



## Washing hands and risk of cross-contamination during chicken preparation among domestic practitioners in five European countries

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### ABSTRACT

Nearly 40% foodborne outbreaks in the European Union are attributable to food practices in domestic homes that include handling and preparation of raw chicken. Hand washing is an important way to prevent cross-contamination with pathogens during chicken preparation. This study, which is part of the EU Horizon 2020 funded consortium SafeConsume, aimed at quantifying and understanding hand washing practices in three categories of households and five European countries. A quantitative survey (n = 1889) was combined with qualitative research, during which 75 participants from France, Norway, Portugal, Romania, and the United Kingdom were observed and interviewed. An original method for analysing video with “The Observer XT” software was developed to identify when and how risk arises. The quantitative survey and qualitative research data revealed that touching raw chicken was more frequent in Romania and Portugal. Practices to avoid touching raw chicken were declared and observed, although observations revealed that these practices were not always consistently followed. Only a third of the participants washed their hands with soap after handling raw chicken with important variations among countries (a majority in Norway and in the UK, a few in France and Portugal, none in Romania), in contrast to the results of the survey. Observations and interviews suggested that rinsing hands with water only and washing hands with soap are considered equivalent by many people. Barriers to washing hands due to improper equipment were mainly observed in Romania. Washing hands after touching raw chicken was motivated by food safety concerns for some participants in Norway and the UK, but not in France and Portugal, where it was motivated by unpleasant feelings on hands, or presented as a habit. Participants not washing their hands after touching the chicken did it after other actions they presumably perceived as unsafe (e. g. touching the bin, handling pets, and blowing the nose), indicating that they did not specifically consider touching raw chicken as risky. Knowledge, habits, and equipment with regard to chicken and hand washing differed among European countries, resulting in safe and risky practices.

### 1. Introduction

*Campylobacter* and *Salmonella* are the first and second most frequently declared foodborne zoonoses in the European Union (EFSA, 2019). These two bacteria are particularly prevalent in raw chicken meat. In 2018, this food category was most frequently contaminated with *Salmonella* and *Campylobacter* in the EU, with 7% and 37.5%

positive samples, respectively (EFSA, 2019). EFSA estimated in 2010 (EFSA, 2010) that 20%–30% campylobacteriosis was caused by handling, preparation and consumption of chicken meat in households. In France, *Campylobacter* and *Salmonella* are the two foodborne pathogens with the highest impact on public health, representing approximately 32% of the total foodborne disease burden. Infections caused by cross-contamination from raw poultry meat were estimated to represent

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3%–29% (90% confidence interval) for *Campylobacter* and 0.1%–4.7% for *Salmonella* (Augustin et al., 2020). This indicates that the risk of cross-contamination from raw poultry is particularly critical for public health in the case of *Campylobacter*, and less so, but still significant, for *Salmonella*.

During the investigation of a *Campylobacter* outbreak in a restaurant that caused 17 infections in the 51 patrons, Brown et al. (Brown, Kidd, Riordan, & Barrell, 1988) observed that the chef did not always wash his hands between handling raw chicken carcasses and cooked foods. The authors also experimentally demonstrated the transfer of *Campylobacter* from naturally contaminated raw chicken meat to hands and from hands to cooked foods. The transfer of *Campylobacter* and *Salmonella* from raw meat to hands and from hands to salads has since been conclusively confirmed (Carrasco, Morales-Rueda, & Garcia-Gimeno, 2012; De Boer & Hahné, 1990; Luber, Brynestad, Topsch, Scherer, & Bartelt, 2006; Oscar, 2013; Ravishankar, Zhu, & Jaroni, 2010; Verhoeff-Bakkenes, Beumer, de Jonge, van Leusden, & de Jong, 2008).

Hand hygiene is a recognised way to limit the transfer of pathogens by healthcare workers (WHO, 2009), fieldworkers (Monaghan & Hutchison, 2016) and food workers (Todd, Michaels, Smith, Greig, & Bartleson, 2010). An analysis of the United States Food and Drug Administration (US-FDA) food safety survey revealed that domestic food handlers who reported always washing their hands with soap before food preparation also reported less foodborne illness (Ali, Verrill, & Zhang, 2014).

The surfactant action, friction and final rinsing in water involved in washing hands with soap can effectively reduce microbial load from the outer layer of skin (Foddai, Grant, & Dean, 2016; WHO, 2009). Thus, hand washing is particularly suited to limit the hand-transfer of pathogens. Hand washing with soap is much more efficient than rinsing with water alone, regardless of the water temperature (Courtenay et al., 2005; Monaghan & Hutchison, 2016), particularly in the presence of meat debris (Jensen, Danyluk, Harris, & Schaffner, 2015).

It is important to understand the risk of cross-contamination at home during raw chicken handling and preparation concerning (a) whether consumers touch raw chicken with bare hands, (b) whether and how hand washing occurs and (c) what factors and barriers guide consumers to wash, or not wash, their hands. For this reason, we analysed the actions of consumers using theories of practice as a guiding framework.

A practice can be understood as a sequencing of actions guided by three basic and interconnected elements: materials (including nature, objects, tools, and resources), images (including meanings, understandings, and purposes), and skills (competence, expertise, and technique) (Shove, Pantzar, & Watseon, 2012; Truninger, 2011). Theories of practice emphasise the practicality of everyday social life in which routines, rather than reflexivity, are paramount. Therefore, it is particularly suitable to analyse food preparation and kitchen routines. Previous studies on food safety in home kitchens have shown how consumers clean kitchens, surfaces, homes and wash hands using observational methods. Some studied incorporated videotaping. The studies consistently showed that actual practices were not consistent with recommended practices, especially for washing hands, which was rarely correct (Evans & Redmond, 2018; Maughan et al., 2016; Mazengia, Fisk, Liao, Huang, & Meschke, 2015; Moore, Sweet, Harrison, & Franck, 2019). All these studies were conducted in one country only, mostly in the UK, Northern Ireland, and the US (Redmond & Griffith, 2003).

This paper is part of a larger research project (safeconsume.eu), which aims to investigate the links between consumer food handling and the risks of foodborne diseases in Europe. The aim of the work presented in this paper is to develop an understanding of hand washing practices during chicken preparation in five European countries, drawing on insights from a mixed methods analysis. Three categories of consumers are considered: elderly households and families with infants who are at higher risk of falling ill with campylobacteriosis and salmonellosis (ECDC) and young men who are less likely to follow food safety

recommendations (Katiyo, de Kock, Coorey, & Buys, 2019; Murray et al., 2017). We conducted a complementary approach, which involved a wide-scale survey of the declarative practices of touching raw chicken and washing hands during chicken preparation, and a qualitative study at home analysing videos and interviews collected during the preparation of chicken. We identified when and how consumers washed hands, considering the three dimensions of practices: materials/equipment, skills/competencies, and knowledge/beliefs (Shove et al., 2012; Truninger, 2011).

The originality of our study lies in the fact that it offers a comparative analysis of five European countries, using a mixed methods approach with similar categories of ‘at risk’ participants and food handling practices. Furthermore, it combines observations of participants’ practices of washing hands, how and when they did it, with their perceptions and reasoning and uses video materials to identify action sequences that can lead up to, and that follow, handwashing.

## 2. Material and methods

### 2.1. Quantitative survey

The SafeConsume quantitative online survey was conducted from December 2018 to April 2019. The survey measured declared consumer food handling practices in a standardised, quantitative, and cross-nationally comparable manner. The recruitment was subcontracted to a professional survey provider administering a large consumer panel worldwide (formerly Research Now SSI, now Dynata). The population sample of households was selected by stratified random sampling based on the Nomenclature of Territorial Units for statistics level 2 (NUTS2) of the respective country (Eurostat, 2021) and the education level of the target respondent (Møretro et al., 2021).

Those who carried the main or shared responsibility for food shopping in the household were invited to participate and were referred to as respondents. Survey data were collected from ten countries, from which we extracted data from the five countries where the qualitative research was conducted to allow comparison: France (432 respondents), Norway (344 respondents), Portugal (310 respondents), Romania (358 respondents) and the UK (445 respondents). Only the three pre-identified groups of young single men (YSM, <30 years of age living alone or in shared housing; 6% of respondents), young families (YF, households including at least one pregnant woman or one child <6 years of age; 44% of respondents with 44% of pregnant women) and elderly households (EH, >65 years of age; 49% of respondents). The profiles of the 1889 respondents are presented in Appendix 1. All respondents were informed about their data protection and guaranteed anonymity. We refer to the respondents for the quantitative survey.

We used only five questions related to handling raw chicken, washing hands after touching raw chicken and general occasions involving washing hands. The questions “How likely is it that you would touch the chicken with your bare hands when you take it out of its packaging?” and “How likely is it that you would clean your hands immediately after touching the chicken?” used an 11-point labelled scale ranging from 1 (“No chance or almost no chance”) to 11 (“Certain or practically certain”). We also analysed three multiple-choice questions. The questions were “Typically, do you touch chicken with your bare hands when preparing it?”, “How would you clean your hands?” and “In general, when would you normally wash your hands at home?”. QuestionData software (v. 6.8) (Grimmersoft) was used to process the survey information. Statistics were calculated using the analysis module.  $\chi^2$  tests of independence were performed to determine the dependence of the answer to each multiple-choice question based on country and household type. Analysis of variance (ANOVA) was performed on the quantitative scores (Statgraphics 18).

## 2.2. Recruitment and methodology of the qualitative study

Transdisciplinary qualitative research was performed between September 2017 and July 2018 in five countries (France, Norway, Portugal, Romania, and the UK). We conducted observational work and semi-structured qualitative interviews with 75 households (15 in each country). Each research team obtained ethical and/or data protection approval depending on the national rules in their respective countries. The aforementioned EH, YF and YSM households were recruited from the general public by a professional service provider (Norstat Norge AS, Oslo, Norway) working with local recruiters in each country. Another recruitment criterion was for the participant to purchase, cook, and eat chicken at home. We also chose households with different education and income levels, living in rural and urban residential areas (Appendix 2). Informed consent was obtained from all participants at the start of the study. The research included two visits. The first visit involved food shopping, grocery packing, transportation, and the storage of purchases at home. The second visit occurred several hours or days after the first visit and took place at the participants' homes. A social scientist and microbiologist observed the participant preparing a meal with chicken and a salad. The participants selected the recipe. The advice they received was to prepare a dish they regularly cooked. Social scientists have conducted observations using the *go-along* methodology (Kusenbach, 2003; Pink, 2007). This technique allows ethnographers "to observe their informants' spatial practices *in situ* while accessing their experiences and interpretations at the same time" (Kusenbach, 2003). Semi-structured interviews were conducted to solicit responses concerning habits of food storage, preparation and consumption, and knowledge about food safety and hygiene.

In the qualitative study, participants were identified using pseudonyms, followed by the type of household in brackets (YSM: young single man, YF: young family with infants, EH: elderly households), their residence (R: rural, U: urban) and country (FR: France, NO: Norway, PT: Portugal, RO: Romania, UK: United Kingdom).

## 2.3. Collection and exploitation of the qualitative study data

The social scientist audio- and video-recorded the food preparation with a handheld camera. Emphasis was on actions with the hands. The 90 h of video recording of every participant's actions concerning their frequency, duration and chronological visualisation were analysed using "The Observer XT" software. We counted occurrences of specific behaviours performed in a specific order. An example is the sequence of 'washing hands with soap' after 'touching raw chicken'. The durations of each behaviour were timed. ANOVA on washing hands with soap duration was performed with XLSTAT software (Addinsoft). We also analysed audio-recorded conversations during food preparation and semi-structured interviews.

To analyse the results, we applied a theory of practice approach that encourages analysis of the materials, equipment, skills, competencies, knowledge, beliefs and their interactions, as these are performed by participants (Martens & Scott, 2017; Meah & Watson, 2011; Sutton, 2006; Torkkeli, Mäkelä, & Niva, 2018; Truninger, 2011).

## 3. Results

### 3.1. Touching raw chicken during food preparation

The survey questionnaire allowed us to quantify chicken handling using bare hands. The question "How likely is it that you would touch the chicken with your bare hands when you take it out of its packaging?" was evaluate on an 11-point scale from "no chance or almost no chance" to "practically certain or certain." The mean (M) score of 7.6 (standard deviation, SD = 3.2) was between 7 ("Good possibility") and 8 ("Probable"). The mean scores differed depending on the country ( $F = 2.86$ ,  $P = 0.0223$ ) or the type of household ( $F = 4.86$ ,  $P = 0.0078$ ). The

interaction country per household type was not significant ( $F = 1.69$ ;  $P = 0.0969$ ), which indicated that the rankings between countries were found in all types of households and *vice versa*. Respondents in the UK ( $M = 7.26$ ,  $SD = 0.23$ ) and Norway ( $M = 7.30$ ,  $SD = 0.24$ ) declared a "Good possibility" and "Probable" likelihood that they would touch chicken with their bare hands. These findings differed from the results of Romanian ( $M = 8.09$ ,  $SD = 0.26$ ) and French ( $M = 8.19$ ,  $SD = 0.27$ ) households ("Probable" to "Very probable"). Portuguese households were at an intermediate level ( $M = 7.52$ ,  $SD = 0.43$ ). Respondents with YF ( $M = 7.33$ ,  $SD = 0.12$ ) were less likely to touch raw chicken with their hands than elderly respondents ( $M = 7.86$ ,  $SD = 0.12$ ).

In the quantitative survey, answers to the question "Typically, do you touch the chicken with your bare hands when preparing it?" indicated that the most frequent occasions for touching the chicken were during cutting (43% of respondents) and moving it to a bowl (33%) (Fig. 1), followed by seasoning (25%) and rinsing (28%). There were significant differences between the countries concerning the manipulation of chickens with bare hands. A majority (62%) of Romanians stated that they touched chicken when cutting it compared to only 30% and 36% French and Norwegian respondents, respectively. The most frequently reason cited by Romanians was seasoning (62%). This reason was less frequent for respondents from other countries. Rinsing chickens was a reason for hand-chicken contact for 48% Romanian respondents compared to 39%, 26%, and 20% respondents from Portugal, Norway, and the UK, respectively. Only 12% French respondents declare this practice ( $X^2 = 162.98$ ,  $P = 0.000$ ). Only 17% respondents stated that they did not touch chicken with their hands during preparation, with no significant differences between countries. Twenty percent of the YF households, 17% YSM, and 14% EH avoided touching chicken with bare hands ( $P = 0.0040$ ). Materials used to manipulate raw chicken were mostly a fork and gloves (Fig. 1), although wearing gloves does not replace the need for hand washing (CDC, 2020).

The majority of participants (67) who were observed preparing chicken at home during the qualitative research touched raw chicken with their hands during the preparation or transfer to a dish or a pan. Hand-chicken contact frequently occurred during trimming and cutting chicken portions in all countries. In Romania and Portugal, the contact was also frequent when removing skin from chicken and when cutting whole chicken into pieces, consistent with the survey responses (45% Portuguese respondents and 62% Romanian respondents). Other observed reasons for touching raw chicken with bare hands were to spread oil and condiments (all countries, as in the survey), stuffing the gut cavity of whole chicken with herbs (France) and eviscerating the chicken (Romania and France) (Appendix 3A). For 14 research participants in France, Norway, and the UK, hand-chicken contact was very brief and was limited to the transfer of chicken breasts, chicken legs, or whole chicken from their packages to cooking devices. These variations were linked to differences in skills and competencies (e.g., diversity in recipes meant chicken-hand contact was necessarily diverse), routines (e.g., habitual trimming and skin removal), beliefs (e.g., skin removal for health- and safety-related reasons), materials (e.g., preparing home-grown chicken entailed slaughter, evisceration and washing, in addition to cooking, with associated use of relevant tools, materials and resources) and combinations of these practices. For instance, skills and materials were both involved when a whole chicken was purchased for a recipe requiring chicken pieces, necessitating chopping of raw chicken at home.

In agreement with the survey, 10 out of 15 Portuguese and 13 out of 15 Romanian participants, but none from the UK, Norway and France, rinsed chicken before cooking. This was done using bowls of cold or warm water, or by rinsing in a stream of cold water.

Few research participants protected their hands to avoid direct contact with raw chicken, such as using a kitchen roll paper, packaging as a glove or forks (one YF each in Portugal and the UK, one YSM in the UK and three EH each in Norway and the UK; Appendix 3A). These findings were consistent with the survey findings, where consumers in

	countries				
	Fr	No	Pt	Ro	UK
number of respondents	432	344	310	358	445
No, I use gloves	4	7	6	8	6
No, I use a plastic bag as a glove	1	3	3	3	4
No, I avoid touching it by using kitchen roll	3	5	2	3	3
No, I use a fork	11	8	4	8	6
Yes, when cutting	30	37	45	62	41
Yes, when moving it to a bowl/pot/pan	28	27	33	42	35
Yes, when adding salt/spices/butter/oil	18	21	22	41	23
Yes, when I rinse it	12	26	39	48	20
Yes, when I wipe it with kitchen roll/ a tea towel	13	16	8	17	12

Fig. 1. Hand-chicken contact declared during food preparation. Results from the quantitative survey in percentage per country. Fr: France, No: Norway, Pt: Portugal, Ro: Romania, UK: United-Kingdom.

the UK were most likely to declare avoiding touching raw chicken. However, one UK participant took great care to avoid touching the chicken during some preparation steps, but used his bare hands during other steps (Appendix 3A). Two YSMs from France and Norway did not touch raw chicken without strategies to protect their hands, using a combination of skills (using simple recipes) and materials (purchasing chicken products adapted to the recipes used) (Appendix 3A).

Knowledge of the risks of raw chicken was not addressed in the quantitative survey, but was discussed during the qualitative research. In Portugal, Romania, and France, participants rarely expressed concerns about the safety of chicken meat. When there was concern, it was mostly associated with storage (freshness and short storage time), need to keep it cold, cooking issues (thorough cooking), contamination by butchers and contaminants like hormones (Appendix 3B and 3C). The risk of hand-to-chicken cross-contamination was not mentioned. These participants touched chicken with bare hands. The perceived risk of hormones by one respondent (Maria-Celeste) prompted her to remove skin of the raw chicken. This increased hand-chicken contact, and the risk of cross-contamination. Among participants who did not touch chicken with bare hands, two (one YF in Portugal and one YSM in UK) explained they got food safety training when working in the food sector.

### 3.2. Hand cleaning following raw chicken handling

In the quantitative survey, respondents were asked to declare how likely it was on an 11-point scale from 1 (“no chance or almost no chance”) to 11 (“practically certain or certain”) that they would clean their hands immediately after touching chicken. The mean response was 8.33 (SD = 0.14). Fifty percent of respondents declared they were almost sure, certain or practically certain. There was no significant country effect (F = 1.08, P = 0.3656), but there were differences between the household groups (F = 34.23, P = 0.0000). YSM (M = 7.9, SD = 0.30) and YF (M = 8.2, SD = 0.1) were significantly less likely than EH (M = 9.3, SD = 0.1) to declare cleaning hands immediately after touching chicken. No country-per-group interaction was found, suggesting that these group differences were found across the five countries.

According to the quantitative survey, the most frequent ways of cleaning hands were regular (34%) and antibacterial soap (29%). Nineteen percent of respondents paid attention to the recommended 21 s minimum time for hand washing (Fig. 2). There were differences between countries for all items, especially in the use of cold (X2 = 51.8, P = 0.000) and warm (X2 = 54.6, P = 0.000) water, and the use of

	countries				
	Fr	No	Pt	Ro	UK
number of respondents	432	344	310	358	445
cold water	10	7	16	8	6
warm water	20	35	21	43	27
running water	23	30	29	29	30
with regular soap	29	44	28	40	31
with antibacterial soap	9	11	11	18	29
make sure >21s	10	14	9	17	19
dry with a cloth or towel	17	11	18	17	17
dry with kitchen roll	7	15	11	12	14
dry in the air	3	4	2	4	6
with a hand disinfectant	4	4	3	4	5
I don't wash	2	0	0	1	0

Fig. 2. How respondents declared cleaning and drying hands immediately after touching raw chicken by country. Results from the quantitative survey in percentage per country.

antibacterial soap (X2 = 81.97, P = 0.000). Portuguese respondents were more likely to clean their hands with cold water, whereas Norwegian and Romanian respondents more often cleaned with hot water. Romanian (40%) and Norwegian (44%) respondents also declared cleaning hands more often with regular soap. Antibacterial soap was more frequently used in UK households than in other countries. Living in urban or rural areas or educational qualifications did not make a difference.

In the qualitative research, we identified four different types of action following raw chicken handling: (1) doing nothing at all, continuing with the recipe and touching other items; (2) drying hands on a cloth, a towel, or a paper towel; (3) rinsing hands with water only; and (4) washing hands with soap. Descriptions of these different cases are provided in Appendix 3C. For the observational analysis, we used the word “washing” for the action of washing with soap and water. Exclusive use of water was termed “rinsing.” When quoting from participants’ reasoning, we present the words they used, irrespective of their actual actions.



We observed that the majority of participants (red in Fig. 3) did not wash their hands with soap after handling raw chicken. The clear exception was Norway, where all participants who touched raw chicken washed their hands with soap after a brief period during which nothing was touched. In the UK, 8 of 12 participants washed their hands after handling the raw chicken. In France, Portugal, and Romania, few participants washed their hands after handling raw chicken. Some, like Dumitra (EH, R, RO), did not wash, rinse, or wipe hands during or after preparing the chicken. On several occasions, there was contact between hands and water while the chicken was rinsed, which may have been interpreted as hand washing, as expressed by Maria-Celeste (EH, U, PT, Appendix 3C). Fabrice (YSM, U, FR) explained he would ‘wash’ hands after touching food as a reflex, but he actually rinsed hands after cutting raw chicken. Bogdan (YSM, U, and RO) knew that chicken can transmit pathogenic microbes that can be removed by washing, but he rinsed and did not wash hands after touching raw chicken. Bernard (EH, U, FR) and Sylviane (EH, R, FR) explained that they would often ‘wash’ hands in the kitchen, but they were not observed using soap. These observations highlight the ambiguity of the concept of “wash” in the common vocabulary. It did not imply the use of soap for all participants and revealed a lack of knowledge of the importance of soap when washing hands. The findings also reveal the importance of routines: several participants mentioned washing hands, while they actually rinsed, as a reflex/habit associated with food handling in the kitchen environment.

In the quantitative survey, 50% of respondents declared that they were almost sure, certain, or practically certain that they would clean their hands immediately after touching chicken, with no difference between countries. This contrasted with the qualitative research results for Romania, Portugal, and France.

Washing hands after handling raw chicken requires access to materials, in particular, running water (Appendix 3D). One urban YSM in Norway and four households (EH and YF) in rural areas of Romania did not have running water in their kitchen, or had no kitchen (a gas stove, fridge and table were placed in a hall connecting the two rooms of the house). The Romanian participants rinsed their hands in the basin of water where they had rinsed chicken. The Norwegian YSM explained

that he would wash his hands more often if he had a sink in his kitchen.

The direct availability of soap is another issue. H el ene and Bernard (EH, U, FR) hid their soap and detergent in a drawer because they said they liked having a clear countertop and never used it. In contrast, Amandine (YF, R, and FR) had an electric soap dispenser over her sink and washed hands with soap seven times during food preparation.

Distributions of the duration of washing hands recorded during the qualitative study (Fig. 4) were not significantly different among countries (ANOVA,  $P > 0.05$ ). Hand washing was brief for some respondents. However, in France, Norway, and Portugal, the percentage of washing hands longer than the recommended 21 s was between 20% and 30%, higher than the percentage in the quantitative survey. For some participants, the duration of hand washing might be an unconscious routine.

Rinsing or washing hands after touching chicken was presented as a habit or was linked with the feeling of dirtiness or greasiness on hands (e.g., Mathilde (YF, U, FR), Appendix 3C) that needed to be removed. In Romania, only one participant (Bogdan (YSM, U, RO, Appendix 3 B) expressed knowledge that chicken could carry dangerous bacteria. He systematically rinsed his hands after touching chicken, but he never used soap. In Norway and the UK, most participants expressed safety concerns about chicken and knew that raw chicken could transmit dangerous bacteria (e.g., Paul (YF, U, UK) and Sahib (YSM, U, UK), Appendix 3B; Josh (YSM, U, UK) and Mary (EH, U, UK), Appendix 3A; Anna (YF, U, NO), Appendix 3C). These participants washed their hands with soap after handling chicken. In the UK, several research participants referred to media campaigns of the risk from chickens (Appendix 3E). Some participants who washed hands with soap (France and UK) after touching raw chicken mentioned safety training when working in the food sector.

### 3.3. Occasions of hand washing

To assess the importance of contact with raw meat among other occasions to wash hands, the quantitative survey asked respondents the following: “In general, when would you normally wash your hands at home?” The main reasons for washing hands were: “After going to the toilet” (81%); “After touching something dirty” (81%); “After touching raw meat or eggs” (71%) and “After mopping up spillages from poultry or eggs” (66%). Household type made a significant difference, especially for the reasons: “After going to the toilet” ( $X^2 = 209.37, P = 0.000$ ) and “After touching something dirty” ( $X^2 = 145.11, P = 0.000$ ). The proportion of EH declaring washing hands for all the reasons (from 64% to 95%) presented in the survey was significantly higher, while 54%–70% of the YF households and 48%–68% of YSM washed hands for these reasons.

In the qualitative fieldwork, we did not always observe hand washing after handling raw chicken. However, we observed several

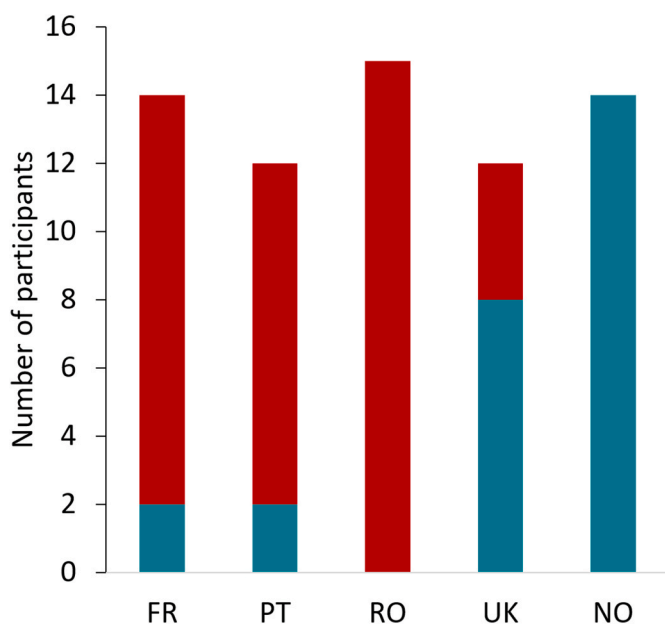


Fig. 3. Observed hand washing with soap immediately after touching raw chicken among participants by country. Results from the qualitative fieldwork. Green/light bars: participants who washed hands with soap. Red/dark bars: participants who rinsed hands with water, or only wipe hands or did nothing. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

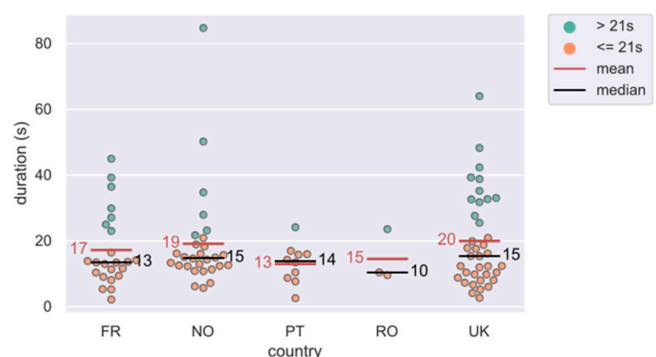


Fig. 4. Duration of washing hands during food preparation among participants in five countries. Results from the qualitative fieldwork.

other occurrences of washing hands during food preparation (Table 1).

In France and Portugal, participants sometimes did not wash hands with soap after handling raw chicken. However, they did so for other reasons that included before starting to cook, after touching the waste bin and after blowing their nose. Amandine (YF, R, FR) washed hands with soap when starting food preparation, and each time after she touched the waste bin and her phone screen, and when she blew her nose. However, she did not wash her hands after touching raw chicken. In the UK, although many research participants washed hands with soap after touching the chicken, hand washing was mainly done after touching the waste bin. Participants also washed their hands with soap each time they touched a pet (once in Norway and France and twice in Portugal). Julie (YF, U, and FR) wiped hands on a towel after manipulating the raw chicken. The only occasions she washed hands was after taking the cat off the countertop and after disposing of waste. She identified the need for hand washing after these actions, but not after touching raw chicken. Filipa (YF, U, and PT) did not wash or rinse her hands after handling raw chicken. She washed hands with antibacterial soap during food preparation on two occasions, both after touching her dog.

The findings suggest that most participants from France, Norway, Portugal, and the UK were aware that it is important to wash hands with soap for hygiene purposes after touching something they identified as a source of contamination. However, participants from France and Portugal usually did not wash their hands after handling raw poultry. This highlighted the fact that raw chicken was not necessarily identified as a source of contamination in these countries.

#### 4. Discussion and conclusion

Both the survey questionnaire and qualitative research indicated that the majority of consumers touched raw chicken with bare hands during preparation. Only a minority developed specific strategies to avoid this contact. These strategies were not always followed throughout the process. Presumably, the routine of using their hands diverted attention

**Table 1**

Occurrences of washing hands with soap during food preparation from the video recorded observations in the qualitative fieldwork.

	France	Norway	Portugal	Romania	UK
<b>Observed participants who washed hands with soap/total participants</b>	<b>10/15</b>	<b>14/15</b>	<b>8/13</b>	<b>2/15</b>	<b>12/14</b>
<b>Total occurrences of washing hands with soap</b>	<b>23</b>	<b>28</b>	<b>10</b>	<b>3</b>	<b>37</b>
<i>Events during food preparation</i>					
Before starting	7	1	4	1	5
<i>In relation to chicken</i>					
After manipulating raw chicken	2	12	2	0	9
After manipulating materials, packaged, in contact with raw chicken	0	0	1	0	2
After manipulating cooked chicken	1	0	0	0	0
After touching raw vegetables	0	1	0	1	5
After manipulating food containers	0	1	0	0	1
<i>In relation to kitchen hygiene</i>					
After touching bin	6	7	0	1	10
After cleaning, wiping surfaces, dishes	1	2	1	0	1
After putting dishes in the dishwasher or the sink	2	1	0	0	3
After checking phone	1	2	0	0	0
After blowing nose	2	0	0	0	0
After manipulating pet	1	1	2	0	0
At the end of preparation	0	0	0	0	1

from the original strategy. Consistently, hand washing with soap was usually needed to mitigate the risk of cross-contamination.

The qualitative study revealed that hand washing after touching chicken is not a systematic practice in the different countries. All participants did so in Norway, most in the UK, few in France and Portugal, and none in Romania. Low rates of actual washing hands after handling raw chicken have been observed in other studies. In a study in Wales (UK) involving a model kitchen, only 10% of 100 older adults adequately washed their hands immediately after handling raw chicken (Evans & Redmond, 2018). In the Netherlands, only 25% of participants washed their hands with soap (Van Asselt, Fischer, De Jong, Nauta, & De Jonge, 2009). In contrast, in the United States, proper hand washing was observed in 40% of respondents after handling chicken breast (Maughan et al., 2016).

Washing hands with water and soap is an effective way to eliminate pathogens that may be present on the hands (CDC, 2020). Our study shows that this knowledge is not necessarily shared and is certainly not applied everywhere. Proper hand washing after touching chicken was not observed in the Romanian households and in only a few of the French and Portuguese households. However, 50% of the respondents declared that they were almost sure, certain, or practically certain to wash hands after handling chicken, with no difference between countries. Similarly, in previous observational studies, respondents most often declared that they actually washed their hands properly after manipulating chicken, but did not do so when observed. Results from a survey in South Africa showed that although at least 85% respondents were concerned about the safety risks with chicken meat, a large proportion of respondents did not wash their hands properly before (31%) and after (36%) handling raw chicken (Katiyo et al., 2019). In the US, 84% respondents reported that they always washed their hands before preparing food, whereas <16% participants correctly performed hand-washing (Moore et al., 2019). Similarly, in a study in the US, all the respondents declared in the questionnaires that they washed their hands before and after handling raw chicken, while washing hands was done properly only 12% of the time (Mazengia et al., 2015). The findings may indicate a difference between normative knowledge or intention, and actual practices. When asked about practices, respondents are likely to select the answer they know is right or they think they ought to be doing (here regarding hygiene), or they believe they do. However, this is not necessarily reflected in their actions where barriers and routines interfere. Quantitative surveys represent a way to collect normative knowledge (Redmond & Griffith, 2003), and the results from qualitative and quantitative approaches allow us to study different dimensions of representations (Caillaud & Flick, 2016).

The action of hand washing is linked to the available materials to wash hands, what hand washing means to respondents and participants and the fact that chicken is perceived as a risky health product or a dirty product. In our study, Romanians presumably have knowledge that is out of step with their practices, which face barriers that include the availability of water or kitchen equipment. Romanians, French and Portuguese consumers may also have false knowledge of safe ways to clean hands, considering rinsing with water to be sufficient. For French and Portuguese consumers, touching raw poultry was presumably not perceived as risky, unlike other actions, such as touching the waste bin, blowing the nose and touching pet, which were followed by hand washing with soap.

This variety of actions is associated with a variety of routines that are reasoned or not. The choice of meat (whole chicken, cut pieces), recipe (whole cooked chicken, chicken purchased whole and cooked in pieces, meat from which the skin was removed for cooking) led to more manipulation and potential cross-contamination. Rinsing chicken is another routine that leads to hand-raw chicken contact. In a study conducted in the UK (Evans & Redmond, 2018), 20% older participants rinsed the raw chicken under running cold water, similar to the 20% UK respondents who declared that they rinsed chicken in our study. Washing hands with soap after touching raw chicken was presented as a

routine practice and not an action specific to handling of raw chicken, by some participants. In contrast, it was specific to chicken for others, for a hygienic reason (mostly in Norway and UK) or because of unpleasant feelings on hands. Most participants from Portugal, Romania, and France routinely rinsed their hands instead of washing them with soap, without expressing a reason for this practice. The exceptions were two elderly French participants who explained that using soap would be excess of hygiene in this situation, compared to going to the toilet, reinforcing the assumption that raw chicken was not perceived as risky by these French consumers.

Qualitative research revealed important differences among countries in the perception of risks associated with raw chicken. The most obvious reason is the actual knowledge of the risk, which is probably linked to the existence of effective campaigns on the health risks associated with handling chicken. These campaigns have been run in Norway and the UK. In France, food safety is assumed. Concerns instead are linked to nutritional risks (Laporte, 2019). In addition, perceptions of the various food safety risks differed among EU countries (Eurobarometer, 2019). French consumers were mostly aware of pesticides in food, whereas food hygiene was paramount for UK consumers. The issue of food poisoning bacteria ranked 6th as a food safety concern in France, but was the 2nd ranked concern in the UK. Accordingly, a study (Didier, 2019) reported appreciable concern about pesticides among French consumers. More generally, education in food hygiene could explain the perceptions associated with different behaviours. Presently, this was evident at the country level (Norway and UK) and at the individual level (participants in the UK, Portugal, and France who were trained in hygiene practices in restaurants).

This knowledge will lead to strategies to avoid touching chicken, to wash hands or alternatively to a simplified strategy, such as choosing a trusted provider, such as supermarkets in Portugal (Brunel & Pichon, 2004). Moreover, the home is not perceived as a place at risk (Byrd-Bredbenner, Berning, Martin-Biggers, & Quick, 2013), which can explain why, despite consumers' awareness of the importance of hand washing as measured in the survey, observed practices revealed incomplete or absent hand washing.

Our study shows that the practice of washing hands after handling raw chicken varies in several European countries. These differences may reflect knowledge, routines, materials, and risk perception. Countries should consider these dimensions when formulating food safety communication policies.

#### CRediT authorship contribution statement

**Pierrine Didier:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization. **Christophe Nguyen-The:** Conceptualization, Validation, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization. **Lydia Martens:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – review & editing, Supervision. **Mike Foden:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – review & editing, Supervision. **Loredana Dumitrascu:** Formal analysis, Investigation. **Augustin Octavian Mihalache:** Formal analysis, Investigation. **Anca Ioana Nicolau:** Resources, Investigation, Writing – review & editing. **Silje Elisabeth Skuland:** Funding acquisition, Project administration, Methodology, Formal analysis, Investigation, Writing – review & editing. **Monica Truninger:** Formal analysis, Investigation, Writing – review & editing. **Luís Junqueira:** Writing – review & editing, Visualization. **Isabelle Maitre:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization.

#### Declaration of competing interest

None.

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#### Appendix 1 2 3. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodcont.2021.108062>.

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