

Appendix A. Screenshots and Functional Description of the Gamified Self-Monitoring App

Figure A1. Login Screen

Participants log in using the ID assigned at enrollment and their password. This procedure ensures that each household's behavioral records and food waste measurements are linked to a unique individual account.



A1

Figure A5. Final (Fifth) Action Check: Daily Food Waste

"Did any food waste occur during this day?"
Participants respond using a three-point scale:
- "Quite a bit"
- "A little"
- "None"
This item captures self-reported daily food waste occurrence. Participants finalize entry by pressing the "Complete Check" button.



A5

Figure A2. Home Screen and Leaderboard

After login, participants are directed to the home screen. The screen displays:
- The participant's current total points (e.g., 23 points)
- A leaderboard showing rankings (individual or group mode)
- The participant's current badge level (upper right corner)



A2

Figure A6. Completion Screen and Food Quiz

After pressing the "Complete Check":
- A brief praise message acknowledges completion.
- A short "Food Quiz" (approximately 10 seconds) appears as an optional engagement feature. Participants may skip the quiz and proceed directly to view their score. This step provides immediate feedback and incorporates light gamification elements to sustain engagement.



A6

Figure A3. Selection of Action Check Date

Participants can select whether to record behaviors for:
- TODAY (current day)
- YESTERDAY (if the previous day's check was missed)
This feature reduces user burden by allowing retrospective entry for one day.



A3

Figure A7. Point Screen for Daily Score

Participants are shown:
- Their score for that day (e.g., 75 points)
- Encouraging messages (e.g., "Good job! Keep it up!")
If the previous day's behavior check remains incomplete, participants are prompted to complete it.



A7

Figure A4. First Action Check: Search

"Did you check for foods to be eaten soon?"
Participants respond using a three-point scale:
- "Not great"
- "So-so"
- "Perfect".
If the behavior was not applicable that day, a "Not applicable" option can be selected.

The same response format was used for the subsequent behavior checks, including moving foods that should be used soon, using foods that should be used soon, and finishing meals.



A4

Figure A8. Badge Screen

The badge screen displays:
- The participant's accumulated total points
- Current badge rank (e.g., Bronze level)
- A record of previous scores
Participants can navigate bidirectionally between the home screen and badge screen.



A8

Note.

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Appendix B. Questionnaire Items and Response Scales

Six Selected Behaviors (Past 2 Weeks)

Construct	Item	Response Options
Searching for food that should be used sooner	During the past two weeks, how often did you search inside your refrigerator to see whether there were foods that needed to be consumed soon?	1 = Not at all in the past two weeks; 2 = About once in the past two weeks; 3 = 1–2 times per week; 4 = 3–4 times per week; 5 = 5 or more times per week
Moving food that should be used sooner †	During the past two weeks, when you found food that needed to be consumed soon, did you move it to a visible place so you would not forget it?	1 = Always; 2 = Often; 3 = Sometimes; 4 = Rarely; 5 = Never; 6 = No such food was found
Knowledge of the refrigerator inventory	During the past two weeks, to what extent were you aware of expiration dates of foods stored in your refrigerator?	1 = Not at all aware; 2 = Slightly aware; 3 = Moderately aware; 4 = Mostly aware; 5 = Almost completely aware; 6 = No food required expiration-date checking
Prioritized use of food that should be used sooner †	During the past two weeks, how often did you prioritize using foods that needed to be consumed soon?	1 = Always; 2 = Often; 3 = Sometimes; 4 = Rarely; 5 = Never
Preventing over-buying	During the past two weeks, when shopping, did you pay attention to buying appropriate quantities to avoid over-purchasing?	1 = Not at all; 2 = Slightly; 3 = Neither; 4 = Somewhat; 5 = Very much
Finishing meals	During the past two weeks, did you try to finish meals that were prepared (or purchased)?	1 = Not at all; 2 = Slightly; 3 = Neither; 4 = To some extent; 5 = Very much; 6 = Not applicable

Additional Behavioral Measures (Past 2 Weeks)

Construct	Item	Response Options
Knowledge of refrigerator inventory	During the past two weeks, to what extent were you aware of the foods stored in your refrigerator?	1 = Not at all aware; 2 = Slightly aware; 3 = Moderately aware; 4 = Mostly aware; 5 = Almost completely aware
Difficulty due to lack of inventory knowledge †	During the past two weeks, how many times did you experience difficulty while shopping because you did not know what food you had at home?	1 = Never; 2 = 1 time; 3 = 2 times; ... ; 14 = 13 times; 15 = 14 or more times; 16 = Do not remember
Over-buying frequency †	During the past two weeks, how many times did you purchase more food than necessary?	Same response scale as above
Duplicate purchasing †	During the past two weeks, how often did you purchase duplicate food items (i.e., items you already had at home)?	1 = None; 2 = 1–2 items; 3 = 3–4 items; 4 = 5–6 items; 5 = 7 or more items; 6 = Do not remember
Use of stored food	During the past two weeks, to what extent did you use up the food stored in your refrigerator?	1 = Not at all; 2 = Slightly; 3 = Neither; 4 = To some extent; 5 = Almost completely
Cooking appropriate amounts	During the past two weeks, did you prepare meals in quantities that could be fully consumed?	1 = Always; 2 = Often; 3 = Sometimes; 4 = Rarely; 5 = Never
Refrigerator organization	During the past two weeks, how often did you organize your refrigerator?	1 = Not at all; 2 = About once; 3 = About once per week; 4 = 2–3 times per week; 5 = 4–5 times per week or more; 6 = Do not remember

Note.

† Reverse-coded prior to analysis so that higher scores indicate more frequent engagement in food waste reduction behaviors. Responses of “No such food was found” and “Not applicable” were treated as missing values and were not reverse-coded. All items were assessed at Baseline and Intervention. Change scores were computed as Intervention – Baseline.

Food Waste Frequency (Past 2 Weeks)

Participants were asked:

"During the past two weeks, how often did your household discard the following types of food?"

Type of Food Waste	Response Options
Plate leftovers	1 = 5 or more times per week; 2 = 3–4 times per week; 3 = 1–2 times per week; 4 = About once in two weeks; 5 = Never discarded; 6 = Do not know
Unserved leftovers	Same response scale as above
Partially used fresh foods (e.g., half-used vegetables or meat)	Same response scale as above
Unused food items (e.g., unopened ham)	Same response scale as above

Note.

Responses of "Do not know" was treated as missing values. All items were assessed at Baseline and Intervention.

Perceived Influences on Food Waste Reduction (Post-intervention Only, Past 4 Weeks)

Participants were asked:

"Reflecting on the past four weeks, to what extent did the following factors influence your food waste reduction behaviors?"

Factor	Response Options
Waste separation and disposal practices	1 = Not at all; 2 = Slightly; 3 = To some extent; 4 = Very much; 5 = Not applicable
Distributed materials	Same response scale as above
Responding to the questionnaire	Same response scale as above

Appendix C. Responses of the Post-Study Survey on the Self-Monitoring App by the Intervention Group (N =63)

How often did you use the app?

Response Options	%
Everyday	52.4%
5-6 times a week	41.3%
3-4 times a week	4.8%
1-2 times a week	1.6%
Did not use it at all	0.0%

Looking back over the past four weeks, to what extent do you think the following factors influenced your actions to reduce food waste?

Variables	1	2	3	4
Food waste separation and disposal to the dedicated bin.	6.3%	14.3%	41.3%	38.1%
Briefing session	4.8%	23.8%	39.7%	28.6%
Leaflet	6.3%	17.5%	46.0%	27.0%
Questionnaire survey responses	6.3%	22.2%	44.4%	27.0%
Performing the target behaviors	4.8%	6.3%	36.5%	47.6%
App Usage	6.3%	14.3%	34.9%	39.7%

1. Had no effect at all, 2. Had little effect, 3. Had some effect, 4. Had a significant effect

How did you feel using the app over the past two weeks?

Variables	1	2	3	4	5
Enjoyable	4.8%	9.5%	22.2%	34.9%	28.6%
Interesting	9.5%	6.3%	25.4%	36.5%	22.2%
Easy	3.2%	3.2%	3.2%	30.2%	60.3%
Useful	7.9%	9.5%	11.1%	41.3%	30.2%
Felt sense of accomplishment.	4.8%	15.9%	12.7%	34.9%	31.7%
Concerned about rankings.	11.1%	27.0%	14.3%	34.9%	12.7%
Felt like working together with others.	1.6%	14.3%	11.1%	27.0%	46.0%
Felt it was a burden.	31.7%	28.6%	7.9%	27.0%	4.8%
Felt it was a hassle.	33.3%	28.6%	14.3%	15.9%	7.9%
Felt it was boring.	30.2%	33.3%	20.6%	11.1%	4.8%

1. Not at all applicable, 2. Not very applicable, 3. Neither applicable nor inapplicable, 4. Somewhat applicable, 5. Very applicable

How were you satisfied by the app design?

Variables	1	2	3	4	5
Overall Structure	1.6%	4.8%	15.9%	52.4%	25.4%
Contents	3.2%	4.8%	33.3%	34.9%	23.8%
Visual	3.2%	6.3%	20.6%	42.9%	27.0%
Ease of use	1.6%	7.9%	11.1%	33.3%	46.0%
Ease for understanding	1.6%	4.8%	11.1%	36.5%	46.0%

1. Dissatisfied, 2. Somewhat dissatisfied, 3. Neither satisfied nor dissatisfied, 4. Somewhat satisfied, 5. Very satisfied

How did you feel using the app?

Variables	1	2	3	4	5
I was prompted to take actions.	3.2%	17.5%	6.3%	49.2%	23.8%
The app motivated me.	1.6%	12.7%	14.3%	47.6%	23.8%
I was encouraged.	4.8%	15.9%	15.9%	44.4%	19.0%
I intended to continue.	1.6%	15.9%	12.7%	39.7%	30.2%
I did not want to lose.	25.4%	27.0%	17.5%	23.8%	6.3%
I was motivated to reduce food waste.	0.0%	7.9%	11.1%	39.7%	41.3%

1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree somewhat, 5. Strongly agree

To what extent did each element of the app influence your food waste reduction behaviors?

Variables	1	2	3	4	5	6
Ranking at the Home Screen (Leaderboard)	6.7%	15.0%	18.3%	38.3%	20.0%	1.7%
Behavior Checks	3.3%	8.3%	10.0%	51.7%	26.7%	0.0%
Daily Score on the Point Screen (Point)	6.7%	10.0%	15.0%	43.3%	23.3%	1.7%
Encouraging messages on the Point Screen.	10.0%	10.0%	16.7%	35.0%	25.0%	3.3%
List of Daily Scores on the Rank Screen (Point)	8.3%	15.0%	20.0%	31.7%	21.7%	3.3%
Weekly Rank Results (Budges)	8.3%	15.0%	16.7%	40.0%	18.3%	1.7%

1. Had no effect at all, 2. Had little effect, 3. Neither, 4. Had some effect, 5. Had a significant effect, 6. Don't remember (N/A)

Appendix D. Means and Standard Deviations of the 13 Behaviors by Group and Research Period

Behavior	Control Group		Intervention Group	
	Baseline	Intervention	Baseline	Intervention
Searching for food that should be used sooner*	2.94 (0.840)	3.19 (0.840)	3.00 (0.984)	3.89 (1.049)
Moving food that should be used sooner*	3.60 (1.078)	3.51 (1.256)	3.61 (1.287)	4.14 (0.895)
Knowledge of expiration dates of stored food*	3.33 (1.032)	3.63 (0.955)	3.24 (1.112)	4.05 (0.958)
Prioritized use of food that should be used sooner*	3.97 (0.746)	4.27 (0.601)	4.08 (0.743)	4.17 (0.610)
Preventing over-buying*	3.54 (1.029)	3.56 (1.089)	3.30 (1.200)	3.97 (0.933)
Finishing meals*	4.52 (0.669)	4.60 (0.752)	4.44 (0.799)	4.78 (0.522)
Knowledge of refrigerator inventory	3.73 (0.846)	3.92 (0.655)	3.63 (0.809)	4.14 (0.800)
Difficulty due to lack of inventory knowledge †	1.79 (1.770)	1.35 (1.461)	1.90 (2.284)	1.18 (1.605)
Over-buying frequency †	1.68 (1.821)	1.27 (1.483)	1.56 (1.767)	1.16 (1.451)
Duplicate purchasing	1.61 (0.686)	1.71 (0.682)	1.75 (0.740)	1.43 (0.560)
Use of stored food	4.25 (0.782)	4.32 (0.737)	4.17 (0.834)	4.60 (0.583)
Cooking appropriate amounts	4.27 (0.908)	4.46 (0.591)	4.24 (0.995)	4.48 (0.877)
Refrigerator organization	3.05 (1.111)	3.02 (1.143)	3.21 (1.095)	4.10 (1.011)

Note. Values are means with standard deviations in parentheses. Responses were measured on a 5-point scale unless otherwise indicated. Items marked † were measured using frequency-based responses (number of occurrences over the past two weeks). Ns ranged from 59 to 63 due to missing responses.

Items marked with an asterisk and shown in bold indicate the six behavioral indicators used in hypothesis testing (H1a–H1f).

All 13 behaviors were measured and are presented for transparency; non-highlighted items were used for exploratory analysis.

Appendix E. Correlations Among Change Scores in 13 Behaviors and Food Waste (Intervention – Baseline)

Behavior	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Change in food waste (Intervention – Baseline)	1													
2. Searching for food that should be used sooner*	-0.158	1												
3. Moving food that should be used sooner*	0.044	.195*	1											
4. Knowledge of expiration dates of stored food*	-.214*	.285**	0.079	1										
5. Prioritized use of food that should be used sooner*	0.129	0.074	0.067	0.001	1									
6. Preventing over-buying*	-.232**	.245**	0.159	.361**	0.073	1								
7. Finishing meals*	-.186*	0.097	0.036	0.173	0.076	.295**	1							
8. Knowledge of refrigerator inventory	-0.118	0.117	.181*	.213*	0.007	.179*	.260**	1						
9. Difficulty due to lack of inventory knowledge †	-0.097	-0.102	-0.154	-.292**	0.108	-.196*	-0.171	-.217*	1					
10. Over-buying frequency †	-0.057	-0.056	-0.094	-.194*	-0.003	-0.174	-0.14	-0.104	.459**	1				
11. Duplicate purchasing	-0.084	-0.082	0.008	-.191*	.186*	-0.081	-0.028	0.022	.300**	.394**	1			
12. Use of stored food	0.071	0.174	0.145	.372**	0.078	.219*	0.171	.247**	-.199*	-.212*	-0.141	1		
13. Cooking appropriate amounts	0.093	0.108	0.053	0.137	0.102	0.1	.182*	.186*	-.217*	-.209*	-0.115	.300**	1	
14. Refrigerator organization	-0.09	.387**	.292**	.297**	0.024	.244**	.189*	0.093	-0.099	-0.038	-0.085	.223*	0.028	1

Note. Values are Pearson's r (two-tailed tests). Ns ranged from 118 to 126 due to missing data. All variables represent change scores (Intervention – Baseline).

Bolded variables indicate the six behavioral indicators used in hypothesis testing (H1a–H1f).

Variables marked with † were measured using frequency-based responses.

*p < .05, **p < .01.

Appendix F. Main Effect Models for Each Behavior: Stratified Bootstrap Estimates

Outcome Variable	Predictor	B	Bootstrap SE	95% CI	p value
Searching for food that should be used sooner	Intercept	0.234	0.101	[0.027, 0.435]	.025
	Intervention group (1 = intervention)	0.672	0.156	[0.374, 0.983]	.002
	Baseline (centered)	-0.588	0.096	[-0.780, -0.397]	.001
Moving food that should be used sooner	Intercept	-0.099	0.146	[-0.400, 0.182]	.499
	Intervention (1 = intervention)	0.681	0.176	[0.345, 1.033]	.002
	Baseline (centered)	-0.630	0.087	[-0.796, -0.462]	.001
Knowledge of the refrigerator inventory	Intercept	0.326	0.095	[0.132, 0.509]	.002
	Intervention group (1 = intervention)	0.437	0.15	[0.146, 0.721]	.007
	Baseline (centered)	-0.567	0.078	[-0.715, -0.406]	.001
Prioritized use of food that should be used sooner	Intercept	0.267	0.071	[0.126, 0.407]	.001
	Intervention group (1 = intervention)	-0.135	0.103	[-0.333, 0.071]	.194
	Baseline (centered)	-0.764	0.095	[-0.950, -0.567]	.001
Finishing meals	Intercept	0.109	0.083	[-0.067, 0.254]	.21
	Intervention group (1 = intervention)	0.201	0.101	[-0.004, 0.404]	.064
	Baseline (centered)	-0.668	0.121	[-0.912, -0.444]	.001
Preventing over-buying	Intercept	0.11	0.129	[-0.137, 0.358]	.42
	Intervention group (1 = intervention)	0.463	0.174	[0.119, 0.798]	.009
	Baseline (centered)	-0.789	0.088	[-0.961, -0.612]	.001

Note.

B = unstandardized coefficient. Bootstrap standard errors and confidence intervals are based on 1,000 stratified bootstrap samples. Baseline values were mean-centered.

The reference category for the intervention variable is the control group.

Appendix G1. Correlations Between Food Waste and Behavioral Measures at Baseline (Weeks 1–2)

Behavior	r	95% CI
Searching for food that should be used sooner	-0.109	[-0.281, 0.058]
Moving food that should be used sooner	-0.048	[-0.180, 0.077]
Knowledge of expiration dates	-0.113	[-0.291, 0.057]
Prioritized use of food that should be used sooner	-0.140	[-0.289, -0.001]
Finishing meals	-0.089	[-0.290, 0.078]
Preventing over-buying	-0.243**	[-0.425, -0.053]

Appendix G2. Correlations Between Food Waste and Behavioral Measures During the Intervention Period (Weeks 3–4)

Behavior	r	95% CI
Searching for food that should be used sooner	-0.002	[-0.142, 0.161]
Moving food that should be used sooner	-0.209*	[-0.343, -0.067]
Knowledge of expiration dates	-0.102	[-0.292, 0.089]
Prioritized use of food that should be used sooner	-0.114	[-0.308, 0.069]
Finishing meals	-0.285**	[-0.497, -0.043]
Preventing over-buying	-0.073	[-0.241, 0.103]