				

Notes: Empty cells = n/a. *1 ETB = 0.019 USD Mar '22 and 0.018 USD Feb '23. 2000 ETB = 38.8USD, 3000ETB = 58.2USD.

Table 2
Campaign recall and appraisal.

	n (%)
Unprompted recall	375 (49)
Primary aim of the campaign:	
Safety of tomatoes	302 (80.5)
Food safety/quality in general	32 (8.5)
Improving public health, water, hygiene, and sanitation, or nutrition	6 (1.5)
Not specified or can't remember	35 (9.3)
Prompted Recall	
Print media (billboard, poster)	498 (65.1)
Radio	298 (39)
TV	297 (38.8)
Door-to-door (household) visit	210 (27.5)
Social media	106 (13.9)
Prompted recall (total, any channel)	599 (78.3)
Primary aim of campaign	
Improving public health	448 (81.6)
Improving food safety	357 (59.7)
Promoting hygiene	214 (35.8)
Improving health/nutrition knowledge	144 (24.1)
Reducing malnutrition	26 (4.4)
Promoting tomato consumption	19 (3.2)
Research	17 (2.8)
Trust information	4.61 (0.68)
Not at all	3 (0.5)
Somewhat	11 (1.85)
Neutral	16 (2.68)
A lot	156 (26.2)
Very much	410 (68.8)
Discussed campaign with others	2.97 (1.18)
Never	75 (12.5)
Rarely	118 (19.7)
Sometimes	240 (40.1)
Often	84 (14)
Always	82 (13.7)

Notes: n = 599 campaign-recall, n = 166 no recall.

(75.2%). Younger consumers, Harar residents, those with higher educational attainment or smaller household size more often recalled the campaign. At baseline, 58.2% of consumers chose outlets based on tomato price, followed by quality and appearance. By endline, tomato safety and quality took the top two spots, while price fell to a third place.

Table 3
Ordered logistic mixed-effects models estimating associations between campaign recall and perceived access to food safety information.

	Perceived access to information on safe tomato purchasing						Perceived access to information on safe food preparation					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	1.005	0.991	0.445–2.269	1.021	0.954	0.501–2.082	1.018	0.963	0.478–1.489	0.945	0.870	0.477–1.870
Campaign recall	1.952	0.002	1.270–3.001				1.654	0.019	1.088–3.514			
Radio recall				1.292	0.251	0.834–2.000				1.154	0.436	0.805–1.656
Print media recall				1.350	0.093	0.951–1.916				1.363	0.096	0.947–1.963
Door-to-door visit				1.135	0.472	0.804–1.604				1.091	0.630	0.765–1.557
TV recall				1.556	0.020	1.072–2.257				1.486	0.028	1.044–2.115
Social media recall				1.282	0.330	0.778–2.113				1.570	0.053	0.994–2.481

Notes: Baseline, and no recall set as references. Models adjusted for: age, marital status, educational attainment, occupation, head of household, household size, household food security, SSS, monthly food expenditure, change in tomato prices, city. Robust standard errors using vce (robust) option in STATA. Random effects (RE) estimates for outlet level and individual level. Model fit: ICC: Intraclass Correlation Coefficient; AIC: Akaike's Information; BIC: Bayesian Information Criterion. aOR: adjusted odds ratio, SE: Standard Error.

3.2. Campaign recall and perceived access to food safety information

Without prompting, 49% of consumers recalled any food-safety message since baseline (Table 2). The primary message, as recalled by 80.5%, concerned tomato safety. When prompted, 65.1% saw a billboard/poster, 38% watched/heard a TV or radio advert spots, and 27.5% were visited by a health extension worker at their household. Only 13.9% had viewed an online post. The proportion of consumers recalling at least one of the five channels when prompted, was 78.3%. The main message was associated with improving public health (83.7%) or food safety (61.2%). At least two-thirds of consumers who recalled the campaign trusted the information received very much (68.8%) or somewhat (14.6%). Over half had at least sometimes discussed the campaign with others (67.8%).

Campaign recall was associated with 1.994 increased odds for better access to safe buying (p < 0.001) and 1.654 higher odds for safe preparation information (p = 0.019) compared to no recall (Table 3, Fig. 2). TV recall increased the odds of higher access to food safety information in both domains (aOR1.556, p = 0.020 and aOR1.486, p = 0.028). Sensitivity analyses with women with children under ten only revealed a similar effect on access to safe buying practices.

3.3. Self-reported behavior

Door-to-door household visit recall (Table 4, Fig. 3) was associated with a 0.520 unit increase on total safe buying behavior scores (p = 0.018). Robustness tests with individual channels included as dummy fixed effects confirmed this finding (0.688, p = 0.002) plus a modest increase of 0.515 on buying score among consumers who recalled a TV (0.515, p = 0.012) or radio spot (0.472, p = 0.028). Sensitivity analyses did not reveal significant associations among mothers with young children. A significant, but small association was observed between prompted recall and safer tomato preparation scores (0.921, p = 0.022). Billboard/poster and door-to-door visit recall were associated with 0.798 (p = 0.020) and 0.706 (p = 0.039) unit increases in safe food preparation behavior scores, respectively. Robustness tests confirmed significant associations between door-to-door household visits (1.013, p = 0.003), print media (1.015, p = 0.003), and TV ads (0.755, p = 0.012). Sensitivity analyses did not show associations between recall and safe tomato preparation practice scores.

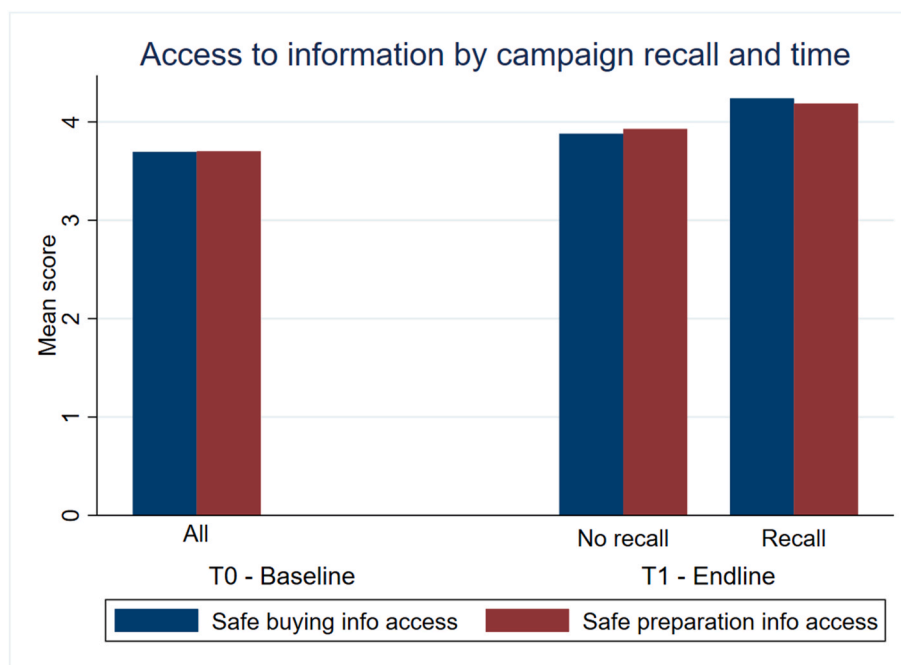


Fig. 2. Access to information by recall and time.

Table 4

Linear regression mixed-effects models estimating associations between campaign recall and safe buying and food preparation behavior.

	Safe tomato buying behavior score						Safe food preparation behavior score					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	Coef.	p	95% CI	Coef.	p	CI 95%	Coef.	p	95% CI	Coef.	p	CI 95%
Endline	0.416	0.258	-0.304-1.136	0.304	0.340	-0.321-0.929	1.075	0.103	-0.217-2.367	0.904	0.142	-0.302-2.110
Campaign recall	0.429	0.149	-0.154-1.011				0.921	0.022	0.135-1.707			
Radio recall				0.192	0.458	-0.316-0.700				0.199	0.626	-0.603-1.002
Print media recall				0.231	0.324	-0.228-0.691				0.798	0.020	0.127-1.470
Door-to-door visit				0.520	0.018	0.090-0.951				0.706	0.039	0.035-1.377
TV recall				0.263	0.246	-0.181-0.708				0.370	0.298	-0.326-1.066
Social media recall				-0.142	0.606	-0.683-0.399				-0.297	0.545	-1.259-0.665

Notes: Baseline, and no recall set as references. Models adjusted for: age, marital status, educational attainment, occupation, head of household, household size, perceived household food security, subjective social status, monthly food expenditure, change in tomato prices, city. Robust standard errors using vce (robust) option in STATA. Random effects (RE) estimates for outlet level and individual level. Model fit: ICC: Intraclass Correlation Coefficient; AIC: Akaike’s Information; BIC: Bayesian Information Criterion. aOR: adjusted odds ratio, SE: Standard Error.

3.4. Intentions

Table 5 shows a 2.5 increase in the adjusted odds in intention to buy intact tomatoes (p = 0.001). Door-to-door visit recall was associated with a 1.409 increase in odds of reporting higher intentions to buy intact tomatoes (p = 0.047) compared to no door-to-door visit recall (Fig. 3). Robustness tests confirmed the positive impact of door-to-door visits (aOR 1.746, p = 0.001) and increased odds of higher intentions with TV (aOR 1.482, p = 0.022), radio (aOR 1.660, p = 0.002), print media (aOR 1.698, p = 0.031), and social media (aOR 1.831, p = 0.042) recall, compared to no recall. Initial models suggested a negative association between TV ad recall and intentions to cook with intact tomatoes only (aOR 0.690, p = 0.027), but this finding disappeared in robustness tests.

3.5. Knowledge

Table 6 confirmed a 2.595 unit increase in knowledge score on safe

buying practices (p = 0.027) over time, but not with prompted recall. However, print media recall was associated with a 1.341 unit increase in knowledge score regarding safe preparation (p = 0.008, Fig. 3), supported by robustness tests.

3.6. Attitudes

None of the models showed significant associations between prompted recall and risk perceptions, although time was associated with reduced worry about home-consumed tomato safety (aOR 0.291, p = 0.004, Table 7). No association was found between prompted recall and perceiving health benefits from buying intact tomatoes only (Table 8). However, radio recall was associated with 1.546 increased odds of perceiving benefits from cooking with intact or slightly bruised tomatoes (p = 0.029). TV ad recall showed a negative association (aOR 0.557, p = 0.008), but again disappeared in robustness tests.

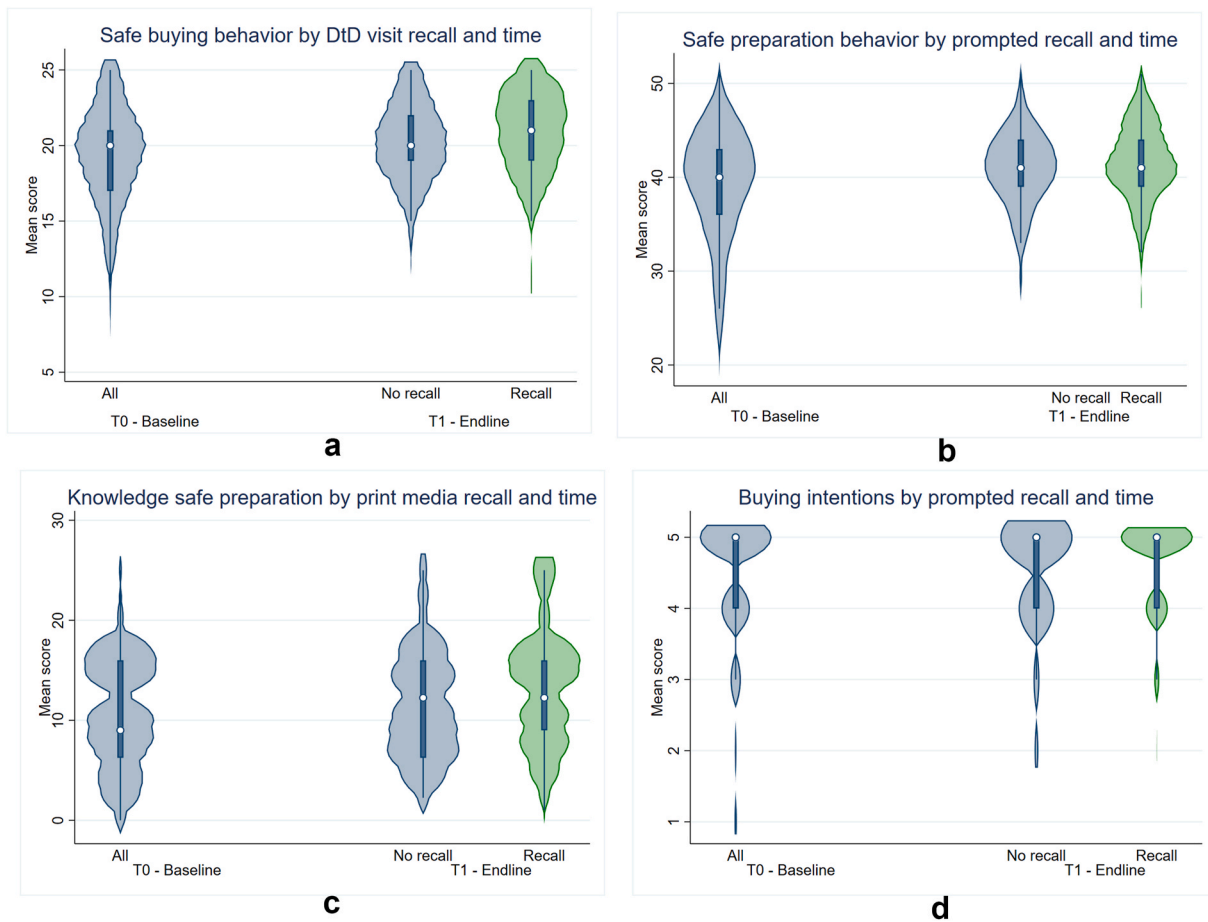


Fig. 3. Violin plots behavior, knowledge, and intentions by recall and over time.

Table 5

Binary logistic regression mixed-effects models estimating associations between campaign recall and food safety intentions.

	Intention buying intact tomatoes						Intention cooking with intact tomatoes					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	0.582	0.070	0.324–1.045	0.717	0.193	0.434–1.183	0.899	0.712	0.512–1.580	0.822	0.452	0.493–1.370
Campaign recall	2.504	0.001	1.464–1.464				1.064	0.774	0.697–1.625			
Radio recall				1.361	0.077	0.967–1.916				1.107	0.548	0.794–1.545
Print media recall				1.467	0.120	0.905–2.377				1.273	0.153	0.914–1.773
Door-to-door visit				1.409	0.047	1.005–1.976				1.344	0.122	0.924–1.956
TV recall				1.048	0.812	0.711–1.545				0.690	0.027	0.497–0.958
Social media recall				1.389	0.281	0.764–2.525				0.980	0.955	0.482–1.994

Notes: refer to notes Table 3.

Table 6

Linear mixed-effects regression estimating associations between campaign recall and food safety knowledge.

	Knowledge score safe tomato buying						Knowledge score safe tomato preparation					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	Coef.	p	95% CI	Coef.	p	CI 95%	Coef.	p	95% CI	Coef.	p	CI 95%
Endline	2.595	0.027	0.300–4.891	2.060	0.074	−0.197–4.317	0.771	0.309	−0.715–2.256	0.433	0.561	−1.026–1.892
Campaign recall	−0.480	0.493	−1.854–0.893				1.015	0.085	−0.141–2.171			
Radio recall				−0.024	0.977	−1.636–1.589				0.026	0.971	−1.349–1.400
Print media recall				0.902	0.279	−0.730–2.535				1.341	0.008	0.357–2.325
Door-to-door visit				−1.155	0.816	−1.462–1.152				0.103	0.837	−0.876–1.081
TV recall				−1.160	0.198	−2.924–0.604				0.190	0.709	−0.807–1.187
Social media recall				0.372	0.703	−1.538–2.282				1.118	0.081	−0.137–2.373

Notes: refer to notes Table 4.

Table 7
Binary logistic mixed-effects regression estimating associations between campaign recall and risk perception and worries about food safety.

	Risk perception perceived safety tomatoes consumed at home (unsafe to safe)						Frequency worrying about safety of tomatoes consumed at home (always to never)					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	1.032	0.926	0.528–2.019	1.043	0.895	0.561–1.939	0.291	0.004	0.126–0.668	0.323	0.004	0.150–0.694
Campaign recall	1.106	0.621	0.741–1.650				1.132	0.616	0.697–1.840			
Radio recall				0.826	0.348	0.554–1.232				1.053	0.815	0.682–1.625
Print media recall				1.112	0.547	0.787–1.571				1.189	0.426	0.776–1.822
Door-to-door visit				1.056	0.766	0.736–1.516				1.037	0.863	0.689–1.561
TV recall				1.195	0.382	0.801–1.783				0.688	0.104	0.439–1.079
Social media recall				0.955	0.847	0.595–1.531				0.810	0.466	0.459–1.428

Notes: refer to notes Table 3.

Table 8
Mixed-effects ordered logistic regression estimating associations between campaign recall and perceived health benefits.

	Perceived health benefits of only buying intact tomatoes at the market (high. Vs. low)						Perceived health benefits of only using intact or slightly bruised tomatoes for cooking					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	2.933	0.165	0.643–0.643	3.871	0.060	0.947–15.812	1.457	0.190	0.830–2.559	1.204	0.479	0.720–2.012
Campaign recall	2.070	0.444	0.322–0.322				0.985	0.943	0.646–1.501			
Radio recall				1.132	0.863	0.277–4.621				1.546	0.029	1.044–2.288
Print media recall				1.342	0.725	0.260–6.927				1.437	0.063	0.981–2.106
Door-to-door visit				1.755	0.406	0.466–6.618				0.944	0.777	0.632–1.410
TV recall				0.584	0.489	0.127–2.681				0.557	0.008	0.361–0.857
Social media recall				3.004	0.354	0.294–30.733				1.043	0.890	0.576–1.888

Notes: refer to notes Table 3.

3.7. Norms

Odds of compliance with perceived social norms to cook with intact tomatoes increased by 1.619 among consumers who recalled the campaign (p = 0.011, Table 9). Robustness tests comparing radio recall to no recall, revealed increased odds of compliance to these norms (aOR 1.458, p = 0.057).

Table 9
Mixed-effects ordered logistic regression estimating associations between campaign recall and social perceived descriptive norms.

	Most people who are important to me only buy intact tomatoes						Most people who are important to me only cook with intact tomatoes					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	1.005	0.988	0.523–1.931	1.058	0.853	0.583–1.918	0.928	0.806	0.806–1.682	0.958	0.878	0.557–1.649
Campaign recall	1.405	0.091	0.948–2.082				1.619	0.011	0.011–2.351			
Radio recall				1.449	0.075	0.963–2.180				1.459	0.057	0.989–2.153
Print media recall				1.011	0.951	0.722–1.415				1.361	0.114	0.929–1.996
Door-to-door visit				1.131	0.512	0.784–1.631				1.008	0.963	0.723–1.405
TV recall				1.123	0.474	0.817–1.544				0.996	0.984	0.701–1.416
Social media recall				0.967	0.890	0.598–1.561				0.983	0.951	0.574–1.683

Notes: refer to notes Table 3.

Table 10
Mixed-effects ordered logistic regression estimating associations between campaign recall and self-efficacy.

	Solely buying intact tomatoes at the market is easy						Solely cooking with intact or slightly bruised tomatoes is easy					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	2.363	0.005	1.303–4.285	1.936	0.030	1.065–3.517	0.967	0.891	1.600–1.559	0.983	0.944	0.613–1.577
Campaign recall	0.647	0.089	0.391–1.069				1.578	0.020	2.020–2.321			
Radio recall				0.968	0.870	0.657–1.427				2.464	0.000	1.698–3.576
Print media recall				0.812	0.411	0.494–1.335				1.120	0.533	0.784–1.600
Door-to-door visit				1.112	0.694	0.655–1.889				1.047	0.805	0.727–1.507
TV recall				0.855	0.440	0.575–1.272				0.829	0.370	0.550–1.250
Social media recall				1.301 (0.428)	0.424	0.683–2.480				0.942 (0.358)	0.875	0.447–1.986

Notes: refer to notes Table 3.

Table 11

Binary logistic mixed-effects regression estimating associations between campaign recall and decision-making autonomy.

	Decision-making autonomy regarding routine food purchasing (high vs. low)						Decision-making autonomy regarding routine food preparation (high vs. low)					
	Prompted recall			Individual channels			Prompted recall			Individual channels		
	aOR	p	95% CI	aOR	p	CI 95%	aOR	p	95% CI	aOR	p	CI 95%
Endline	1.252	0.433	0.714–2.198	1.540	0.148	0.858–2.763	1.131	0.663	0.652–1.961	1.386	0.216	0.826–2.325
Campaign recall	1.404	0.268	0.770–2.560				1.501	0.165	0.846–2.665			
Radio recall				1.063	0.864	0.528–2.141				1.186	0.652	0.565–2.490
Print media recall				0.891	0.676	0.519–1.531				0.968	0.915	0.532–1.761
Door-to-door visit				1.232	0.489	0.682–2.227				1.124	0.725	0.586–2.155
TV recall				1.834	0.084	0.921–3.654				1.591	0.216	0.762–3.321
Social media recall				0.493	0.105	0.210–1.158				0.491	0.065	0.231–1.044

Notes: refer to notes Table 3.

$p = 0.020$). Radio recall associated with 2.5 increased odds of finding cooking with intact tomatoes easy ($p < 0.001$). Sensitivity analyses with the target population revealed prompted recall to be associated with 2.216 higher odds ($p = 0.002$) of higher confidence in cooking with intact tomatoes. Decision-making autonomy regarding tomato buying and preparation, despite an observed increase, was unrelated with campaign recall (Table 11).

4. Discussion

Improving food safety in urban informal markets across Sub-Saharan Africa requires empowering consumers to make safer choices (Jaffee & Grace, 2023). Guided by the Integrated Behavioral Model, this study evaluated the impact of the nine-month “Abo!” multimedia consumer food safety campaign on self-reported behavior and behavioral determinants concerning buying tomatoes in informal markets and handling at households, in Dire Dawa and Harar, Ethiopia. The campaign achieved high coverage (78.3%) and prompted recall was associated with a two-fold increase in odds of better access to food safety information. Traditional channels including TV, radio, and print media were most frequently recalled, and over a quarter of the panel recalled a door-to-door health extension worker visit.

Households visit recall was most evidently associated with safer buying and tomato preparation behavior and increased odds of intentions to buy safer tomatoes. Traditional media (print, TV, radio ads) was associated with improved behavior, food safety attitudes including perceived health benefits, social norms, self-efficacy, and knowledge, while social media recall showed no association with any of the outcomes. While several mass media behavior change campaigns in high-resource contexts and Sub-Saharan Africa have shown positive impacts on a range of health behaviors including health promotion (Noar, 2006), HIV/AIDS prevention (Bertrand et al., 2006), and nutrition (Watson et al., 2023), our findings particularly align with nutrition and food safety impact studies underscoring the potential of combining interpersonal counseling with mass media (Kim et al., 2019). In-person methods, going beyond informing to boost capabilities, can be highly effective. Trusted messengers like health extension workers can moreover create spill-over effects by informing family, neighbors, and the community (Bass et al., 2022).

Social media’s limited impact in this study could be due to low message recall (13.9%). A review investigating the currently limited social media behavior change interventions using tailor-made or commercial social media platforms in low- and middle-income countries report that there is a lack of robust evidence of effectiveness (Seiler et al., 2022). Our findings contradict results from a mass-media food safety campaign in Burkina Faso, where the social media component was well-recalled and strongest associated with food safety outcomes (Madjidian et al., under review). Differences could be due to the campaign targeting different audiences. Despite social media’s potential, limited phone ownership especially among Ethiopian women (Warner, Mekonnen, & Habte, 2023), as well as restriction of social media and internet access at times, might have diminished impact.

The Integrated Behavioral Model posits that positive attitudes, norms, and agency towards food safety behavior drive consumer food safety intentions, and ultimately behavior (Montano & Kasprzyk, 2015; Yzer, 2012). Poor food safety knowledge, although not the strongest predictor of behavior (Abbot et al., 2009; Mullan et al., 2013; Wilcock et al., 2004) has been associated with increased foodborne disease risks (Redmond & Griffith, 2003). Knowledge can contribute to behavior change when consumers are able to make informed decisions (Losasso et al., 2012). Campaigns have been effective in elevating knowledge when context-tailored to the challenge at hand (Hoffmann et al., 2019; Young et al., 2015). We found an already impressive level of food safety knowledge scores at baseline, with up to 90% of our consumer panel providing correct answers to questions. Knowledge increases were modestly associated with print media recall and time. Where the effect of print media on knowledge shows that materials (mostly non-textual) aided in bringing across the message, already high baseline scores or underreporting of campaign recall (supported by the discrepancy between unprompted and prompted recall) (Charlesworth et al., 2023), may have masked knowledge increases attributable to the campaign.

A lack of concern about the consequences of consuming unsafe food and other competing priorities or concerns prevailing in society (e.g., conflict, drought, food insecurity) may take precedence over knowledge and implementing practices (Bass et al., 2022). Heightened risk perceptions or “fear appeals” may prompt behavior change, especially in populations at risk (Witte & Allen, 2000). The “Abo!” campaign deliberately invested in generating positive emotions around food safety behavior instead of communicating risks. Interestingly, tomato safety concerns were significantly lower at endline compared to baseline. However, this reduction was not associated with recall, which contrasts evidence from amongst others a study in Vietnam stressing that food safety messages could also amplify worry through information acquisition (Ha et al., 2019).

Under the hypothesis that individuals are better at following food safety ‘rules’ when they believe that others are also following them, social norms (i.e. beliefs about how other people in one’s environment would act) were targeted through communicating simple rules. Particularly radio ads could be effective as shown by increased compliance with social norms related to cooking with intact tomatoes only. Although interpretations on the relative importance of norms on intentions or behaviors are inconclusive, their potential effects should not be underestimated as they compare to effects of risk perceptions and perceived benefits (Scholderer & Veflen, 2019; Young et al., 2017). Without believing that engaging in safe behavior benefits their health, people are less likely to change behavior (Champion & Skinner, 2008). Consequently, the positive association between radio recall and perceived advantages of exclusively using intact tomatoes for cooking is encouraging.

Food purchasing, handling, and preparation practices are shaped by daily habits, routines, and experiences (Bass et al., 2022; Young & Waddell, 2016), as well as wider socio-cultural, economic, and contextual factors. The “Abo!” campaign showed potential to improve behavior, including at the household level, which matches evidence

from low- and high-resource contexts where educational interventions successfully changed household food safety behavior (Bass et al., 2022; Young et al., 2015). In this context, consumers might be better able to control critical steps to guarantee food safety, which is in line with the increased odds of consumer perceived capabilities to safely handle and prepare tomatoes at households.

Campaign recall was associated with higher intentions to buy safer tomatoes. Intentions do not directly translate into action, and the weaker association between particularly door-to-door household visit recall and actual buying behavior, may be explained by contextual constraints beyond the control of the consumer, such as limited availability or affordability of intact tomatoes in the region (Amenu et al., 2023). Additionally, a lack of safe water, unhygienic environments combined with high temperatures and seasonal effects, and inadequate market sanitation and infrastructure likely challenge both vendor and consumer food safety behavior (Gazu et al., 2021). Vendors' inability to supply undamaged tomatoes combined with low consumer purchasing power, may be particularly restrictive. Evidence from China, Vietnam, Nigeria and Malawi show that higher purchasing power leads to higher willingness to pay for safer food, and increased purchasing of safer, better quality food (Alimi & Workneh, 2016; De Filippo et al., 2021; Lagerkvist et al., 2013; Liu & Niyongira, 2017; Nindi et al., 2023; Wertheim-Heck et al., 2019). Our models (not shown) implied that price shocks and seasonality, strongly affecting vegetable and fruit prices (Bachewe & Minten, 2023) could have lowered consumers' motivation or capability to buy better quality tomatoes. Most consumers perceived that a doubling in tomato prices during the campaign period related to the COVID-19 pandemic and cost of living crises had increased food insecurity, which may reinforce risky behaviors through reduced availability and affordability of safe food (Laborde et al., 2020). Such contextual or socio-economic barriers may also explain the decreased odds of the target audience's confidence in their capability to exclusively buy intact tomatoes. Hence, besides good knowledge, intentions and attitudes, an enabling environment alongside motivation and capacity to change behavior at both supply and demand side, taking into account consumers' needs and purchasing power, are vital for improving food safety in informal food markets (Grace et al., 2019).

4.1. Methodological considerations

This study fills an important research gap in understanding impacts of food safety behavior change interventions on behavior and behavioral determinants in Sub-Saharan Africa (Hoffmann et al., 2019; Karanja et al., 2022; Ortega & Tschirley, 2017) by offering evidence on a mass media campaign's impact on food safety consumer behavior and determinants in Eastern Ethiopia. The study design was robust with a representative panel and high follow-up rate (78%). Since the study was implemented at population level in two cities with potential spillover to others, the absence of a contemporary control was infeasible, which limits our ability to claim causality. We mitigated social-desirability bias for self-reported behavior through diverse question formats (Redmond & Griffith, 2003). Yet, consumers might have overestimated their likelihood of engaging in the desired behaviors (Ajzen et al., 2004). Several food safety studies have shown discrepancies between cognitive measurements including self-reported behavior, and observed or actual practices (da Cunha et al., 2019; Dharod et al., 2007). Overestimating of practices could be attributed to judgmental heuristics, social-desirability bias, memory issues, or reporting bias (Zhang et al., 2022). Hence, future research could add observations of purchasing and food preparation practices for a more accurate assessment. We systematically captured various behaviors and behavioral determinants linked to the Integrated Behavioral Model concepts, which often lack assessment (Milton & Mullan, 2010), but to avoid respondent fatigue, we used single-item questions for determinants. While determinants' interrelations with behavior were outside this study's scope, future research including a qualitative component could delve into these interrelations for deeper

insights. Finally, understanding the relative influence of socio-economic factors on behavior remains important for future studies despite our study's adjustments for many of those factors.

5. Conclusions

Consumers are key to determining the safety of vegetables they and their families eat, through purchasing decisions and preparation practices. Harnessing their demand for safer food can potentially drive food safety in urban informal markets. Findings from this study show that a consumer campaign, combining health extension worker household visits with print media, TV, and radio adverts, can empower consumers to buy safer tomatoes, and improve safe food practices. Alongside consumer demand and capability, achieving sufficient food safety in informal markets requires a conducive environment. This includes infrastructural and market changes for hygienic food chains and incentives for supply chain actors to offer affordable and safe food.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data underlying this manuscript are available from <https://hdl.handle.net/20.500.11766.1/FK2/TEXTYQ5>.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodcont.2024.110509>.

References

- Abbot, J. M., Byrd-Bredbenner, C., Schaffner, D., Bruhn, C., & Blalock, L. (2009). Comparison of food safety cognitions and self-reported food-handling behaviors with observed food safety behaviors of young adults. *European Journal of Clinical Nutrition*, 63(4), 572–579.
- Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology*, 19(6), 586.
- Ajzen, I., Brown, T. C., & Carvajal, F. (2004). Explaining the discrepancy between intentions and actions: The case of hypothetical bias in contingent valuation. *Personality and Social Psychology Bulletin*, 30(9), 1108–1121.
- Alimi, B. A., & Workneh, T. S. (2016). Consumer awareness and willingness to pay for safety of street foods in developing countries: A review. *International Journal of Consumer Studies*, 40(2), 242–248.
- Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G., & Vaz, A. (2013). The women's empowerment in agriculture index. *World Development*, 52, 71–91.
- Amenu, K., Bedasa, M., Wamile, M., Worku, H., Kasim, K., Taha, M., ... Grace, D. (2021). *Qualitative assessment of chicken and vegetable value chains in Harar and Dire Dawa, Ethiopia: Food safety perspectives*. ILRI Research Report82. Nairobi, Kenya.
- Amenu, K., Megersa, B., Jaleta, M. B., Dinede, G., Worku, H., Kasim, K., Taha, M., Ibrahim, A. M., Kedir, J., & Mego, L. (2023). Potential food safety risks in tomato value chains in urban settings of Eastern Ethiopia: A qualitative investigation. *Frontiers in Sustainable Food Systems*, 7, 1–11.
- Asiegbu, C. V., Lebelo, S. L., & Tabit, F. T. (2016). The food safety knowledge and microbial hazards awareness of consumers of ready-to-eat street-vended food. *Food Control*, 60, 422–429.
- Aworh, O. C. (2021). Food safety issues in fresh produce supply chain with particular reference to sub-Saharan Africa. *Food Control*, 123, Article 107737.
- Bachewe, F. N., & Minten, B. (2023). Towards understanding vegetable and fruit markets for improved consumption and nutrition: The case of Ethiopia. *Food Security*, 1–17.
- Ballard, T., Coates, J., Swindale, A., & Deitchler, M. (2011). Household hunger scale: Indicator definition and measurement guide. *Food and nutrition technical assistance II project, FHI*, 360, 23. Washington, DC.
- Bardosh, K. L., Hussein, J. W., Sadik, E. A., Hassen, J. Y., Ketema, M., Ibrahim, A. M., McKune, S. L., & Havelaar, A. H. (2020). Chicken eggs, childhood stunting and environmental hygiene: An ethnographic study from the Campylobacter genomics and environmental enteric dysfunction (CAGED) project in Ethiopia. *One Health Outlook*, 2(1), 5. <https://doi.org/10.1186/s42522-020-00012-9>
- Bass, S. B., Brajuha, J., Kelly, P. J., D'Avanzo, P., Lambertini, E., Nordhagen, S., & Monterrosa, E. C. (2022). Changing behavior, attitudes, and beliefs about food safety: A scoping review of interventions across the World and implications for empowering consumers. *Foodborne Pathogens and Disease*, 19(1), 19–30.
- Bertrand, J. T., O'Reilly, K., Denison, J., Anhang, R., & Sweat, M. (2006). Systematic review of the effectiveness of mass communication programs to change HIV/AIDS-related behaviors in developing countries. *Health Education Research*, 21(4), 567–597.
- Birke, W., & Zawide, F. (2019). Transforming research results in food safety to community actions: A call for action to advance food safety in Ethiopia. *Environmental Ecological Research*, 7(3), 153–170.
- Brascoe, F., Asgedom, D., & Casari, G. (2019). *Strategic analysis and intervention plan for fresh and industrial tomato in the Agro-commodities procurement zone of the pilot integrated agro-industrial park in central-eastern oromia, Ethiopia*. Addis Ababa: FAO.
- Byrd-Bredbenner, C., Maurer, J., Wheatley, V., Schaffner, D., Bruhn, C., & Blalock, L. (2007). Food safety self-reported behaviors and cognitions of young adults: Results of a national study. *Journal of Food Protection*, 70(8), 1917–1926.
- Byrd-Bredbenner, C., Wheatley, V., Schaffner, D., Bruhn, C., Blalock, L., & Maurer, J. (2007a). Development and implementation of a food safety knowledge instrument. *Journal of Food Science Education*, 6(3), 46–55.
- Byrd-Bredbenner, C., Wheatley, V., Schaffner, D., Bruhn, C., Blalock, L., & Maurer, J. (2007b). Development of food safety psychosocial questionnaires for young adults. *Journal of Food Science Education*, 6(2), 30–37.
- Champion, V. L., & Skinner, C. S. (2008). The health belief model. *Health behavior and health education: Theory, research, and practice*, 4, 45–65.
- Chan, M. (2014). Food safety must accompany food and nutrition security. *The Lancet*, 9958(384), 1910–1911.
- Charlesworth, J., Liddelow, C., Mullan, B., Tan, H., Abbott, B., & Potter, A. (2023). Did you get the message? Examining prompted and unprompted recall of messages in a safe food-handling media campaign. *British Food Journal*, 125(4), 1232–1244.
- da Cunha, D. T., de Rosso, V. V., Pereira, M. B., & Stedefeldt, E. (2019). The differences between observed and self-reported food safety practices: A study with food handlers using structural equation modeling. *Food Research International*, 125, Article 108637. <https://doi.org/10.1016/j.foodres.2019.108637>
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- De Filippo, A., Meldrum, G., Samuel, F., Tuyet, M. T., Kennedy, G., Adeyemi, O. A., Ngothiha, P., Wertheim-Heck, S., Talsma, E. F., & Shittu, O. O. (2021). Barrier analysis for adequate daily fruit and vegetable consumption among low-income residents of Hanoi, Vietnam and Ibadan, Nigeria. *Global Food Security*, 31, Article 100586.
- Dharod, J. M., Pérez-Escamilla, R., Paciello, S., Bermúdez-Millán, A., Venkitanarayanan, K., & Damio, G. (2007). Comparison between self-reported and observed food handling behaviors among Latinas. *Journal of Food Protection*, 70(8), 1927–1932.
- Dione, M. M., Diarra, S., Ilboudo, G. S., Konkobo-Yameogo, C., Lallogo, V. R., Roesel, K., ... Knight-Jones, T. J. (2021). *Value chain assessment of animal-source foods and vegetables in Ouagadougou, Burkina Faso—Considering food safety, quality and hygiene perceptions and practices*. ILRI Research Report87. Kenya, Nairobi.
- Emana, B., Afari-Sefa, V., Nenguwo, N., Ayana, A., Kebede, D., & Mohammed, H. (2017). Characterization of pre-and postharvest losses of tomato supply chain in Ethiopia. *Agriculture & Food Security*, 6(1), 1–11.
- Fischer, A. R. H., Frewer, L. J., & Nauta, M. J. (2006). Toward improving food safety in the domestic environment: A multi-item rasch scale for the measurement of the safety efficacy of domestic food-handling practices. *Risk Analysis*, 26(5), 1323–1338. <https://doi.org/10.1111/j.1539-6924.2006.00813.x>
- Gazu, L., Alonso, S., Mutua, F., Roesel, K., Lindahl, J. F., Amenu, K., Maximiano Sousa, F., Ulrich, P., Guadu, T., & Dione, M. (2023). Foodborne disease hazards and burden in Ethiopia: A systematic literature review, 1990–2019. *Frontiers in Sustainable Food Systems*, 7, Article 1058977.
- Gazu, L., Amenu, K., Dinede, G., & Knight-Jones, T. J. (2021). *Food safety consumer campaign expert consultation at Addis Ababa and Dire Dawa, Ethiopia. Workshop report*.
- Gemeda, B., Amenu, K., Girma, S., Grace, D., Srinivasan, R., Roothaert, R., & Knight-Jones, T. (2023). Knowledge, attitude and practice of tomato retailers towards hygiene and food safety in Harar and Dire Dawa, Ethiopia. *Food Control*, 145, Article 109441.
- Gemeda, B. A., Amenu, K., Mego, L., Dione, M. M., Ilboudo, G., Lallogo, V. R., ... Knight-Jones, T. J. (2021). *Overview of quantitative knowledge, attitude and practice of tomato traders on tomato hygiene and safety in Ethiopia and Burkina Faso*. Presentation at a webinar for the 'Urban food markets in Africa' project, 12 July 2021 PUB LOC: Nairobi, Kenya PUB: ILRI.
- Global Alliance for Improved Nutrition. (2020). *Consumer-facing interventions to improve food safety perceptions and practices in low- and middle-income countries: A review. A USAID EatSafe project report*. Geneva, Switzerland: GAIN. Available via: <https://hdl.handle.net/10568/114540>.
- Grace, D. (2015). Food safety in low and middle income countries. *International Journal of Environmental Research and Public Health*, 12(9), 10490–10507. <https://www.mdpi.com/1660-4601/12/9/10490>.
- Grace, D., Alonso, S., Mutua, F., Roesel, K., Lindahl, J. F., & Amenu, K. (2018). *Food safety investment expert advice: Burkina Faso, Ethiopia, Nigeria*. Nairobi, Kenya: ILRI. <https://hdl.handle.net/10568/91963>.
- Grace, D., Dipeolu, M., & Alonso, S. (2019). Improving food safety in the informal sector: Nine years later. *Infection Ecology & Epidemiology*, 9(1), Article 1579613. <https://doi.org/10.1080/200808686.2019.1579613>
- Ha, T. M., Shakur, S., & Pham Do, K. H. (2019). Consumer concern about food safety in Hanoi, Vietnam. *Food Control*, 98, 238–244. <https://doi.org/10.1016/j.foodcont.2018.11.031>
- Havelaar, A. H., Kirk, M. D., Torgerson, P. R., Gibb, H. J., Hald, T., Lake, R. J., Praet, N., Bellinger, D. C., De Silva, N. R., & Gargouri, N. (2015). World Health Organization global estimates and regional comparisons of the burden of foodborne disease in 2010. *PLoS Medicine*, 12(12), Article e1001923.
- Havelaar, A. H., Sapp, A. C., Amaya, M. P., Nane, G. F., Morgan, K. M., Devleeschauwer, B., Grace, D., Knight-Jones, T., & Kowalczyk, B. B. (2022). Burden of foodborne disease due to bacterial hazards associated with beef, dairy, poultry meat, and vegetables in Ethiopia and Burkina Faso, 2017. *Frontiers in Sustainable Food Systems*, 6, Article 1024560.
- Henson, S., Jaffee, S., & Wang, S. (2023). *New directions for tackling food safety risks in the informal sector of developing countries*. Nairobi, Kenya: ILRI. <https://hdl.handle.net/10568/130652>.
- Hoffmann, V., Moser, C., & Saak, A. (2019). Food safety in low and middle-income countries: The evidence through an economic lens. *World Development*, 123, Article 104611.
- Jaffee, S., Henson, S., Unnevehr, L., Grace, D., & Cassou, E. (2019). *The safe food imperative: Accelerating progress in low-and middle-income countries*. Washington DC, United States: Agriculture and Food Series. World Bank.
- Jaffee, S., & Grace, D. (7 June 2023). *Less sticks, more carrots: New directions for improving food safety in informal markets in low-and middle-income countries*. Presentation at World Food Safety Day webinar <https://hdl.handle.net/10568/130869>. Nairobi Kenya: ILRI.
- Karanja, A., Ickowitz, A., Stadlmayr, B., & McMullin, S. (2022). Understanding drivers of food choice in low- and middle-income countries: A systematic mapping study. *Global Food Security*, 32, Article 100615. <https://doi.org/10.1016/j.gfs.2022.100615>
- Kendall, P. A., Elsbernd, A., Sinclair, K., Schroeder, M., Chen, G., Bergmann, V., Hillers, V. N., & Medeiros, L. C. (2004). Observation versus self-report: Validation of a consumer food behavior questionnaire. *Journal of Food Protection*, 67(11), 2578–2586.
- Kim, S. S., Nguyen, P. H., Yohannes, Y., Abebe, Y., Tharany, M., Drummond, E., Frongillo, E. A., Ruel, M. T., & Menon, P. (2019). Behavior change interventions delivered through interpersonal communication, agricultural activities, community mobilization, and mass media increase complementary feeding practices and reduce child stunting in Ethiopia. *The Journal of Nutrition*, 149(8), 1470–1481. <https://doi.org/10.1093/jn/nxz087>

- King, T., Cole, M., Farber, J. M., Eisenbrand, G., Zabaraz, D., Fox, E. M., & Hill, J. P. (2017). Food safety for food security: Relationship between global megatrends and developments in food safety. *Trends in Food Science & Technology*, *68*, 160–175.
- Laborde, D., Martin, W., Swinnen, J., & Vos, R. (2020). COVID-19 risks to global food security. *Science*, *369*(6503), 500–502.
- Lagerkvist, C. J., Hess, S., Okello, J., & Karanja, N. (2013). Consumer willingness to pay for safer vegetables in urban markets of a developing country: The case of Kale in Nairobi, Kenya. *Journal of Development Studies*, *49*(3), 365–382.
- Liguori, J., Trübsswasser, U., Pradeilles, R., Le Port, A., Landais, E., Talsma, E. F., Lundy, M., Béné, C., Bricas, N., & Laar, A. (2022). How do food safety concerns affect consumer behaviors and diets in low-and middle-income countries? A systematic review. *Global Food Security*, *32*, Article 100606.
- Liu, A., & Niyongira, R. (2017). Chinese consumers food purchasing behaviors and awareness of food safety. *Food Control*, *79*, 185–191.
- Losasso, C., Gibin, V., Cappa, V., Roccatò, A., Vanzo, A., Andrighetto, I., & Ricci, A. (2012). Food safety and nutrition: Improving consumer behaviour. *Food Control*, *26*(2), 252–258.
- Madjidian, D., van Asseldonk, M., Talsma, E., Dione, M., Ilboudo, G., Roesel, K., Grace, D., Knight-Jones, T.J.D., de Vet, E. (under review) Empowering consumers to purchase safe ready-to-eat chicken from street restaurants in Ouagadougou, Burkina Faso: Impact of a multi-media behavior change campaign.
- Milton, A., & Mullan, B. (2010). Consumer food safety education for the domestic environment: A systematic review. *British Food Journal*, *112*(9), 1003–1022.
- Montano, D. E., & Kasprzyk, D. (2015). Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. *Health behavior: Theory, research and practice*, *70*(4), 231.
- Mullan, B. A., Wong, C., & Kothe, E. J. (2013). Predicting adolescents' safe food handling using an extended theory of planned behavior. *Food Control*, *31*(2), 454–460. <https://doi.org/10.1016/j.foodcont.2012.10.027>
- Nindi, T. C., Bauchet, J., & Ricker-Gilbert, J. (2023). Information and the trade-off between food safety and food security in rural markets: Experimental evidence from Malawi. *Journal of Economic Behavior & Organization*, *216*, 170–186.
- Noar, S. M. (2006). A 10-year retrospective of research in health mass media campaigns: Where do we go from here? *Journal of Health Communication*, *11*(1), 21–42.
- Nordhagen, S., Lambertini, E., DeWaal, C. S., McClafferty, B., & Neufeld, L. M. (2022). Integrating nutrition and food safety in food systems policy and programming. *Global Food Security*, *32*, Article 100593.
- Odeyemi, O. A., Sani, N. A., Obadina, A. O., Saba, C. K. S., Bamidele, F. A., Abughoush, M., Asghar, A., Dongmo, F. F. D., Macer, D., & Aberoumand, A. (2019). Food safety knowledge, attitudes and practices among consumers in developing countries: An international survey. *Food Research International*, *116*, 1386–1390. <https://doi.org/10.1016/j.foodres.2018.10.030>
- Ortega, D. L., & Tschirley, D. L. (2017). Demand for food safety in emerging and developing countries: A research agenda for Asia and sub-saharan Africa. *Journal of Agribusiness in Developing and Emerging Economies*, *7*(1), 21–34. <https://doi.org/10.1108/JADEE-12-2014-0045>
- Patil, S. R., Morales, R., Cates, S., Anderson, D., & Kendall, D. (2004). An application of meta-analysis in food safety consumer research to evaluate consumer behaviors and practices. *Journal of Food Protection*, *67*(11), 2587–2595.
- Pires, S. M., Desta, B. N., Mughini-Gras, L., Mmbaga, B. T., Fayemi, O. E., Salvador, E. M., Gobena, T., Majowicz, S. E., Hald, T., Hoejskov, P. S., Minato, Y., & Devleeschauwer, B. (2021). Burden of foodborne diseases: Think global, act local. *Current Opinion in Food Science*, *39*, 152–159. <https://doi.org/10.1016/j.cofs.2021.01.006>
- Raaijmakers, I., Snoek, H., Maziya-Dixon, B., & Achterbosch, T. (2018). Drivers of vegetable consumption in urban Nigeria: Food choice motives, knowledge, and self-efficacy. *Sustainability*, *10*(12), 4771. Special issue: Towards Sustainable Global Food Systems <https://doi.org/10.3390/su1012477>.
- Rabe-Hesketh, S., & Skrondal, A. (2008). *Multilevel and longitudinal modeling using Stata*. STATA press.
- Redmond, E. C., & Griffith, C. J. (2003). Consumer food handling in the home: A review of food safety studies. *Journal of Food Protection*, *66*(1), 130–161.
- Rice, B., Hernández, M., Glauber, J., & Vos, R. (2022). *The Russia-Ukraine war is exacerbating international food price volatility*. <https://www.ifpri.org/blog/russia-ukraine-war-exacerbating-international-food-price-volatility>.
- Roesel, K., & Grace, D. (2014). *Food safety and informal markets: Animal products in sub-Saharan Africa*. London, UK: Routledge. <https://doi.org/10.4324/9781315745046>
- Scholderer, J., & Veflen, N. (2019). Social norms and risk communication. *Trends in Food Science & Technology*, *84*, 62–63. <https://doi.org/10.1016/j.tifs.2018.08.002>
- Seiler, J., Libby, T. E., Jackson, E., Lingappa, J. R., & Evans, W. D. (2022). Social media-based interventions for health behavior change in low- and middle-income countries: Systematic review. *Journal of Medical Internet Research*, *24*(4), Article e31889. <https://doi.org/10.2196/31889>
- Snyder, L. B., Hamilton, M. A., & Huedo-Medina, T. (2009). Does evaluation design impact communication campaign effect size? A meta-analysis. *Communication Methods and Measures*, *3*(1–2), 84–104.
- StataCorp, L. (2019). *Stata statistical software: Release 16 college station*. TX StataCorp LP.
- Unnevehr, L. (2015). Food safety in developing countries: Moving beyond exports. *Global Food Security*, *4*, 24–29.
- Warner, J., Mekonnen, Y., & Habte, Y. (2023). *The digital divide in rural Ethiopia: Determinants and implications of sex-disaggregated mobile phone ownership and use* (p. 012196). Intl Food Policy Res Inst. Discussion Paper.
- Watson, D., Mushamiri, P., Beeri, P., Rouamba, T., Jenner, S., Proebstl, S., Kehoe, S. H., Ward, K. A., Barker, M., & Lawrence, W. (2023). Behaviour change interventions improve maternal and child nutrition in sub-saharan Africa: A systematic review. *PLOS Global Public Health*, *3*(3), Article e0000401.
- Wertheim, H., & Spaargaren. (2016). Shifting configurations of shopping practices and food safety dynamics in hanoi, Vietnam: A historical analysis. *Agriculture and Human Values*, *33*(3), 655–671.
- Wertheim-Heck, S., Raneri, J. E., & Oosterveer, P. (2019). Food safety and nutrition for low-income urbanites: Exploring a social justice dilemma in consumption policy. *Environment and Urbanization*, *31*(2), 397–420.
- Wilcock, A., Pun, M., Khanona, J., & Aung, M. (2004). Consumer attitudes, knowledge and behaviour: A review of food safety issues. *Trends in Food Science and Technology*, *15*(2), 56–66.
- Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behavior*, *27*(5), 591–615.
- World Health Organization. (2015). *WHO estimates of the global burden of foodborne diseases: Foodborne disease burden epidemiology reference group 2007-2015*. World Health Organization.
- World Health Organization. (2016). *Five Keys to Safer Food Manual*. Geneva, Switzerland: Department of Food Safety, Zoonoses and Foodborne Diseases. WHO. <https://www.who.int/publications/i/item/9789241594639>.
- Young, I., Reimer, D., Greig, J., Turgeon, P., Meldrum, R., & Waddell, L. (2017). Psychosocial and health-status determinants of safe food handling among consumers: A systematic review and meta-analysis. *Food Control*, *78*, 401–411.
- Young, I., & Waddell, L. (2016). Barriers and facilitators to safe food handling among consumers: A systematic review and thematic synthesis of qualitative research studies. *PLoS One*, *11*(12), Article e0167695. <https://doi.org/10.1371/journal.pone.0167695>
- Young, I., Waddell, L., Harding, S., Greig, J., Mascarenhas, M., Sivaramalingam, B., Pham, M. T., & Papadopoulos, A. (2015). A systematic review and meta-analysis of the effectiveness of food safety education interventions for consumers in developed countries. *BMC Public Health*, *15*(1), 1–14.
- Yzer, M. C. (2012). The integrated model of behavioral prediction as a tool for designing health messages. Chapter 2. *Health Communication Message Design, Theory and Practice*, 21–40.
- Zhang, M., Zhu, Q., & Bai, J. (2022). The disparity between self-reported and observed food safety behavior: A case involving consumers from rural China. *Food Control*, *138*, Article 108981. <https://doi.org/10.1016/j.foodcont.2022.108981>