The effect of timers and precommitments on handwashing: a randomised controlled trial in a kitchen laboratory

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Executive Summary

Foodborne illnesses are caused by eating food contaminated with bacteria, viruses, other parasites, or chemical contaminants like heavy metals. Recent estimates put the number of yearly cases of foodborne illness at 2.4 million in the UK, imposing an estimated total burden of £9 billion (Daniel et al., 2018). Many foodborne illness outbreaks originate in food service establishments, for example, eating out accounts for an estimated 37% of all foodborne norovirus cases, and takeaways account for 26% (Food Standards Agency, 2022).

A significant contributor to outbreaks is poor adherence by staff to workplace food safety hygiene practices (e.g. handwashing) (Olsen et al., 2000).

Meta-analysis of food safety training in commercial settings has found that training alone may not lead to improvements in key handwashing behaviours (McFarland et al., 2019). Conversely, there is evidence that behavioural interventions may be effective (Her & Almanza, 2019; York et al., 2009; Yu et al., 2018).

This study trialled two behavioural interventions aimed at improving handwashing behaviour in food handlers in the UK. The first intervention was a tap mounted timer (“SaniTimer”) that counts down from 30 seconds when the tap is turned on. Users can see the countdown on a small screen and use it to time how long they have been washing their hands. Previous work in a university restaurant kitchen found that installing this timer led to a 4.1 second increase in the average duration of handwashing (Her & Almanza, 2019). We accompanied the timer with a poster encouraging participants to use it and showing the Food Standards Agency’s (FSA) guidance on handwashing technique from the Safer food, better business pack (Food Standards Agency, 2019).

The second intervention asked participants to precommit to five statements about good hand hygiene. Previous research has demonstrated the effectiveness of committing to action in advance on the uptake of a wide range of behaviours, including weight loss (Coupe et al., 2019), smoking cessation (Black et al., 2020), and safe water consumption (Inauen & Mosler, 2016). The statements covered when people should wash their hands (after touching raw meat and before handling food)

and often neglected elements of proper handwashing technique (using soap, washing the backs of both hands, and washing fingertips). Before taking part, participants had to agree to each statement and sign their name.

To test the interventions, we ran a three-arm randomised controlled trial (RCT) in a laboratory kitchen. We allocated participants to three groups at random:

- the Timer group used a sink with the tap-mounted timer and poster,
- the Precommitment group agreed to five statements on good hand hygiene before attending the kitchen,
- the Control group featured no interventions.

Participants in all groups completed a short online training session on good hand hygiene before taking part.

In the kitchen, we gave participants a food preparation task (the “burger task”), which involved handling raw meat. The task included eight points at which participants following official guidance would be expected to wash their hands. To create an element of time pressure, participants only had 25 minutes to complete the task. At the end of the session, participants completed a short questionnaire.

Cameras were trained on the sink throughout to capture handwashing behaviour. The trial footage was manually coded to establish four main outcome measures: the number of times participants washed their hands; the number of times they washed their hands using soap; the number of times they washed using soap and washed the backs of their hands; and the mean duration of handwashing attempts using soap.

Our analysis compared each of the treatment groups to the Control group. The main findings were as follows:

- Participants in the Timer group washed their hands for 1.9 seconds longer on average than Control group participants. This difference was statistically significant when other sources of variation were controlled for ($\beta = 2.20$, 95% CI = 0.34-4.06, $p = .021$).
- Participants in the Precommitment group washed their hands for 2.5 seconds longer on average than those in the Control group. This difference was

statistically significant when other sources of variation were controlled for (β = 2.30, 95% CI = 0.33-4.27, p = .022).

- We found no statistically significant differences between either treatment group and the Control group on any other outcome measure.

Our results indicate that the tap-mounted timer has the expected direct effect of encouraging users to spend longer washing their hands but with no concomitant improvement in handwashing frequency or technique. This is consistent with prior findings using the same device (Her & Almanza, 2019), and poses the question of whether the achieved increase in duration constitutes a meaningful improvement in hand hygiene.

We also found effects on duration but not quality for the precommitment intervention. This was surprising as the precommitment intervention was designed to directly target handwashing frequency and technique, with any increase in duration being a secondary consequence. We have no plausible causal explanation for this finding, so further research is needed to establish whether it is a real effect and—if so—what is its cause.

The study was preregistered on Open Science Framework (DOI: 10.17605/OSF.IO/ZPVNX) before trial launch and any data collection. The study was funded by the Food Standards Agency.

Introduction

Background

In 2009 in the UK, there were over 500,000 estimated cases of foodborne disease due to known pathogens (Food Standards Agency, 2014). Foodborne illnesses are caused by eating food contaminated with bacteria, viruses, other parasites, or chemical contaminants like heavy metals. Recent estimates put the number of yearly cases of foodborne illness at 2.4 million in the UK, imposing an estimated total burden of £9 billion (Daniel et al., 2018). Many foodborne illness outbreaks originate in food service establishments, for example, eating out accounts for an estimated 37% of all foodborne norovirus cases, and takeaways account for 26% (Food Standards Agency, 2022). A significant contributor to outbreaks is poor adherence by staff to food safety hygiene practices in the workplace (e.g. handwashing), (Olsen et al., 2000). Workers' hand hygiene is estimated to account for 89% of variance in outbreaks caused by food contaminated with pathogens in food service establishments (Guzewich & Ross, 1999).

Poor hand hygiene can be caused by washing for too short a time, not washing frequently enough, or by poor technique—in particular, failing to apply soap to all parts of the hand. Preliminary research, conducted before the onset of the Covid-19 pandemic, identified knowledge gaps around effective handwashing practice in food handlers, including around the length of time required for washing and drying hands (Ipsos Mori, 2017). However, this research also found behavioural barriers to handwashing: participants said they were likely to forget to wash when busy or under pressure; that there was little expectation of handwashing from seniors; and necessary materials were often not available.

There is a body of research showing that training alone is unlikely to improve behaviour. A meta-analysis of food safety training in commercial settings found that while training did improve knowledge in most studies, it did not lead to any change in handwashing behaviour in five of the six behaviours examined (McFarland et al., 2019). Even in the study that did record an increase in the frequency of handwashing, there was no accompanying improvement in handwashing technique,

duration, or increase in handwashing during peak periods (Yu et al., 2018). Another meta-analysis found a statistically significant overall effect of training on observed handwashing behaviour (Insfran-Rivarola et al., 2020), although the effect size (SMD = 0.45) was only small-medium.

Recent research has shown the potential benefits of behavioural interventions to improve hand hygiene. Two studies found that installing timers at sinks were effective in increasing the average duration of handwashing attempts by food handlers. Her et al. (2019) installed tap-mounted timers that counted down 30 seconds when the water was turned on, alongside informational posters about their use and proper handwashing technique. The authors reported a statistically significant increase in mean handwashing duration from a pre-treatment baseline (11.6s to 15.7s). Similarly, Yu et al. (2018) found statistically significant increases in the frequency (71.2 times/day to 102.7 times/day), mean duration (12.8s to 19.2s), and the quality of handwashing attempts – relative to a pre-treatment baseline – when they introduced a “motivational” soap dispenser that played 18 seconds of music whenever food handlers applied soap.

In other domains, the act of making a precommitment or forming a plan to translate intention into action has been shown to support the regulation of existing behaviour and the uptake of a new behaviour. Forming specific implementation intentions of the form “Whenever situation x arises, I will initiate the goal-directed response y" (Brandstätter et al., 2001; Gollwitzer, 1999) has been shown to be an effective strategy when tackling self-regulatory problems (e.g., remembering to act, seizing opportunities, and overcoming initial reluctance) (Gollwitzer & Sheeran, 2006). Additionally, previous research has demonstrated the effectiveness of committing to action in advance on the uptake of a wide range of behaviours, including weight loss (Coupe et al., 2019), smoking cessation (Black et al., 2020), and safe water consumption (Inauen & Mosler, 2016).[1] In principle, if someone has the goal of washing their hands appropriately, then making precommitments or forming implementation intentions could help them achieve it. However, we are not aware of any studies exploring the effects of these strategies on handwashing.

The purpose of this laboratory trial is to test the effect of two behavioural interventions aimed at improving handwashing behaviour in employees of Food Business Operators (FBOs): timers and precommitments.

Hypotheses

Hypothesis 1: Installing a timer at the sink and a poster prompting proper handwashing technique will increase the duration and quality of handwashing attempts relative to control, with no expected effect on handwashing frequency.

Hypothesis 2: Asking participants to make a series of pre-trial commitments to comply with specific elements of the FSA's handwashing guidance will increase the duration, frequency, and quality of handwashing attempts, relative to control.

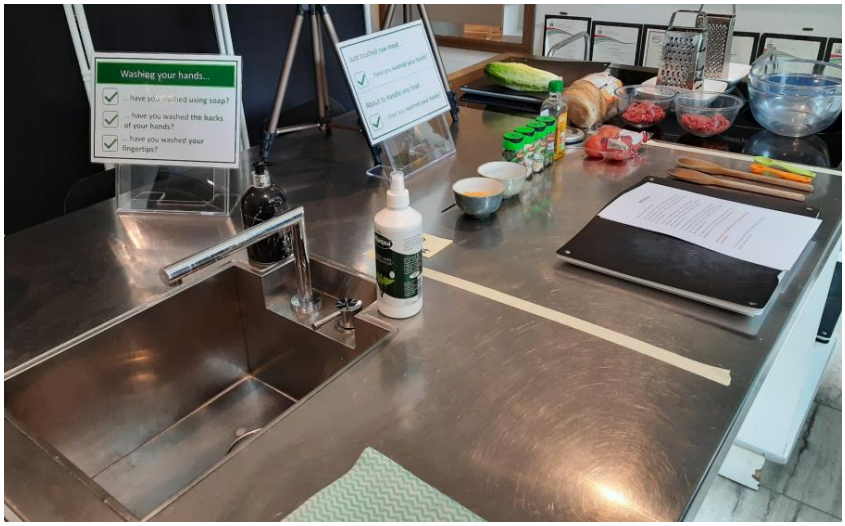
Methods

Trial design

The trial used a three-arm between-subjects design. We carried out testing in a laboratory kitchen: a cookery school with three separate workstations, screened off from each other. Up to three participants were tested at a time, and each was assigned their own workstation and sink for use (see Figure 1).[2]

We asked all participants to complete a food preparation task following a set recipe. The recipe required that participants handle raw meat and included multiple steps at which handwashing would be expected (eight handwashing occasions expected in total, if the task was completed). The task instructions emphasised the need to work as quickly as possible because food handlers say they are more likely to forget to wash their hands during busy periods (Ipsos Mori, 2017). Before attending the laboratory session, all participants were required to complete a short online training session and post-training quiz, in their own time.

Figure 1: Image of workstation in the experimental laboratory kitchen



At recruitment, we randomly assigned participants with equal probability to one of the three treatment groups:

In the Timer group, two interventions were placed at the sink: (i) a tap-mounted timer that counts seconds while participants are washing their hands, and (ii) a poster encouraging participants to use it to time 20 seconds rubbing their hands with soap, and showing the six steps of effective handwashing technique from the FSA's Safer food, better business guidance (Food Standards Agency, 2019). (Figure 2 shows the poster, which includes an image of the timer device.)

Figure 2: Poster placed by the sink for the Timer group.

Note: The top-right shows the tap-mounted "SaniTimer" device, which begins a 30-second countdown whenever the tap is turned on. The poster encourages participants to use the timer to make sure they wash their hands for 20 seconds and use proper handwashing technique.

In the Precommitment group, the pre-session training included a prompt to commit to a series of statements about handwashing - adapted from FSA guidelines - by electronically signing their name (typing it into a textbox). The statements were:

- If I touch raw meat, then I will wash my hands afterwards
- If I am going to touch or handle any food, then I will wash my hands first
- When I wash my hands, I will wet my hands under warm running water and use soap
- When I wash my hands, I will wash the back of each hand by rubbing against my palms
- When I wash my hands, I will wash my fingertips by rubbing against my other hand’s palm

Posters reminding Precommitment group participants of these handwash statements were displayed to participants in view of the sink and the workstation during the food preparation task (Figure 3).

Participants in the Control group received no handwashing intervention other than the baseline training completed by all participants. Otherwise, all environmental influences were held constant.

Each laboratory session consisted of 3 slots and each slot was quasi-randomly assigned to a different treatment group.[3] To minimise the risk of bias based on time of session, participants attending the same session were assigned to different treatment groups. Likewise, to minimise the risk of differences between the workstations confounding treatment effects, the treatment groups assigned to each workstation were rotated between sessions. Opaque barriers were installed to physically separate participants being tested in the same session and minimise potential spillover effects (i.e., participants washing their hands differently because they see other participants doing so or can see interventions from other treatment groups).

Figure 3: Posters for the Precommitment group.

Note: The upper poster was placed in view of participants' workstations, so they could see it while preparing food. The lower poster was placed in view of the sink so it could be seen while participants washed their hands.

We did not inform participants about the focus of this study, or of the FSA's involvement, until the end of the experiment. When initially consenting to take part, participants were given a very general description of the study's purpose (understanding how food handlers complete a guided food preparation task, under time constraints). A post-participation survey included a question asking participants what they thought the purpose of the study was, to check whether they had discerned the study objective. At the end of their session, all participants were fully debriefed and explicitly asked if they would like to withdraw from the study.

Procedure

The target population for this trial was UK food handlers employed at FBOs. To access our target population, a recruitment agency was used to recruit and allocate participants to testing slots, which had been pre-assigned to treatment groups. Participants were paid £60-70 for taking part.[4]

Before attending the lab session, participants were emailed a link to an online pre-trial training session and post-training quiz. The training materials covered key aspects of the FSA's guidance on handwashing behaviour (see Appendix A1. Pre-trial training materials and post-training quiz for details). The post-training quiz gave feedback on any incorrect answers and participants had to input the correct answer to proceed to the next question and complete the training. We recorded their first answers for use in the analysis. All participants were required to complete their training before their lab session date, and any who did not were excluded from the study. The recruitment agency sent regular reminders to participants to complete their training.

Upon arrival at the lab, participants were directed to their assigned workstation, where they were asked to read through a study information sheet and sign a consent form.

The food preparation task was described to participants as "the burger task". Participants were told that they would play the part of a worker in a hamburger restaurant preparing orders from customers. The task required participants to input a fictitious order on a tablet device we provided and then prepare the burger patty and assemble the garnish. Participants were instructed to complete the burger task twice

within a fixed 25-minute time limit, and that they should try and prepare the burger faster the second time. A written copy of the recipe was provided to all participants as a guide (see Appendix A2. Food preparation task instructions). The task was designed with a total of 8 distinct handwash points, according to FSA guidance (also shown in Appendix A2. Food preparation task instructions). Cameras focused on the sinks captured footage of participants' handwashing behaviour. An additional camera was also present in each workstation as a decoy, focused on the food preparation area, to mitigate experimenter demand effects.

After completing the food preparation task and cleaning their workstation, participants completed a post-participation survey on their tablet device. This survey included questions about the participants' understanding of the experiment and some additional background information (see Appendix A3. Post-trial survey). After the post-participation survey, participants were fully debriefed as to the purpose of the study.

Outcome measures

The primary outcome measures of the study are the frequency, duration, and quality of handwash attempts made by each participant during the food preparation task.

- Frequency: A count of handwashing attempts made by each participant.
- Duration: The mean duration of handwashing attempts where soap was used, from first application of soap to starting to rinse.[5]
- Quality:
    - A count of handwashing attempts in which soap was used.
    - A count of handwashing attempts in which the participant washed the backs of both of their hands (back-hands count).

Cameras placed above the sinks in each workstation recorded participants' handwashing behaviour in the session. The outcome measures were then derived from the coded video recordings by one primary coder and a dummy coder (see Appendix A5. Code frame).

Coders were not informed of the study's hypotheses or treatments and were blind to treatment as far as was possible. The sole exception to this was the tap-mounted

timer, which was necessarily visible in footage of the sink, although only from the rear so it was not clear what the device was. All coders completed training against pilot footage (which was not used in the analysis) before coding any footage from the main study. As a quality check, we randomly selected 10% of participants to be double coded and analysed inter-coder reliability on this subset.

In some instances, it was unclear to the coders whether a sequence of footage contained one or multiple distinct handwashing attempts. This occurred when participants applied soap and rinsed multiple times. We amended the code frame to include a flag identifying these instances as “ambiguous” and ran a sensitivity analysis excluding them for each primary outcome model.

The post-participation survey probed how participants engaged with the interventions. We asked participants how long they tried to spend washing their hands each time they did so, and how they kept track of time. We also tested whether participants in the Precommitment group could recall the statements they had committed to. The real precommitment statements were presented in lists alongside dummy statements and participants were asked to say which they had committed to. We presented the statements across two questions – one for statements prompted at workstations and one for statements prompted at the sink (see Figure 3).

The post-participation survey also collected background information to inform our analysis, including what participants thought the purpose of the experiment was, information about their job and workplace, and demographic information. For a full list of questions asked, see Appendix A3. Post-trial survey.

Power/sample size

Pre-trial power analysis identified a target sample size of 207 participants (n = 69 in each group). This would allow us sufficient power (0.8) to detect a medium-sized effect, accounting for the need to control the family-wise Type 1 error rate using Bonferroni adjustments when comparing all arms against one another (Freidlin & Korn, 2017).

Statistical Methods

We preregistered our analysis plan on the Open Science Framework (Kitchen lab study, DOI: 10.17605/OSF.IO/ZPVNX) before data collection began.

We analysed each of the primary outcome measures listed above separately. For each, we carried out a generalized linear model (GLM) with the primary outcome as the dependent variable. For the three “count” outcomes, we used a Poisson log-link GLM. For average duration, no transformation was necessary, so we used an identity link function.

For each outcome measure, the model includes Experimental arm as the primary independent variable of interest. In the models, experimental arm is dummy coded into two binary variables to indicate the presence/absence of the two intervention sets.

The two quality measures (count of handwashing occasions in which soap was used and count of handwashing occasions in which participants washed the backs of both of their hands) also include the count of handwashing attempts made as an essential covariate, to account for variation in handwashing frequency.

In addition, the initial model for each outcome measure features the following non-essential independent variables:[6]

- Which of the three workstations the participant was assigned to;
- FBO employer type (collected in the post-trial questionnaire);
- Job type (collected in the post-trial questionnaire);
- Age (collected in the post-trial questionnaire);
- Gender (collected in the post-trial questionnaire);
- The participant’s score on knowledge measures taken from the pre-trial survey;
- Whether the participants correctly guessed the purpose of the trial was to observe handwashing behaviour;
- Whether the participant finished the task;
- Which day of the week testing took place on;[a]
- Which time slot testing took place in[a].

To arrive at a parsimonious model and avoid over-fitting, we iteratively dropped non-essential independent variables are from the models as long as doing so improved goodness of fit according to Akaike's Information Criterion.

Ethics and Registration

Ethics approval was obtained for this trial from London School of Economics' Research ethics committee (Kitchen lab study, Ref: 55135). This study and the data analysis plan were preregistered on Open Science Framework (Kitchen lab study, DOI: 10.17605/OSF.IO/ZPVNX) before trial launch and any data collection. The full trial protocol can also be accessed via the Open Science Framework preregistration.

Results

Participants

The experiment ran between 7th March and 27th May 2022. In total, 214 participants took part over 21 sessions. We excluded 11 participants who had not completed their training and three who could be personally identified from their video footage (a requirement of the study's ethical approval). Technical issues led to lost footage for a further five participants. This left us a total of n = 195 (Timer: n = 69; Precommitment: n = 59; Control: n = 67) participants, which was below our target sample size.

Participants were aged between 17 and 64 years old (M = 35.2, SD = 11.9).[7] Eighty-three identified as male (43%) and 107 as female (55%).[8] Eighty-seven gave their job type as chef/cook (45%), nine as kitchen porter (5%) and 99 as "other" (51%), Baseline demographic characteristics for each treatment group can be found in Appendix B1. Sample demographics.

Participants scored an average of 5.79 (SD = 1.20) out of 8 on the pre-trial training quiz. One-way ANOVA found no baseline differences in training score between treatment groups (Timer: M = 5.68, SD = 1.27; Precommitment: M = 5.83, SD = 1.22; Control: M = 5.87 SD = 1.11; F (2, 192) = 0.45, p = .639).

Eight participants (4.1%) ran out of time and were unable to finish the food preparation task fully. At the end of each session, but before debriefing, we asked participants what they thought the purpose of the experiment was. In total, 41 (21%) correctly guessed that the purpose of the experiment was to examine handwashing behaviour. The proportion of participants who correctly guessed the experimental purpose did not differ across treatment arms ($X^2(2,194) = 3.32$, p = .190).

Inter-coder reliability

To determine agreement between the two coders on the subsample selected for double coding, we ran Kendall's W for each of the four primary outcomes. The

results show statistically significant agreement between the two coders on every outcome measure (handwashing attempt count: W = .976, p = .007; mean duration: W = .926, p = .012; count of attempts in which soap was used: W = .998, p = .005; count of attempts in which soap was used and the backs of both hands were washed: W = .960, p = .008).

Engagement with the interventions

The post-trial survey probed how well participants engaged with the interventions (see Table 10, Table 11, and Table 12 in Appendix B2. Post-trial survey responses).

Thirty-two participants in the Timer group (46%) said they used the countdown timer attached to the sink to keep track of how long they spent washing their hands. Of those, 28 said the timer was the main thing they used to keep track. The rest of the group either said they did not use the timer (n = 31) or could not say how long they tried to wash their hands for (n = 6). The most common reason for not using the timer was “I didn’t notice it” (n = 15).

Eight participants in the Precommitment group (14%) correctly recalled all the statements they had committed to as part of the precommitment intervention. Forty-four (75%) correctly recalled both statements pertaining to handwashing frequency[9] but only nine (15%) correctly recalled all three statements pertaining to handwashing quality.[10]

Table 1: Summary of handwashing primary outcome variables

	Timer (N = 69)	**Precommitment (N = 59)**	**Control (N = 67)**
	Mean (SD)	Mean (SD)	Mean (SD)
Mean duration	10.51 (5.94)	11.10 (6.41)	8.65 (4.76)
Handwash attempt count	5.48 (2.13)	6.37 (2.62)	6.13 (2.65)
Soap-use count	4.68 (2.23)	5.15 (2.52)	5.24 (2.44)
% Soap-use[11]	85%	80%	84%
Back-hands count	3.78 (2.37)	4.34 (2.35)	3.86 (2.50)
% Back-hands[12]	67%	65%	59%

Duration of handwashing attempts

Participants in the Control group washed their hands for 8.65 seconds on average (SD = 4.76) compared with 10.51 seconds (SD = 5.94; +1.9 seconds relative to control) in the Timer group and 11.10 seconds (SD = 6.41; +2.5 seconds relative to control) in the Precommitment group (Table 1).

Our best-fit linear regression model found statistically significant increases in duration for both interventions when compared against the Control group.[13] The model's coefficients show the size of the increase in duration relative to the control, after accounting for other covariates (Table 2). The timer intervention was associated with a 2.20 second increase in handwashing duration ($p = .021$) and the precommitment intervention was associated with a 2.30 second increase in handwashing duration ($p = .022$).

Sensitivity analysis (see Appendix B3. Mean duration and soap use sensitivity analysis) shows the effect of the timer intervention on duration is not robust to the exclusion of “ambiguous” handwash attempts.[14]

If we exclude Timer group participants who said they did not use the timer from our best-fit model, the duration increase associated with the timer is larger (2.77 seconds, p = .016) and robust to exclusion of “ambiguous” handwashing attempts.

Our results are broadly in line with our hypotheses: both interventions appeared to increase handwashing duration in our preregistered analysis. However, post hoc analyses suggest the effect of the timer intervention may be driven by a sub-group of Timer group participants who say they actually used the timer.

Table 2: GLM model with mean duration as the outcome variable

	Mean duration		
Predictors	β	95% CI	p
(Intercept)	5.94	1.38 – 10.50	**.011**
Timer	2.20	0.34 – 4.06	**.021**
Precommitment	2.30	0.33 – 4.27	**.022**
Finished task: No	4.46	0.31 – 8.60	**.035**
Purpose correct: No	-1.23	-3.16 – 0.69	.210
Training score	0.68	0.02 – 1.34	**.042**
Table (baseline = C)			
A	0.24	-1.68 – 2.16	.808
B	-1.84	-3.79 – 0.11	.064
Note: N = 188 (7 cases dropped due to missing data for one or more covariate(s)).			

Frequency of handwashing

Participants in the Control group washed their hands 6.13 times on average (SD = 2.65) compared with 5.48 times (SD = 2.13) in the Timer group and 6.37 times (SD = 2.62) in the Precommitment group (Table 1). The food preparation task included an

expected eight handwashing occasions; only 17 participants (9%) washed their hands at least this often (Timer group: 6%, Precommitment group: 12%, Control group: 9%).

Our best-fit Poisson log-link regression model found no effect of either intervention on the number of handwashing attempts made (Table 3). This is consistent with Hypothesis 1 (no effect of the timer intervention), but not Hypothesis 2 (more handwashing with the precommitment intervention).

Our best-fit model did find a statistically significant effect of gender: women washed their hands more often than men on average, holding relevant covariates constant. This is consistent with previous findings (Judah et al., 2009), so we ran a post hoc model with an interaction term between gender and treatment group. The interaction model was a worse fit than the main effects model reported in Table 3 and the interaction term was not statistically significant.

Table 3: GLM Poisson model with handwash frequency as the outcome variable

	Handwash attempt count		
Predictors	Exp(β)	95% CI	P
(Intercept)	5.54	3.96 – 7.76	**<.001**
Timer	0.90	0.78 – 1.04	.154
Precommitment	1.02	0.89 – 1.18	.729
Male: Yes	0.88	0.78 – 0.99	**.033**
Purpose Correct: No	0.91	0.80 – 1.05	.204
Training score	1.04	0.99 – 1.09	.106

N = 189 (6 cases dropped due to missing data for one or more covariate(s)).
Exp(β) is the exponentiated beta coefficient which if > 1 indicates a positive rate of change on the outcome variable, and < 1 a negative rate of change.

Soap use

Participants in the Control group washed their hands with soap 5.24 times on average (SD = 2.44) compared with 4.68 times (SD = 2.23) in the Timer group and 5.15 times (SD = 2.52) in the Precommitment group (Table 1). Over 80% of all handwashing attempts made during the task included soap use (Timer group: 85%, Precommitment group: 80%, Control group: 84%).

Our best-fit Poisson log-link regression model found no effect of either intervention on the number of handwashing attempts using soap, controlling for the total number of handwashing attempts (Table 4). This was contra to our hypotheses, which posited that both interventions would increase soap use.

Table 4: GLM Poisson model with soap count as the outcome variable

	Soap-use count		
Predictors	Exp(β)	95% CI	p
(Intercept)	2.01	1.47 – 2.76	**<.001**
Timer	1.04	0.89 – 1.21	.659
Precommitment	0.93	0.79 – 1.09	.348
Age	1.00	0.99 – 1.00	.488
Attempt count	1.18	1.15 – 1.21	**<.001**
Purpose correct: No	0.89	0.77 – 1.04	.130

N = 191 (4 cases dropped due to missing data for one or more covariate(s)).
Exp(β) is the exponentiated beta coefficient which if > 1 indicates a positive rate of change on the outcome variable, and < 1 a negative rate of change.

The result did not change when we ran an alternative model specification as a robustness check. The soap-use model suffered from under-dispersion, so the preregistered Poisson distribution may have been a poor fit. The alternative logistic regression model treated soap use as a binary dependent variable (1 = the participant used soap every time they washed their hands, 0 = the participants washed their hands without soap at least once). We used the same approach to covariate selection as the main analysis. For no combination of covariates trialled did

the model explain our data significantly better than the null (intercept-only) model unless we dropped treatment group as a factor.

Handwashing technique

Participants in the Control group washed the backs of both hands 3.86 times on average (SD = 2.50) compared with 3.78 times (SD = 2.37) in the Timer group and 4.34 times (SD = 2.35) in the Precommitment group (Table 1).

Our best-fit Poisson log-link regression model found no effect of either intervention on the number of handwashing attempts in which participants washed the backs of both hands, controlling for the total number of handwashing attempts (Table 5). This was contrary to our hypotheses, which posited that both interventions would improve compliance with proper handwashing technique.

Taking together the results for soap use and handwashing technique, we find no evidence of an effect on handwashing quality for either intervention treatment. This result is contrary to both Hypothesis 1 and Hypothesis 2.

Nonetheless, over the whole sample, participants who washed their hands for longer on average were more likely to wash the backs of both hands ($\rho = 0.42$, $p < .001$). When we split the sample by treatment group, this finding holds for the Timer ($\rho = 0.55$, $p = <.001$) and Control groups ($\rho = 0.49$, $p = <.001$), but not in the Precommitment group ($\rho = 0.23$, $p = .111$).

Table 5: GLM Poisson model with back-hands count as the outcome variable

	Back-hands count		
Predictors	Exp(β)	95% CI	p
(Intercept)	1.42	1.04 – 1.93	**.027**
Timer	1.15	0.96 – 1.38	.126
Precommitment	1.02	0.85 – 1.23	.804
Male: Yes	1.05	0.90 – 1.23	.548
Attempt count	1.20	1.16 – 1.24	**<.001**
Purpose correct: No	0.78	0.67 – 0.92	**.004**
Table (baseline = C)			
A	0.96	0.81 – 1.14	.627
B	0.82	0.69 – 0.99	**.038**

N = 184 (9 cases dropped due to missing data for one or more covariate(s)).
Exp(β) is the exponentiated beta coefficient which if > 1 indicates a positive rate of change on the outcome variable, and < 1 a negative rate of change.

Discussion

We found evidence that both a timer and a precommitment intervention led to an increase in the amount of time participants spent rubbing their hands with soap before rinsing (duration of handwashing). However, it did not improve quality of handwashing.

Participants who had access to a tap-mounted timer washed their hands for 1.9 seconds longer on average than Control group participants. Likewise, participants who committed in advance to five statements of good hand hygiene washed their hands for 2.5 seconds longer on average than those in the Control group.

We did not find any evidence of an associated effect on either the frequency or quality of handwashing. Participants washed their hands on average 5.97 times across the food preparation task, washed their hands with soap 5.02 times, and washed the backs of both hands with soap 3.97 times.

These results provide mixed evidence for our initial hypotheses. Hypothesis 1 predicted the observed effect of the timer on duration and the lack of effect on frequency. However, it also stated there would be an improvement in the quality of handwashing, which was not observed. Hypothesis 2 correctly predicted the increase in handwashing duration in the Precommitment group, but we also expected to see increases in handwashing frequency and quality, neither of which were observed.

Effectiveness of the timer intervention

The tap-mounted timer had the expected effect on handwashing duration, but there were two surprising findings:

Firstly, the magnitude of the effect was smaller than has been previously reported in other studies (Her & Almanza, 2019; Yu et al., 2018). Yu and colleagues reported that attaching a musical timer to soap dispensers led to a 6.4-second increase in handwashing duration relative to pre-test baseline. Her and colleagues found a 4.1-second increase using the same timer device as used in this study, again relative to

a pre-test baseline. Our observed mean difference (1.9 seconds) is smaller. Only 8 participants in the Timer group washed their hands for the advised length of time or longer, so a ceiling effect is unlikely to explain why the timer appeared to have a smaller effect in this study than in previous studies.

There are methodological differences between this study and those previously published, which may account for some of the discrepancy in observed effect sizes. We applied a stricter definition of handwashing duration than those studies – beginning with first application of soap and ending when rinsing starts. Yu and colleagues defined handwashing as ending when participants wiped their hands and Her and colleagues chose turning off the tap as the endpoint. These definitional differences seem likely to underpin the higher baseline durations reported in those studies.

Another reason we might expect a smaller effect than previously reported is if our participants did not engage as well with the intervention. This would not be surprising as previously reported studies were field trials run over multiple weeks, so participants encountered the interventions repeatedly. By contrast, our participants generally washed their hands 5-6 times in a 25-minute task, so they had limited opportunities to familiarise themselves with the timer. Indeed, the most common reason given for not using the timer was “I didn’t notice it”. Nearly half (n = 31) of Timer group participants said they did not use the timer to keep track of how long they washed their hands for. If we drop these participants from our main analysis, the effect of the timer becomes larger (2.77 seconds) and more robust. This finding makes intuitive sense – the timer works most well for those users consciously engaging with it – but it is the result of a post hoc split so we cannot infer causality.

The second surprising finding was that, while the timer did appear to have the expected effect on duration, we did not see a concomitant increase in participants washing the backs of their hands. We hypothesised that the timer would increase quality for two reasons: Firstly, the poster installed by the sink in the Timer group showed the FSA’s guidance on handwashing techniques, including explicitly prompting participants to wash the backs of their hands. Secondly, washing one’s hands for longer makes it easier to follow the guidance on technique. We did observe an overall relationship between mean duration and handwashing technique,

but this did not manifest as a detectable difference across treatment group. In other words, participants spent longer washing their hands, but it is not clear that they achieved better hand hygiene by doing so.

This does raise the question of whether directly targeting handwashing duration is worthwhile. Previous work using the same timer device found an effect on duration with no concomitant improvement in quality measures (Her & Almanza, 2019). Similarly, training methods focusing on duration in children led to some parts of the hands (e.g., fingertips, palms) being missed (Öncü & Vayısoğlu, 2021).

We did not observe an effect on soap use either, suggesting that the poster did not prompt participants who were not planning to use soap to do so. Soap use was generally high, being used for at least 80% of all handwashing attempts, across all groups. It should be noted that duration was only measured for handwashing attempts in which soap was used, so we would not necessarily expect a relationship between the soap use and duration.

Lastly, we did not find evidence of a “backfire” effect on handwashing frequency (Osman et al., 2020). In other words, the timer did not detectably discourage handwashing by making it more onerous.

Effectiveness of the precommitment intervention

The precommitment intervention did not have the expected effects on the frequency of handwashing, the frequency of soap-use, or whether participants applied proper handwashing technique by washing the backs of their hands. It was, however, associated with an increase in mean handwashing duration. We designed the precommitment intervention to directly target frequency and quality, with any effect on duration being a secondary consequence. Our results are therefore difficult to interpret cleanly.

Firstly, we consider why the precommitment intervention did not have the expected proximate effect on handwashing frequency or quality. In general, the evidence on the effectiveness of pledges and especially written pledges is mixed, with some studies finding positive effects (Katzev & Pardini, 1987; Lokhorst et al., 2013), but others finding they are not effective (e.g., Shu et al., 2012).

Perhaps participants made the commitment dishonestly and did not intend to follow through. The study offered money for taking part and committing to the prompt statements was mandatory for participants in the Precommitment group, so they were financially incentivised to do so. Even if the commitment was made honestly, we might not have induced a strong enough commitment for it to be effective. For instance, it has been hypothesized that people keep commitments to maintain a positive self-image (Cialdini, 2008) or reduce cognitive dissonance (Harmon-Jones & Harmon-Jones, 2012). It therefore follows that if the commitment is not strong enough to trigger self-image concerns or cause significant cognitive dissonance, it will not be effective (Sheeran et al., 2005). Since signing the prompt statements was mandatory to complete the online training, participants may have clicked through without feeling strongly enough committed to trigger these mechanisms. Furthermore, implementation intentions generally apply to goals one sets for oneself. In this experiment, participants agreed to pre-written statements, which may have reduced the self-regulatory element of the precommitment mechanism.

Even if participants did intend to follow through on their prior commitments, there may have been an "intention-action gap" at play (Sheeran & Webb, 2016). For example, they may have underestimated how difficult adhering to their commitment was when completing the food preparation task under time pressure. Alternatively, they may have failed to remember what they had committed to. The former seems unlikely: only three participants in the Precommitment group said they found the task "Somewhat difficult", and none answered "Very difficult". Recall failure is more plausible: while a majority correctly recalled each prompt statement in the post-trial quiz, only eight (14%) correctly recalled them all.

Alternatively, it has been hypothesized that people keep commitments because the commitment is worded as an 'implementation' intention, which lays down an automatic process where an action is triggered in response to a situational cue (Cialdini, 2008; Lokhorst et al., 2013). However, if the precommitment is not worded specifically enough (either the cue to action is not worded specifically enough or the connection between the situation and action is not specific enough) then it might not be effective (Gollwitzer et al., 2010). Implementation intentions have been shown to be successful at inducing rare or one-off actions, such as voting in an election or having a flu vaccination. Our precommitments were general enough to cover all food

preparation tasks. It may be that they would have worked if they were more specifically tied to our burger-making task, which raises the possibility that implementation intentions are not really effective for such general activities.

As with the timer intervention, the absence of an effect on soap-use may be at least partially explained by a ceiling effect. Soap was used for at least 80% of all handwashing attempts, across all groups.

The finding of increased duration in the absence of any detectable changes in how frequently participants washed the backs of their hands is puzzling. It is possible that another aspect of handwashing technique did improve and that this accounted for the change in duration. The precommitment statements and posters prompted participants to wash their fingertips, but this could not be reliably measured from test footage and so was dropped from our list of outcomes ahead of preregistration. However, this is an entirely speculative account, with no supporting evidence.

Taken together, we found no evidence suggesting that the precommitment intervention had the intended immediate effect on handwashing frequency and quality. There was an increase in duration relative to control, but with no obvious causal mechanism we recommend treating this finding with caution.

Strengths and limitations

To our knowledge, this is the first randomised controlled laboratory trial monitoring handwashing behaviour in food handlers. This approach allowed us to control many potentially confounding sources of variation in hand hygiene to draw robust conclusions about the effectiveness of our interventions. For example, much of the existing literature compares hand hygiene before and after an intervention is introduced (Her & Almanza, 2019; Yu et al., 2018). These “pre-post” studies are often easier to implement than between-subjects randomisation, but risk confounding treatment effects with unrelated changes during the fieldwork period (e.g., prevalence of Covid-19). The laboratory setting of this study afforded us considerable control over the environment in which participants prepared food, as well as their baseline level of training. We could therefore isolate treatment effects and, taken with our secondary measures, make inferences about the mechanisms by which our interventions were operating. Finally, the emphasis on behavioural

observation means our results will not suffer from the “intention-action” gap often associated with self-report measures (Sheeran & Webb, 2016).

While laboratory studies allow for more complete control of how interventions are applied, they do come with a number of critical limitations. Firstly, the study could not take place in a real professional kitchen, so the food preparation task and time pressure under which it was completed were necessarily artificial. Most obvious was the safety constraint that we could not ask participants to actually cook any food, just to prepare it. It also meant that participants were preparing food in an unfamiliar setting and in the absence of the usual social environment of their workplace. This means our findings may lack ecological validity.

The study cannot support inferences about the longevity of any observed effects. The food preparation task lasted up to 25 minutes, so participants in the Timer group did not have long to notice the timer and discern from the poster how to use it, while preparing food under a time limit. We cannot know from our results whether the effect on duration would grow stronger over time as use becomes habitual or if it attenuates as food handlers learn to ignore it. Similarly, the training and precommitment intervention took place at most two weeks before the testing session. To determine longevity, one would need to conduct a field trial with a longer data collection period.

Laboratory trials are expensive for the number of observations they yield, so our sample size is relatively low. This means that we would not have the power to detect interactions or smaller effects of interest, or to interrogate our findings through subsample analysis. This issue was compounded by practical difficulties in recruitment. Late drop-out rates were far higher than the recruiter had anticipated, and this led us to miss our target sample size even after extending fieldwork to accommodate more testing sessions.

Finally, the nature of the population of interest means we cannot claim to have a representative sample. We opted to use a recruiter to access our sample. This had the advantage of speed and cost-effectiveness but did mean less control over the sampling process than if we had carried out all recruitment ourselves. Because our design allocated treatment at random, we would not expect sampling biases to confound our results, but it is possible that our participants were more or less

sensitive to our interventions than food handlers as a population would be. The only practical alternative in the timeframe available was to recruit through an employer, which poses its own practical (will participants feel pressured to act in a given manner?) or ethical (how can we guarantee participants do not feel obliged to take part?) problems.

Concluding remarks

We found evidence that the tap-mounted timer had the expected direct effect of encouraging users to spend longer washing their hands but did not have any effect on quality. This result replicates similar findings from a prior pre-post field trial using the same timer device. We also found effects on duration but not quality for the precommitment intervention, but we have not got a good explanation for this finding, which would require further research to establish whether it is a real effect and—if so—what is its cause. We are not aware of any work exploring the long-term effectiveness of the timer devices on duration; this should be addressed in future research. More fundamentally, it is unclear whether the achieved increase in duration results in any meaningful improvement in hand hygiene because of the lack of improvement in handwashing quality.

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End notes

[1] It should be noted that in recent years an influential paper on the effectiveness of signing an honesty declaration to reduce dishonesty was debunked and retracted (Shu et al., 2012). As a result of this retraction and the wider replication crisis, the validity of research on the effectiveness of pre-commitment interventions has been called into question.

[2] The cookery school was in Wandsworth, London, UK (https://theavenuecookeryschool.com/contact/).

[3] For each time and date, the three slots were sorted into a random order using Python (the function random.shuffle()). The recruitment agency then recruited into a session's slots in order. For example, if a session's treatments are shuffled into [2, 3, 1], then the first participant recruited for that session was assigned to Group 2, the second recruited to the control, and the third to treatment 1.

[4] Early morning slots offered a higher incentive as sign-up for these sessions was lower.

[5] This definition necessarily means duration measures only covered handwashing instances in which the participants used soap. This outcome was therefore missing for any participants who never used soap.

[6] In this list, [a] indicates covariates that were not listed in the initial analysis plan as counterbalancing between the treatment groups should have accounted for any systematic effects. We decided to include these additional covariates early in fieldwork in response to a higher drop-out rate than anticipated, which could have undermined our counterbalancing. As a robustness check, any best-fit models including these covariates were also checked without them.

[7] Excluding two participants who refused to answer this question

[8] Four selected "I identify in a different way" and one refused to answer the question

[9] “If I touch raw meat, then I will wash my hands afterwards”, and “If I am going to touch or handle any food, then I will wash my hands first”

[10] “Using soap and wetting my hands under warm running water”, “Washing the backs of my hands by rubbing against the other hand’s palm”, and “Washing my fingertips by rubbing against my other hand’s palm”

[11] % soap-use is the proportion of handwash attempts where soap was used (soap-use count / handwash attempt count).

[12] % back-hands is the proportion of handwash attempts where backs of both hands were washed (back-hands count / handwash attempt count).

[13] After making a Bonferroni correction to account for the number of pairwise comparisons

[14] The coders were instructed to label a handwashing attempt as “ambiguous” if it was unclear from the footage as to whether one or multiple handwashing attempts had been made. These ambiguous attempts have the potential to distort the study’s primary outcomes if coded imperfectly, so re-running the primary analysis without them serves as a check of our findings’ robustness

Appendix A: Experimental Design

A1. Pre-trial training materials and post-training quiz

Welcome to our Food Safety Training!
As part of our study, we will ask you to carry out a food preparation task to a given recipe. As this will involve handling raw ingredients, we require you to complete a short training course before attending our test kitchen. The training will include a short quiz at the end.
Click to begin.

Did you know…

- that you play an important part in keeping people healthy?
- that every time you wash your hands, you reduce the risk of people getting sick?

Click here to see how you can make a real difference to keeping customers happy and healthy.

Harmful bacteria and viruses such as e-coli, salmonella and norovirus can spread very easily from people's hands to food, work surfaces and equipment. These germs cause illnesses such as sickness, nausea and diarrhoea. It is estimated that every year in the UK around 500,000 people fall ill with foodborne diseases like this[1], and that across Europe around 5,000 people die every year[2].
Many of these cases could have been avoided with better hand hygiene. Germs can get onto your hands in all sorts of ways. Some are obvious, like sneezing, coughing or using a tissue. Others less so, like touching your hair, face or body, or handling money. It's safest to assume that, unless you've just washed them, your hands are holding germs which could easily get into the food you're preparing.
As food handing professionals, we play a vital role in helping to prevent the spread of disease by washing our hands properly. But what's the right way to wash?
Click to find out more

To thoroughly wash your hands, you need warm water, liquid soap, and a disposable towel. Washing your hands properly should take at least 20 seconds between applying soap and rinsing with water (or the duration of singing happy birthday, twice), during which you should cycle through these 6 steps[3]:

Step 1: Wet your hands under warm running water and apply liquid soap

Step 2: Rub your hands together to make a lather

Step 3: Rub the palm of one hand along the back of the other and along the fingers. Repeat with the other hand

Step 4: Put your palms together with fingers interlocked and rub in between each of the fingers

Step 5: Rub around your thumbs on each hand and then rub the fingertips of each hand against your palms

Step 6: Rinse off the soap with clean water and dry your hands thoroughly on a disposable towel. Turn off the tap with the towel and then throw the towel away (images from here)

Correct technique is important in hand hygiene, but so is carrying out these steps regularly, throughout the food handling process…

Click to continue

When handling food, it is important to wash your hands during these following critical moments, when there is an increased chance of harmful bacteria and viruses being transmitted by your hands.

When to wash your hands:

Before touching or handling any food, especially ready-to-eat food

After touching raw meat, poultry, fish, eggs or unwashed vegetables

When entering the kitchen e.g. after a break or going to the toilet

After touching or emptying bins

After any cleaning

After touching a cut or changing a dressing

After touching items such as phones, light switches, door handles, cash registers and money

After sneezing or coughing

(images from here)

Click to continue

Thanks for reading our training material. Please answer the following questions…

True or False?

1. You should wash your hands after taking a break to smoke.

   True False

(if respondent clicks on True), display ü

(if respondent clicks on False), display X

(once respondent clicks, reveal the following information)

Always wash your hands after every break you take, including after a break to smoke.

Click to continue

True or False?

2. It is more important to clean your fingertips than the backs of your hands, as they make the most contact with food you handle True

   False

(if respondent clicks on True), display X

(if respondent clicks on False), display ü

(once respondent clicks, reveal the following information)

Cleaning your fingertips only is a food safety risk. When washing your hands, it is important to clean them all over, including the backs of your hands, and between your fingers, as these can all be areas where harmful bacteria and viruses can otherwise remain, and transfer to food you're handling.

Click to continue

True or False?

3. E.coli, Salmonella and Norovirus are all potential diseases that can spread through improper hand hygiene .

True False

(if respondent clicks on True), display ü
(if respondent clicks on False), display X
(once respondent clicks, reveal the following information)

Food poisoning can lead to illnesses, resulting in symptoms such as nausea, vomiting, diarrhoea and in extreme cases, even death. Proper hand hygiene can limit the spread of these illnesses, as harmful bacteria and viruses can spread very easily from hands to food.

Click to continue

True or False?

4. Handling money may allow harmful bacteria to spread to your hands.

True False

(if respondent clicks on True), display ü
(if respondent clicks on False), display X
(once respondent clicks, reveal the following information)

Money can transmit harmful bacteria'. In fact, did you know that, in the UK, faecal bacteria can be present on up to 14% of banknotes, and 10% of credit cards?[4]. It is therefore important to thoroughly wash your hands after handling any money

Click to continue

True or False?

5. It’s fine to not specifically wash your fingertips, as they will be cleaned when handwashing anyway. True False

(if respondent clicks on True), display X
(if respondent clicks on False), display ü
(once respondent clicks, reveal the following information)

Fingertips are the part of the hand likely making most regular contact with food, and it can be an overlooked area in handwashing. It is important to thoroughly wash every area of the hand with liquid soap, to help prevent the spread of food-borne illnesses

Click to continue

6. Put these handwashing steps in the correct order

(Randomly display order of the following steps)
Wet your hands under warm running water and apply liquid soap
Rub your hands together to make a lather
Rub the palm of one hand along the back of the other and along the fingers. Repeat with the other hand
Put your palms together with fingers interlocked and rub in between each of the fingers
Rub around your thumbs on each hand and then rub the fingertips of each hand against your palms
Rinse off the soap with clean water and dry your hands thoroughly on a disposable towel. Turn off the tap with the towel and then throw the towel away

(If the respondent scores between 1 and 5 display X, and reveal the following message):

Oops, you got something wrong, the right order is (present the order above, as Step 1- Step 6)

(If the respondent scores 6 display ü, and reveal the following message):
Congratulations, you got all the steps in the right order

Click to continue

Enter the correct answer

7. If you are washing correctly, you should rub your hands with soap for at least this long before rinsing with water:

(answer entry box) seconds

(if respondent types anything but “20”), display X
(if respondent types in “20”), display ü
(once respondent clicks, reveal the following information)

You should be washing your hands for a duration of 20 seconds if you are thoroughly cycling through the 6 recommended steps. To help keep a count, this is approximately the duration of singing Happy Birthday twice.

Click to continue

Multiple choice

8. Which of the following are points when you should wash your hands while working with food?

a) After emptying bins
b) After cleaning your workstation
c) After using your phone
d) After peeling fruit that has already been washed

e) After turning on a light switch

f) After holding a kitchen knife

g) After going to the toilet

(if respondent clicks on d or f, or fails to click on all 5 correct answers), display X

(if respondent clicks on a, b, c, e and g), display ü

(once respondent clicks, reveal the following information)

You must always wash your hands properly before handling or preparing food, including after handling raw food and before handling ready-to-eat food. If you touch any surfaces that might not be clean, you need to wash your hands again before handling food.

Click to continue

Now you know the correct handwashing procedure to keep people safe and healthy. Thanks for completing the training!

A2. Food preparation task instructions

Instructions

Welcome to the burger task!

Today, you will play the part of a worker in a hamburger restaurant. You will register an order from a customer using your tablet, and then you will prepare a classic burger, following the recipe cards at your workstation.

Your job is to complete the order as quickly as possible while following all the steps of the recipe, exactly. For safety reasons, you won't actually cook the burgers, just prepare the patties and assemble the garnish.

The tablet will time you as you prepare the burger and will tell you how long you took at the end. You will run through this task twice, from start to finish. See if you can go faster on your second run! You have 25 minutes in total.

You should have all the ingredients and equipment you need at your workstation, but if you need help, please ask an experimenter.

Please wait for an experimenter to check you are ready before you do anything!

The first thing you will need to do is input the order for one classic burger, using your tablet.

Figure 4: Food preparation task tablet screen: putting in burger order

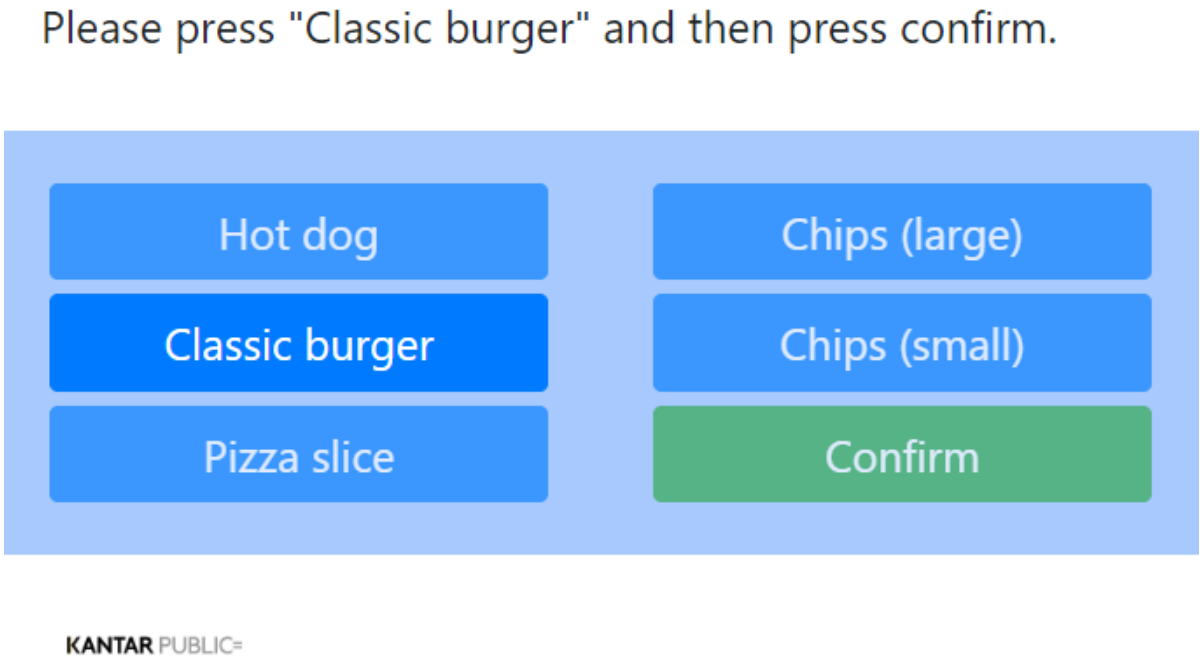
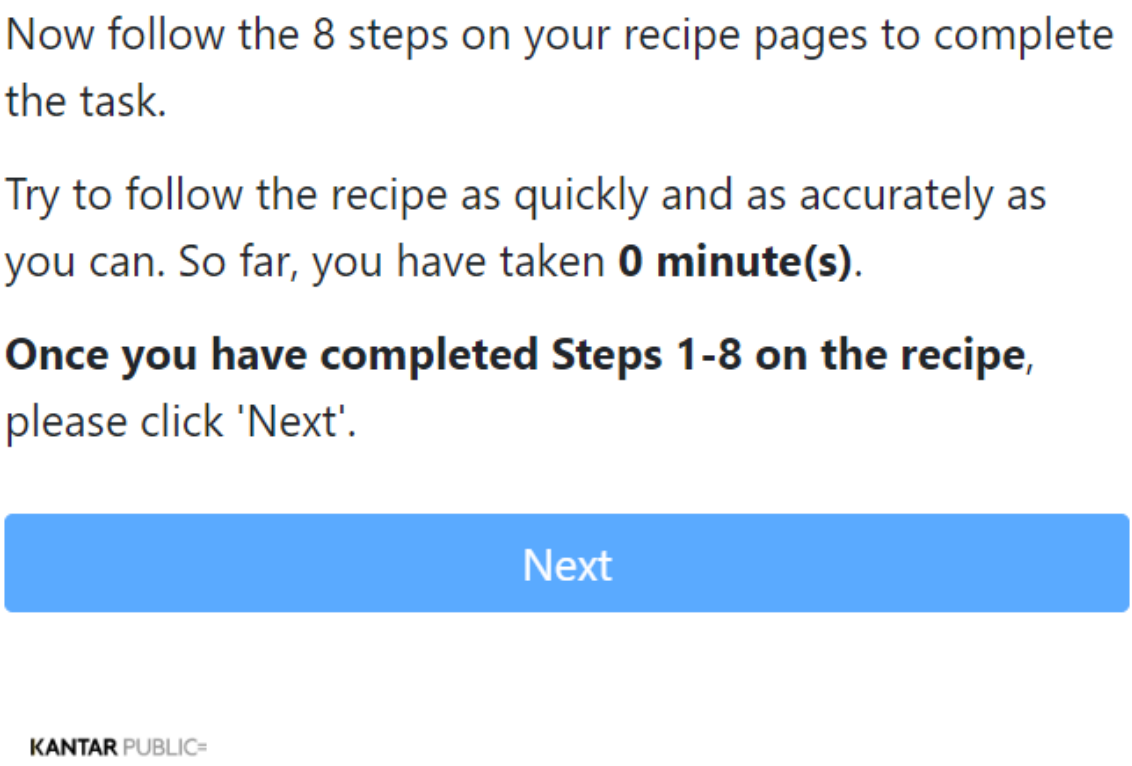


Figure 5: Food preparation task tablet screen: instructions and time in task



Classic burger recipe

This recipe makes one classic burger.

Step 1
Begin by preparing the patty. Add one portion minced beef to a mixing bowl.

Step 2
Add 1 tbsp breadcrumbs, ½ tsp dried herb mix, and ½ tsp onion powder to the mixing bowl containing the beef mince. Then add 1 tbsp olive oil and mix thoroughly by hand.

Step 3
Roll the meat mix into a ball and flatten it to form a patty. Put the patty on a plate and season with a pinch of salt and pepper (salt and pepper are pre-mixed in a bowl at your workstation). Then, set the plate aside on your hob area, for cooking.

At this point, if you were preparing a burger for real, you would cook it. For the purposes of this study we will skip that step and move on to the garnish.

Step 4
Now prepare the garnish. Tear off a leaf of lettuce from the head. Wash your leaf and one tomato.

Step 5
Now prepare the salsa. Grate the tomato into a clean bowl and add 1 pinch salt and pepper, 1 pinch dried coriander, and 1 pinch garlic powder. Then mix the salsa using a spoon.

Step 6

Now prepare the bun for your burger. Garnish the bottom half of each bun with 1 tbsp salsa place the lettuce leaf on top.

Step 7

Before you do anything else, please tidy your workstation.

Put any leftover salsa into the bin nearest you. Then place all the bowls and utensils you have used in the designated area for dirty crockery.

Lastly, please wipe down your workstation's countertop with a paper towel.

Step 8

Now use the tablet to register the order as complete and follow the instructions on the screen.

The steps at which we expected handwashing were as follows:

- After putting the order into the tablet, and before touching any food
- After mixing the beef patty by hand, and before touching the vegetables
- After touching the unwashed vegetables, and before touching the spices
- After putting leftover food into the bin, and before restarting
- After putting the second order into the tablet, and before touching any food
- After mixing the second beef patty by hand, and before touching the vegetables
- After touching the unwashed vegetables on the second run, and before touching the spices
- After putting leftover food into the bin

A3. Post-trial survey

Introduction

Ask all
Text

This survey will last about 10 minutes. Your responses will be kept anonymous and analysed together with other participants' responses.

Purpose

Ask all
Singlecode

First, what do you think the purpose of this study is? Please give as much detail as you can.

1. [open text input]
2. I don't know

Workintro1

Ask all
Text

Now, a few questions about your work as a food handler. If you have more than one job, please answer for the one you consider to be your main job.

Fbotype

Ask all
Singlecode

Which of the following best describes the place you work for in your main job?

1. Restaurant, i and takeaway
2. Catering business run from home, b&b, mobile catering and temporary business
3. Marquee, food stall, food pop up or food van
4. Nursery, school or care home
5. Distance selling, mail order or online food delivery including dark kitchen

jobtype

Ask all
Singlecode

Which of the following best describes your role?

1. Chef or cook
2. Kitchen porter
3. Something else

Facility1

Ask all
Multicode

Which of the following does your place of work offer/use?
Please select all that apply.

1. Food hygiene training for new staff
2. Food hygiene refresher training for existing staff
3. Diaries recording food hygiene checks and incidents
4. Safer food, better business information pack
5. Information included in this pack displayed in premises, e.g., handwashing guidance
6. Probes to check the temperature of food you are cooking, reheating or storing
7. A change of apron to be used after working with raw food
8. Disposable cloths for cleaning surfaces
9. Clean catering workwear (e.g., jackets, hats) for use at each shift
10. Liquid soap for handwashing
11. Sealed and labelled containers for foods containing allergens
12. Damaged utensils that are routinely used for food preparation and cooking
13. None of these

[scripter notes: randomise options but always k‘ep 'none of t’ese' at the bottom]

Facility2

Ask all
Multicode

Which of the following does your place of work have?
Please select all that apply.

1. A separate sink dedicated solely to washing vegetables and salads
2. A separate sink dedicated solely to handwashing
3. A separate bin just for food waste
4. A separate place to prepare raw and cooked foods
5. Brightly coloured waterproof dressings or plasters to cover cuts
6. Separate chopping boards for raw and cooked foods
7. Separate utensils for raw and cooked foods
8. Separate utensils/equipment/area for allergens
9. A sign encouraging people to wash their hands before working with food
10. Fridge and freezer temperature checks, i.e., are the temperatures monitored in the fridge and freezer?
11. None of these

[scripter notes: randomise options but always k‘ep 'none of t’ese' at the bottom]

Hwnorm

Ask all
Singlecode

How frequently do your co-workers wash their hands after handling or touching meat at work?

1. Always
2. Often
3. Sometimes
4. Rarely
5. Never
6. My co-workers never need to handle meat
7. Don’t know

Workintro2

Ask all
Text

Next, we would like to ask you a few questions about the food preparation task you have just completed. You may need to think back about your experience and please answer the follow questions to the best of your knowledge.

Taskease1

Ask all
Singlecode

How easy or difficult did you find completing today's kitchen task?

1. Very easy
2. Somewhat easy
3. Neither easy nor difficult
4. Somewhat difficult
5. Very difficult

Taskease2

Ask only if any option selected except for 'very easy' in 'taskease1'
Singlecode

What did you find most difficult about today's kitchen task?

1. Following the recipe precisely
2. Completing the task quickly
3. Working in an unfamiliar kitchen
4. Something else

Hwduration

Ask all
Singlecode/open

How long did you try to spend washing your hands each time you did so in today's kitchen task?

1. [open numeric input] seconds each time
2. I didn't think about it / i don't know
3. I didn't wash my hands

Hwtimer1

Ask only if valid numeric input provided in 'hwdurantion'
Multicode/open

Which of the following, if any, did you use to keep track of how long you spent washing your hands?
Please select all that apply.

1. The countdown timer attached to the sink
2. A clock or watch (including phone clocks)
3. Counting the seconds up from zero
4. Counting the seconds down from zero
5. Reciting a song (out loud or in your head)
6. Something else (please specify): [open text input]
7. I did not keep track *exclusive

[scripter notes: only show option 1 if participant belongs to group 1 (timer treatment group). Randomise response presentation order for option 1-5]

Hwtimer2

Ask only if any options in ‘hwtimer1’ selected except for ‘i did not keep track’
Singlecode

Which of the following was the main thing you used to keep track of how long you spent washing your hands?

1. The countdown timer attached to the sink
2. A clock or watch (including phone clocks)
3. Counting the seconds up from zero
4. Counting the seconds down from zero
5. Reciting a song (out loud or in your head)
6. Something else
7. Don’t know

[scripter notes: please only show codes if the corresponding response option at hwtimer1 was selected; please also present codes in the same order as in hwtimer1 (if they appear)]

Hwtimer3

Ask only if group = 1 and option 1 not selected in ‘hwtimer1’
Multicode

You said you didn’t use the timer device at the sink to keep track of how long you spent washing your hands. Why?
Please select all that apply.

1. I didn’t notice it
2. I wasn’t sure how to use it
3. It didn’t work
4. Something else (please specify) *open
5. None of these reasons
6. Don’t know

Hwtimer4

Ask only if any options in ‘hwtimer3’ = 1 – 4 selected
Singlecode

Which was the main reason you didn’t use the timer device at the sink to keep track of how long you spent washing your hands?

1. I didn’t notice it
2. I wasn’t sure how to use it
3. It didn’t work
4. I did something else to keep track of how long i spent washing my hands
5. None of these reasons
6. Don’t know

[scripter notes: please only show codes if the corresponding response option at hwtimer3 was selected; please also present codes in the same order as in hwtimer3 (if they appear)]

Precommit1

Ask only if group = 2
Multicode

When you completed your remote training before today's session, you were asked to commit to doing several things and electronically sign your name.

Which two of the following did you to commit to doing?

1. Washing my hands after touching raw meat
2. Washing my hands before touching or handling any food
3. Washing my hands after disposing of or composting food waste
4. Washing my hands after cleaning
5. Washing my hands after using a mobile phone
6. Washing my hands after touching light switched or door handles
7. Can't remember *exclusive

[scripter notes: do not allow the participant to proceed if more than two codes are selected. If they try, please display the error message "you have selected too many answers. Please select only two options from the list."; please randomise presentation order of response codes 1-6]

Precommit2

Ask only if group = 2
Multicode

When you completed your remote training before today's session, you were asked to commit to doing several things and electronically sign your name.

And which three of the following did you to commit to doing whenever you wash your hands?

1. Using soap and wetting my hands under warm running water
2. Washing the backs of my hands by rubbing against the other hand's palm
3. Interlocking my fingers and rubbing between each finger thoroughly
4. Rubbing around the thumbs on each hand when washing my hands
5. Washing my fingertips by rubbing against my other hand's palm
6. Drying my hands thoroughly afterwards
7. Turning the tap off using a paper towel
8. Can't remember [exclusive] *exclusive

[scripter notes: do not allow the participant to proceed if more than two codes are selected. If they try, please display the error message "you have selected too many answers. Please select only three options from the list."; please randomise presentation order of response codes 1-7]

Workintro3

Ask all
Text

We would like to gather some information about you to help us understand our work better.

Age

Ask all
Singlecode

How old are you?

1. [open numeric input]
2. I prefer not to say

Agegroup

Ask if ‘prefer not to say’ selected in ‘age’
Singlecode

If you are happy to, could you please tell us which of the following group your age is in?

1. 16-25
2. 26-35
3. 36-49
4. 50-65
5. 66+
6. I prefer not to say

Gender

Ask all
Singlecode

What is your gender?

1. Male
2. Female
3. I identify in a different way
4. I prefer not to say

Finish

Ask all

Text

Thank you for completing the survey. Your data will be stored anonymously and securely with us. Should you wish to withdraw from this study, please close the tab now. You will not be able to withdraw after you submit your response.

A4. Materials

Participants' views of one another and other workstations were obscured using 180cm tall folding dividers. These dividers consisted of a metal frame that could be arranged flexibly, with black canvas panels to block line of sight (Figure 6).

Figure 6: Opaque dividers.

A5. Code frame

Table 6: Code frame

One coding sheet to be completed for each participant. These sheets will then be aggregated during data processing. A fresh row should be created for each handwashing attempt.

Coder name:
Participant Number:
Footage batch:
Today's date:

Video number	Handwashing attempt number	Whether soap applied (1) "Yes" (0) "No"	**Complete if soap applied** (leave blank if not)				Flag - ambiguous whether this was one or multiple attempts (if coded as multiple attempts, please flag each corresponding row) (1) "Yes" (0) "No"
			Timestamps (hh:mm:ss)		Backs of hands rubbed (0) "Did not wash the back of either hand" (1) "Washed the back of one hand but not the other" (2) "Washed the backs of both hands" (-1) "Not visible"	Flag - vegetables/dishes washed at the same time (1) "Yes" (0) "No"	
			Soap applied	Rinsing begins			

Definitions
A handwashing attempt includes any instance in which a participant places their hands under running water.
Participants may place their hands under water and remove them multiple times within the same attempt, provided the tap is not turned off in between

Appendix B: Additional Results

B1. Sample demographics

Table 7: Summary of sample demographics and work background

	Timer (N = 69)	Commitment (N = 59)	Control (N = 67)	Overall (N = 195)
Age (mean)	35.34	34.45	35.63	35.17
Gender				
Female	49% (34)	56% (33)	60% (40)	55% (107)
Male	48% (33)	44% (26)	36% (24)	43% (83)
Other/Missing	2.9% (2)	0% (0)	5% (3)	3% (5)
Job type				
Chef/cook	42% (29)	46% (27)	46% (31)	45% (87)
Kitchen porter	7% (5)	2% (1)	4% (3)	5% (9)
Other	51% (35)	53% (31)	49% (33)	51% (99)
Industry type				
Restaurant, café, takeaway	64% (44)	59% (35)	55% (37)	60% (116)
Catering	12% (8)	19% (11)	12% (8)	14% (27)
Food stall	1% (1)	0% (0)	3% (2)	2% (3)
Nursey, school, care home	6% (4)	2% (1)	10% (7)	6% (12)

	Timer (N = 69)	Commitment (N = 59)	Control (N = 67)	Overall (N = 195)
Distance selling	3% (2)	0% (0)	3% (2)	2% (4)
Something else	14% (10)	20% (12)	16% (11)	17% (33)

Note: Means presented for continuous variables (age), and % (n) for categorical variables (gender, job type, and industry type).

B2. Post-trial survey responses

Table 8: Access to and use of hygiene facilities at work

	Timer (N = 69)	Precommitment (N = 59)	Control (N = 67)
		% (n)	
Which of the following does your place of work offer/use? Select all that apply.			
Food hygiene training for new staff	81% (56)	73% (43)	88% (59)
Food hygiene refresher training for existing staff	73% (50)	48% (28)	69% (46)
Diaries recording food hygiene checks and incidents	70% (48)	64% (38)	79% (53)
Safer food, better business information pack	48% (33)	41% (24)	52% (35)
Information included in this pack displayed in premises, e.g., handwashing guidance	83% (57)	71% (42)	87% (58)
Probes to check the temperature of food you are cooking, reheating or storing	74% (51)	73% (43)	84% (56)
A change of apron to be used after working with raw food	51% (35)	41% (24)	52% (35)
Disposable cloths for cleaning surfaces	87% (60)	81% (48)	85% (57)
Clean catering workwear (e.g., jackets, hats) for use at each shift	73% (50)	54% (32)	78% (52)
Liquid soap for handwashing	99% (68)	93% (55)	94% (63)

	Timer (N = 69)	Precommitment (N = 59) % (n)	Control (N = 67)
Sealed and labelled containers for foods containing allergens	80% (55)	83% (49)	85% (57)
Damaged utensils that are routinely used for food preparation and cooking	12% (8)	19% (11)	12% (8)
None of these	1% (1)	0% (0)	3% (2)

Table 9: Access to additional hygiene facilities at work

	Timer (N = 69)	Precommitment (N = 59)	Control (N = 67)
		% (n)	
Which of the following does your place of work have? Select all that apply.			
A separate sink dedicated solely to washing vegetables and salads	57% (39)	41% (24)	48% (32)
A separate sink dedicated solely to handwashing	83% (57)	70% (41)	88% (59)
A separate bin just for food waste	86% (59)	63% (37)	76% (51)
A separate place to prepare raw and cooked foods	70% (48)	59% (35)	75% (50)
Brightly coloured waterproof dressings or plasters to cover cuts	71% (49)	75% (44)	84% (56)
Separate chopping boards for raw and cooked foods	81% (56)	80% (47)	91% (61)
Separate utensils for raw and cooked foods	68% (47)	66% (39)	78% (52)
Separate utensils/equipment/area for allergens	59% (41)	51% (30)	70% (47)
A sign encouraging people to wash their hands before working with food	83% (57)	71% (42)	84% (56)
Fridge and Freezer temperature checks, i.e., are the temperatures monitored in the fridge and freezer?	81% (56)	85% (50)	88% (59)
None of these	1% (1)	2% (1)	2% (1)

Table 10: Handwashing descriptive norm

	Timer (N = 69)	Precommitment (N = 59)	Control (N = 67)
		% (n)	
How frequently do your co-workers wash their hands after handling or touching meat at work?			
Always	65% (45)	66% (39)	64% (43)
Often	12% (8)	14% (8)	21% (14)
Sometimes	10% (7)	5% (3)	3% (2)
Rarely	0% (0)	2% (1)	2% (1)
My co-workers never need to handle meat	12% (8)	10% (6)	9% (6)
Don’t know	1% (1)	3% (2)	1% (1)

Table 11: Recall of precommitment statements about handwash prompts

	Precommitment (N = 59) % (n)
When you completed your remote training before today's session, you were asked to commit to doing several things and electronically sign your name.	
Which two of the following did you to commit to doing?	
Washing my hands after touching raw meat	**92% (54)**
Washing my hands before touching or handling any food	**80% (47)**
Washing my hands after disposing of or composting food waste	7% (4)
Washing my hands after cleaning	9% (5)
Washing my hands after using a mobile phone	2% (1)
Washing my hands after touching light switched or door handles	2% (1)
Can't remember	3% (2)

Note: The responses highlighted in bold represent the correct commitment statements.

Table 12: Recall of precommitment statements about handwash technique

	Precommitment (N = 59) % (n)
When you completed your remote training before today's session, you were asked to commit to doing several things and electronically sign your name.	
And which three of the following did you commit to doing whenever you wash your hands?	
Using soap and wetting my hands under warm running water	**63% (37)**
Washing the backs of my hands by rubbing against the other hand's palm	**61% (36)**
Interlocking my fingers and rubbing between each finger thoroughly	51% (30)
Rubbing around the thumbs on each hand when washing my hands	27% (16)
Washing my fingertips by rubbing against my other hand's palm	**58% (34)**
Drying my hands thoroughly afterwards	20% (12)
Turning the tap off using a paper towel	5% (3)
Can't remember	3% (2)

Note: The responses highlighted in bold represent the correct commitment statements.

Table 13: Used the intervention in Timer treatment

	Timer (N = 69) % (n)
Which of the following, if any, did you use to keep track of how long you spent washing your hands? Select all that apply.	
The countdown timer attached to the sink	46% (32)
A clock or watch (including phone clocks)	3% (2)
Counting the seconds up from zero	22% (15)
Counting the seconds down from zero	10% (7)
Reciting a song (out loud or in your head)	12% (8)
Something else	6% (4)
I did not keep track	9% (6)
Missing	9% (6)

Table 14: Mainly used the intervention in Timer treatment

	Timer (N = 69) % (n)
Which of the following was **the main thing you used** to keep track of how long you spent washing your hands?	
The countdown timer attached to the sink	41% (28)
A clock or watch (including phone clocks)	1% (1)
Counting the seconds up from zero	17% (12)
Counting the seconds down from zero	7% (5)
Reciting a song (out loud or in your head)	9% (6)
Something else	3% (2)
Don’t know	4% (3)
Missing	17% (12)

Table 15: Reasons for not using intervention in Timer treatment

	Timer (N = 69) % (n)
You said you didn't use the timer device at the sink to keep track of how long you spent washing your hands. Why? Select all that apply.	
I didn't notice it	22% (15)
I wasn't sure how to use it	14% (10)
It didn't work	1% (1)
Something else	3% (2)
None of these reasons	4% (3)
Don't know	1% (1)
Missing	55% (38)

Table 16: Main reason for not using intervention in Timer treatment

	Timer (N = 69) % (n)
What was **the main reason** you didn't use the timer device at the sink to keep track of how long you spent washing your hands?	
I didn't notice it	22% (15)
I wasn't sure how to use it	12% (8)
I did something else to keep track of how long I spent washing my hands	3% (2)
None of these reasons	1% (1)
Don't know	1% (1)
Missing	61% (42)

Table 17: Perceived task difficulty

	Timer (N = 69)	Precommitment (N = 59)	Control (N = 67)
		% (n)	
How easy or difficult did you find completing today's kitchen task?			
Very easy	54% (37)	52% (31)	51% (34)
Somewhat easy	30% (21)	29% (17)	31% (21)
Neither easy nor difficult	13% (9)	14% (8)	15% (10)
Somewhat difficult	3% (2)	5% (3)	3% (2)
Very difficult	0% (0)	0% (0)	0% (0)
What did you find **most difficult** about today's kitchen task?			
Following the recipe precisely	9% (6)	17% (10)	18% (12)
Completing the task quickly	7% (5)	9% (5)	12% (8)
Working in an unfamiliar kitchen	25% (17)	20% (12)	18% (12)
Something else	6% (4)	2% (1)	2% (1)
Missing	54% (37)	53% (31)	51% (34)

B3. Mean duration and soap use sensitivity analysis

Table 18: GLM regression for mean duration without ambiguous cases

	Mean duration No ambiguous cases		
Predictors	β	95% CI	p
(Intercept)	5.89	1.21 – 10.58	**.014**
Timer	1.92	-0.003 – 3.83	.050
Precommitment	2.39	0.37 – 4.41	**.021**
Finished task: No	5.25	1.00 – 9.49	**.016**
Purpose correct: No	0.69	0.01 – 1.36	**.047**
Training score	-1.27	-3.25 – 0.71	.209
Table (baseline = C)			
A	0.73	-1.25 – 2.71	.471
B	-1.50	-3.51 – 0.51	.143
N = 187 (7 cases dropped due to missing data for one or more covariate(s)).			

Table 19: GLM regression for mean duration without ambiguous cases and without participants who did not use the timer intervention

	Mean duration No ambiguous cases and used timer intervention		
Predictors	β	95% CI	p
(Intercept)	7.16	1.98 – 12.35	**.007**
Timer	2.77	0.52 – 5.01	**.016**
Precommitment	2.42	0.39 – 4.45	**.019**
Finished task: No	3.96	-0.67 – 8.58	.093
Training score	0.46	-0.29 – 1.20	.230
Purpose correct: No	-1.09	-1.54 – 2.68	.326
Table (baseline = C)			
A	0.57	-3.57 – 0.86	.598
B	-1.35	25.09 – 38.99	.231
N = 158 (37 cases dropped due to missing data for one or more covariate(s)).			

Table 20: Logistic regression for the probability soap is used in every handwash attempt

	% Soap used every time		
Predictors	Exp(β)	95% CI	p
(Intercept)	1.85	0.36 – 9.46	.459
Timer	0.63	0.32 – 1.26	.191
Precommitment	1.16	0.56 – 2.40	.691
Purpose correct: No	2.06	1.00 – 4.24	**.049**
Training score	0.84	0.66 – 1.08	.170
N = 194 (1 case dropped due to missing data for one or more covariate(s)).			

For enquiries about this publication, contact the Food Standards Agency.

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