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► To cite this version:

Pierrine Didier, Christophe Nguyen-The, Lydia Martens, Mike Foden, Loredana Dumitrascu, et al.. Washing hands and risk of cross-contamination during chicken preparation among domestic practitioners in five European countries. *Food Control*, 2021, 10.1016/j.foodcont.2021.108062 . hal-03164574

HAL Id: hal-03164574

<https://hal.science/hal-03164574>

Submitted on 15 Mar 2021

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Journal Pre-proof

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PII: S0956-7135(21)00200-0

DOI: <https://doi.org/10.1016/j.foodcont.2021.108062>

Reference: JFCO 108062

To appear in: *Food Control*

Received Date: 14 December 2020

Revised Date: 23 February 2021

Accepted Date: 4 March 2021

Please cite this article as: Didier P., Nguyen-The C., Martens L., Foden M., Dumitrascu L., Mihalache A.O., Nicolau A.I., Skuland S.E., Truninger M., Junqueira L. & Maitre I., Washing hands and risk of cross-contamination during chicken preparation among domestic practitioners in five European countries, *Food Control*, <https://doi.org/10.1016/j.foodcont.2021.108062>.

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CRediT author statement

Add after you name the terms that best describe your contributions (see list of terms and definitions in the table below)

Pierrine Didier: conceptualization, methodology, validation, formal analysis, investigation, resources, writing original drafting, writing-review and editing, visualization. **Christophe Nguyen-The:** conceptualization, validation, formal analysis, investigation, resources, writing original drafting, writing-review and editing, visualization. **Lydia Martens:** conceptualization, methodology, validation, formal analysis, investigation, resources, writing-review and editing, supervision. **Mike Foden:** conceptualization, methodology, validation, formal analysis, investigation, resources, writing-review and editing, supervision. **Loredana Dumitrascu:** formal analysis, investigation. **Augustin Octavian Mihalache:** formal analysis, investigation. **Anca Ioana Nicolau:** resources, investigation, writing-review and editing. **Silje Elisabeth Skuland:** funding acquisition, project administration, methodology, formal analysis, investigation, review and 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 drafting, writing-review and editing, visualization.

Term	Definition
Conceptualization	Ideas; formulation or evolution of overarching research goals and aims
Methodology	Development or design of methodology; creation of models
Software	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components
Validation	Verification, whether as a part of the activity or separate, of the overall replication/ reproducibility of results/experiments and other research outputs
Formal analysis	Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data
Investigation	Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools
Data Curation	Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse
Writing - Original Draft	Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)
Writing - Review &	Preparation, creation and/or presentation of the published work by those from

Term	Definition
Editing	the original research group, specifically critical review, commentary or revision – including pre-or postpublication stages
Visualization	Preparation, creation and/or presentation of the published work, specifically visualization/ data presentation
Supervision	Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team
Project administration	Management and coordination responsibility for the research activity planning and execution
Funding acquisition	Acquisition of the financial support for the project leading to this publication

Journal Pre-proof

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

3
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18 Declarations of interest: none

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25

26 ABSTRACT

27 Nearly 40% foodborne outbreaks in the European Union are attributable to food practices in
28 domestic homes that include handling and preparation of raw chicken. Hand washing is an
29 important way to prevent cross-contamination with pathogens during chicken preparation.

30 This study, which is part of the EU Horizon 2020 funded consortium SafeConsume, aimed at
31 quantifying and understanding hand washing practices in three categories of households and

32 five European countries. A quantitative survey (n=1889) was combined with qualitative

33 research, during which 75 participants from France, Norway, Portugal, Romania, and the

34 United Kingdom were observed and interviewed. An original method for analysing video

35 with “The Observer XT” software was developed to identify when and how risk arises. The

36 quantitative survey and qualitative research data revealed that touching raw chicken was

37 more frequent in Romania and Portugal. Practices to avoid touching raw chicken were

38 declared and observed, although observations revealed that these practices were not always

39 consistently followed. Only a third of the participants washed their hands with soap after

40 handling raw chicken with important variations among countries (a majority in Norway and

41 in the UK, a few in France and Portugal, none in Romania), in contrast to the results of the

42 survey. Observations and interviews suggested that rinsing hands with water only and

43 washing hands with soap are considered equivalent by many people. Barriers to washing

44 hands due to improper equipment were mainly observed in Romania. Washing hands after

45 touching raw chicken was motivated by food safety concerns for some participants in

46 Norway and the UK, but not in France and Portugal, where it was motivated by unpleasant

47 feelings on hands, or presented as a habit. Participants not washing their hands after

48 touching the chicken did it after other actions they presumably perceived as unsafe (e.g.

49 touching the bin, handling pets, and blowing the nose), indicating that they did not
50 specifically consider touching raw chicken as risky. Knowledge, habits, and equipment with
51 regard to chicken and hand washing differed among European countries, resulting in safe
52 and risky practices.

53 KEYWORDS: Consumer, kitchen, food safety, soap, habits, practices

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56 1/ INTRODUCTION

57 *Campylobacter* and *Salmonella* are the first and second most frequently declared foodborne
58 zoonoses in the European Union (EFSA, 2019). These two bacteria are particularly prevalent
59 in raw chicken meat. In 2018, this food category was most frequently contaminated with
60 *Salmonella* and *Campylobacter* in the EU, with 7% and 37.5% positive samples, respectively
61 (EFSA, 2019). EFSA estimated in 2010 (EFSA, 2010) that 20% to 30% campylobacteriosis was
62 caused by handling, preparation and consumption of chicken meat in households. In France,
63 *Campylobacter* and *Salmonella* are the two foodborne pathogens with the highest impact on
64 public health, representing approximately 32% of the total foodborne disease burden.
65 Infections caused by cross-contamination from raw poultry meat were estimated to
66 represent 3% to 29% (90% confidence interval) for *Campylobacter* and 0.1% to 4.7% for
67 *Salmonella* (Augustin et al., 2020). This indicates that the risk of cross-contamination from
68 raw poultry is particularly critical for public health in the case of *Campylobacter*, and less so,
69 but still significant, for *Salmonella*.

70 During the investigation of a *Campylobacter* outbreak in a restaurant that caused 17
71 infections in the 51 patrons, Brown et al. (Brown, Kidd, Riordan, & Barrell, 1988) observed
72 that the chef did not always wash his hands between handling raw chicken carcasses and
73 cooked foods. The authors also experimentally demonstrated the transfer of *Campylobacter*
74 from naturally contaminated raw chicken meat to hands and from hands to cooked foods.
75 The transfer of *Campylobacter* and *Salmonella* from raw meat to hands and from hands to
76 salads has since been conclusively confirmed (Carrasco, Morales-Rueda, & Garcia-Gimeno,
77 2012; De Boer & Hahné, 1990; Luber, Brynestad, Topsch, Scherer, & Bartelt, 2006; Oscar,
78 2013; Ravishankar, Zhu, & Jaroni, 2010; Verhoeff-Bakkenes, Beumer, de Jonge, van Leusden,
79 & de Jong, 2008).

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

86 The surfactant action, friction and final rinsing in water involved in washing hands with soap
87 can effectively reduce microbial load from the outer layer of skin (Foddai, Grant, & Dean,
88 2016; WHO, 2009). Thus, hand washing is particularly suited to limit the hand-transfer of
89 pathogens. Hand washing with soap is much more efficient than rinsing with water alone,
90 regardless of the water temperature (Courtenay et al., 2005; Monaghan & Hutchison, 2016),
91 particularly in the presence of meat debris (Jensen, Danyluk, Harris, & Schaffner, 2015).

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

97 A practice can be understood as a sequencing of actions guided by three basic and
98 interconnected elements: materials (including nature, objects, tools, and resources), images
99 (including meanings, understandings, and purposes), and skills (competence, expertise, and
100 technique) (Shove, Pantzar, & Watseon, 2012; Truninger, 2011). Theories of practice
101 emphasise the practicality of everyday social life in which routines, rather than reflexivity,
102 are paramount. Therefore, it is particularly suitable to analyse food preparation and kitchen
103 routines. Previous studies on food safety in home kitchens have shown how consumers

104 clean kitchens, surfaces, homes and wash hands using observational methods. Some studied
105 incorporated videotaping. The studies consistently showed that actual practices were not
106 consistent with recommended practices, especially for washing hands, which was rarely
107 correct (Evans & Redmond, 2018; Maughan et al., 2016; Mazengia, Fisk, Liao, Huang, &
108 Meschke, 2015; Moore, Sweet, Harrison, & Franck, 2019). All these studies were conducted
109 in one country only, mostly in the UK, Northern Ireland, and the US (Redmond & Griffith,
110 2003).

111 This paper is part of a larger research project (safeconsume.eu), which aims to investigate
112 the links between consumer food handling and the risks of foodborne diseases in Europe.
113 The aim of the work presented in this paper is to develop an understanding of hand washing
114 practices during chicken preparation in five European countries, drawing on insights from a
115 mixed methods analysis. Three categories of consumers are considered: elderly households
116 and families with infants who are at higher risk of falling ill with campylobacteriosis and
117 salmonellosis (ECDC) and young men who are less likely to follow food safety
118 recommendations (Katiyo, de Kock, Coorey, & Buys, 2019; Murray et al., 2017). We
119 conducted a complementary approach, which involved a wide-scale survey of the declarative
120 practices of touching raw chicken and washing hands during chicken preparation, and a
121 qualitative study at home analysing videos and interviews collected during the preparation
122 of chicken. We identified when and how consumers washed hands, considering the three
123 dimensions of practices: materials/equipment, skills/competencies, and knowledge/beliefs
124 (Shove, et al., 2012; Truninger, 2011).

125 The originality of our study lies in the fact that it offers a comparative analysis of five
126 European countries, using a mixed methods approach with similar categories of 'at risk'
127 participants and food handling practices. Furthermore, it combines observations of

128 participants' practices of washing hands, how and when they did it, with their perceptions
129 and reasoning and uses video materials to identify action sequences that can lead up to, and
130 that follow, handwashing.

131

132 2/ MATERIAL AND METHODS

133 2.1 / Quantitative survey

134 The SafeConsume quantitative online survey was conducted from December 2018 to April
135 2019. The survey measured declared consumer food handling practices in a standardised,
136 quantitative, and cross-nationally comparable manner. The recruitment was subcontracted
137 to a professional survey provider administering a large consumer panel worldwide (formerly
138 Research Now SSI, now Dynata). The population sample of households was selected by
139 stratified random sampling based on the Nomenclature of Territorial Units for statistics level
140 2 (NUTS2) of the respective country (Eurostat, 2021) and the education level of the target
141 respondent (Møretrø et al., 2021).

142 Those who carried the main or shared responsibility for food shopping in the household
143 were invited to participate and were referred to as respondents. Survey data were collected
144 from ten countries, from which we extracted data from the five countries where the
145 qualitative research was conducted to allow comparison: France (432 respondents), Norway
146 (344 respondents), Portugal (310 respondents), Romania (358 respondents) and the UK (445
147 respondents). Only the three pre-identified groups of young single men (YSM, <30 years of
148 age living alone or in shared housing; 6% of respondents), young families (YF, households
149 including at least one pregnant woman or one child <6 years of age; 44% of respondents
150 with 44% of pregnant women) and elderly households (EH, >65 years of age; 49% of
151 respondents). The profiles of the 1889 respondents are presented in Appendix 1. All

152 respondents were informed about their data protection and guaranteed anonymity. We
153 refer to the respondents for the quantitative survey.

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

167 2.2 / Recruitment and methodology of the qualitative study

168 Transdisciplinary qualitative research was performed between September 2017 and July
169 2018 in five countries (France, Norway, Portugal, Romania, and the UK). We conducted
170 observational work and semi-structured qualitative interviews with 75 households (15 in
171 each country). Each research team obtained ethical and/or data protection approval
172 depending on the national rules in their respective countries. The aforementioned EH, YF
173 and YSM households were recruited from the general public by a professional service
174 provider (Norstat Norge AS, Oslo, Norway) working with local recruiters in each country.
175 Another recruitment criterion was for the participant to purchase, cook, and eat chicken at

176 home. We also chose households with different education and income levels, living in rural
177 and urban residential areas (Appendix 2). Informed consent was obtained from all
178 participants at the start of the study. The research included two visits. The first visit involved
179 food shopping, grocery packing, transportation, and the storage of purchases at home. The
180 second visit occurred several hours or days after the first visit and took place at the
181 participants' homes. A social scientist and microbiologist observed the participant preparing
182 a meal with chicken and a salad. The participants selected the recipe. The advice they
183 received was to prepare a dish they regularly cooked. Social scientists have conducted
184 observations using the *go-along* methodology (Kusenbach, 2003; Pink, 2007). This technique
185 allows ethnographers "to observe their informants' spatial practices *in situ* while accessing
186 their experiences and interpretations at the same time" (Kusenbach, 2003). Semi-structured
187 interviews were conducted to solicit responses concerning habits of food storage,
188 preparation and consumption, and knowledge about food safety and hygiene.

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

193

194 2.3 / Collection and exploitation of the qualitative study data

195 The social scientist audio- and video-recorded the food preparation with a handheld camera.
196 Emphasis was on actions with the hands. The 90 hours of video recording of every
197 participant's actions concerning their frequency, duration and chronological visualisation
198 were analysed using "The Observer XT" software. We counted occurrences of specific
199 behaviours performed in a specific order. An example is the sequence of 'washing hands

200 with soap' after 'touching raw chicken'. The durations of each behaviour were timed.
201 ANOVA on washing hands with soap duration was performed with XLSTAT software
202 (Addinsoft). We also analysed audio-recorded conversations during food preparation and
203 semi-structured interviews.

204 To analyse the results, we applied a theory of practice approach that encourages analysis of
205 the materials, equipment, skills, competencies, knowledge, beliefs and their interactions, as
206 these are performed by participants (Martens & Scott, 2017; Meah & Watson, 2011; Sutton,
207 2006; Torkkeli, Mäkelä, & Niva, 2018; Truninger, 2011).

208

209 3/ RESULTS

210 3.1 / Touching raw chicken during food preparation

211 The survey questionnaire allowed us to quantify chicken handling using bare hands. The
212 question "How likely is it that you would touch the chicken with your bare hands when you
213 take it out of its packaging?" was evaluate on an 11-point scale from "no chance or almost
214 no chance" to "practically certain or certain." The mean (M) score of 7.6 (standard deviation,
215 SD=3.2) was between 7 ("Good possibility") and 8 ("Probable"). The mean scores differed
216 depending on the country (F=2.86, P=0.0223) or the type of household (F=4.86, P=0.0078).
217 The interaction country per household type was not significant (F=1.69; P=0.0969), which
218 indicated that the rankings between countries were found in all types of households and *vice*
219 *versa*. Respondents in the UK (M=7.26, SD=0.23) and Norway (M=7.30, SD=0.24) declared a
220 "Good possibility" and "Probable" likelihood that they would touch chicken with their bare
221 hands. These findings differed from the results of Romanian (M=8.09, SD=0.26) and French
222 (M=8.19, SD=0.27) households ("Probable" to "Very probable"). Portuguese households
223 were at an intermediate level (M=7.52, SD=0.43). Respondents with YF (M=7.33, SD=0.12)

224 were less likely to touch raw chicken with their hands than elderly respondents (M=7.86,
225 SD=0.12).

226 Figure 1 about here

227 In the quantitative survey, answers to the question “Typically, do you touch the chicken with
228 your bare hands when preparing it?” indicated that the most frequent occasions for
229 touching the chicken were during cutting (43% of respondents) and moving it to a bowl
230 (33%) (Figure 1), followed by seasoning (25%) and rinsing (28%). There were significant
231 differences between the countries concerning the manipulation of chickens with bare hands.
232 A majority (62%) of Romanians stated that they touched chicken when cutting it compared
233 to only 30% and 36% French and Norwegian respondents, respectively. The most frequently
234 reason cited by Romanians was seasoning (62%). This reason was less frequent for
235 respondents from other countries. Rinsing chickens was a reason for hand-chicken contact
236 for 48% Romanian respondents compared to 39%, 26%, and 20% respondents from Portugal,
237 Norway, and the UK, respectively. Only 12% French respondents declare this practice
238 ($\chi^2=162.98$, $P=0.000$). Only 17% respondents stated that they did not touch chicken with
239 their hands during preparation, with no significant differences between countries. Twenty
240 percent of the YF households, 17% YSM, and 14% EH avoided touching chicken with bare
241 hands ($P=0.0040$). Materials used to manipulate raw chicken were mostly a fork and gloves
242 (Figure 1), although wearing gloves does not replace the need for hand washing (CDC, 2020).
243 The majority of participants (67) who were observed preparing chicken at home during the
244 qualitative research touched raw chicken with their hands during the preparation or transfer
245 to a dish or a pan. Hand-chicken contact frequently occurred during trimming and cutting
246 chicken portions in all countries. In Romania and Portugal, the contact was also frequent
247 when removing skin from chicken and when cutting whole chicken into pieces, consistent

248 with the survey responses (45% Portuguese respondents and 62% Romanian respondents).
249 Other observed reasons for touching raw chicken with bare hands were to spread oil and
250 condiments (all countries, as in the survey), stuffing the gut cavity of whole chicken with
251 herbs (France) and eviscerating the chicken (Romania and France) (Appendix 3A). For 14
252 research participants in France, Norway, and the UK, hand-chicken contact was very brief
253 and was limited to the transfer of chicken breasts, chicken legs, or whole chicken from their
254 packages to cooking devices. These variations were linked to differences in skills and
255 competences (e.g., diversity in recipes meant chicken-hand contact was necessarily diverse),
256 routines (e.g., habitual trimming and skin removal), beliefs (e.g., skin removal for health- and
257 safety-related reasons), materials (e.g., preparing home-grown chicken entailed slaughter,
258 evisceration and washing, in addition to cooking, with associated use of relevant tools,
259 materials and resources) and combinations of these practices. For instance, skills and
260 materials were both involved when a whole chicken was purchased for a recipe requiring
261 chicken pieces, necessitating chopping of raw chicken at home.

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

265 Few research participants protected their hands to avoid direct contact with raw chicken,
266 such as using a kitchen roll paper, packaging as a glove or forks (one YF each in Portugal and
267 the UK, one YSM in the UK and three EH each in Norway and the UK; Appendix 3A). These
268 findings were consistent with the survey findings, where consumers in the UK were most
269 likely to declare avoiding touching raw chicken. However, one UK participant took great care
270 to avoid touching the chicken during some preparation steps, but used his bare hands during
271 other steps (Appendix 3A). Two YSMs from France and Norway did not touch raw chicken

272 without strategies to protect their hands, using a combination of skills (using simple recipes)
273 and materials (purchasing chicken products adapted to the recipes used) (Appendix 3A).
274 Knowledge of the risks of raw chicken was not addressed in the quantitative survey, but was
275 discussed during the qualitative research. In Portugal, Romania, and France, participants
276 rarely expressed concerns about the safety of chicken meat. When there was concern, it was
277 mostly associated with storage (freshness and short storage time), need to keep it cold,
278 cooking issues (thorough cooking), contamination by butchers and contaminants like
279 hormones (Appendix 3B and 3C). The risk of hand-to-chicken cross-contamination was not
280 mentioned. These participants touched chicken with bare hands. The perceived risk of
281 hormones by one respondent (Maria-Celeste) prompted her to remove skin of the raw
282 chicken. This increased hand-chicken contact, and the risk of cross-contamination. Among
283 participants who did not touch chicken with bare hands, two (one YF in Portugal and one YSM in UK)
284 explained they got food safety training when working in the food sector.

285 3.2 / Hand cleaning following raw chicken handling

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

295 Figure 2 about here

296 According to the quantitative survey, the most frequent ways of cleaning hands were regular
297 (34%) and antibacterial soap (29%). Nineteen percent of respondents paid attention to the
298 recommended 21 s minimum time for hand washing (Figure 2). There were differences
299 between countries for all items, especially in the use of cold ($\chi^2=51.8$, $P=0.000$) and warm
300 ($\chi^2=54.6$, $P=0.000$) water, and the use of antibacterial soap ($\chi^2=81.97$, $P=0.000$). Portuguese
301 respondents were more likely to clean their hands with cold water, whereas Norwegian and
302 Romanian respondents more often cleaned with hot water. Romanian (40%) and Norwegian
303 (44%) respondents also declared cleaning hands more often with regular soap. Antibacterial
304 soap was more frequently used in UK households than in other countries. Living in urban or
305 rural areas or educational qualifications did not make a difference.

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

313 Figure 3 about here

314 We observed that the majority of participants (red in Figure 3) did not wash their hands with
315 soap after handling raw chicken. The clear exception was Norway, where all participants
316 who touched raw chicken washed their hands with soap after a brief period during which
317 nothing was touched. In the UK, 8 of 12 participants washed their hands after handling the
318 raw chicken. In France, Portugal, and Romania, few participants washed their hands after
319 handling raw chicken. Some, like Dumitra (EH, R, RO), did not wash, rinse, or wipe hands

320 during or after preparing the chicken. On several occasions, there was contact between
321 hands and water while the chicken was rinsed, which may have been interpreted as hand
322 washing, as expressed by Maria-Celeste (EH, U, PT, Appendix 3C). Fabrice (YSM, U, FR)
323 explained he would 'wash' hands after touching food as a reflex, but he actually rinsed hands
324 after cutting raw chicken. Bogdan (YSM, U, and RO) knew that chicken can transmit
325 pathogenic microbes that can be removed by washing, but he rinsed and did not wash hands
326 after touching raw chicken. Bernard (EH, U, FR) and Sylviane (EH, R, FR) explained that they
327 would often 'wash' hands in the kitchen, but they were not observed using soap. These
328 observations highlight the ambiguity of the concept of "wash" in the common vocabulary. It
329 did not imply the use of soap for all participants and revealed a lack of knowledge of the
330 importance of soap when washing hands. The findings also reveal the importance of
331 routines: several participants mentioned washing hands, while they actually rinsed, as a
332 reflex/habit associated with food handling in the kitchen environment.

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

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

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

348 Figure 4 about here

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

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

367 3.3 / Occasions of hand washing

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

378 In the qualitative fieldwork, we did not always observe hand washing after handling raw
379 chicken. However, we observed several other occurrences of washing hands during food
380 preparation (Table 1).

381 Table 1 about here

382 In France and Portugal, participants sometimes did not wash hands with soap after handling
383 raw chicken. However, they did so for other reasons that included before starting to cook,
384 after touching the waste bin and after blowing their nose. Amandine (YF, R, FR) washed
385 hands with soap when starting food preparation, and each time after she touched the waste
386 bin and her phone screen, and when she blew her nose. However, she did not wash her
387 hands after touching raw chicken. In the UK, although many research participants washed
388 hands with soap after touching the chicken, hand washing was mainly done after touching
389 the waste bin. Participants also washed their hands with soap each time they touched a pet
390 (once in Norway and France and twice in Portugal). Julie (YF, U, and FR) wiped hands on a
391 towel after manipulating the raw chicken. The only occasions she washed hands was after

392 taking the cat off the countertop and after disposing of waste. She identified the need for
393 hand washing after these actions, but not after touching raw chicken. Filipa (YF, U, and PT)
394 did not wash or rinse her hands after handling raw chicken. She washed hands with
395 antibacterial soap during food preparation on two occasions, both after touching her dog.
396 The findings suggest that most participants from France, Norway, Portugal, and the UK were
397 aware that it is important to wash hands with soap for hygiene purposes after touching
398 something they identified as a source of contamination. However, participants from France
399 and Portugal usually did not wash their hands after handling raw poultry. This highlighted
400 the fact that raw chicken was not necessarily identified as a source of contamination in these
401 countries.

402

403 4/ DISCUSSION AND CONCLUSION

404 Both the survey questionnaire and qualitative research indicated that the majority of
405 consumers touched raw chicken with bare hands during preparation. Only a minority
406 developed specific strategies to avoid this contact. These strategies were not always
407 followed throughout the process. Presumably, the routine of using their hands diverted
408 attention from the original strategy. Consistently, hand washing with soap was usually
409 needed to mitigate the risk of cross-contamination.

410 The qualitative study revealed that hand washing after touching chicken is not a systematic
411 practice in the different countries. All participants did so in Norway, most in the UK, few in
412 France and Portugal, and none in Romania. Low rates of actual washing hands after handling
413 raw chicken have been observed in other studies. In a study in Wales (UK) involving a model
414 kitchen, only 10% of 100 older adults adequately washed their hands immediately after
415 handling raw chicken (Evans & Redmond, 2018). In the Netherlands, only 25% of participants

416 washed their hands with soap (Van Asselt, Fischer, De Jong, Nauta, & De Jonge, 2009). In
417 contrast, in the United States, proper hand washing was observed in 40% of respondents
418 after handling chicken breast (Maughan, et al., 2016).

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

440 collect normative knowledge (Redmond & Griffith, 2003), and the results from qualitative
441 and quantitative approaches allow us to study different dimensions of representations
442 (Caillaud & Flick, 2016).

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

452 This variety of actions is associated with a variety of routines that are reasoned or not. The
453 choice of meat (whole chicken, cut pieces), recipe (whole cooked chicken, chicken purchased
454 whole and cooked in pieces, meat from which the skin was removed for cooking) led to more
455 manipulation and potential cross-contamination. Rinsing chicken is another routine that
456 leads to hand-raw chicken contact. In a study conducted in the UK (Evans & Redmond,
457 2018), 20% older participants rinsed the raw chicken under running cold water, similar to the
458 20% UK respondents who declared that they rinsed chicken in our study. Washing hands
459 with soap after touching raw chicken was presented as a routine practice and not an action
460 specific to handling of raw chicken, by some participants. In contrast, it was specific to
461 chicken for others, for a hygienic reason (mostly in Norway and UK) or because of
462 unpleasant feelings on hands. Most participants from Portugal, Romania, and France
463 routinely rinsed their hands instead of washing them with soap, without expressing a reason

464 for this practice. The exceptions were two elderly French participants who explained that
465 using soap would be excess of hygiene in this situation, compared to going to the toilet,
466 reinforcing the assumption that raw chicken was not perceived as risky by these French
467 consumers.

468 Qualitative research revealed important differences among countries in the perception of
469 risks associated with raw chicken. The most obvious reason is the actual knowledge of the
470 risk, which is probably linked to the existence of effective campaigns on the health risks
471 associated with handling chicken. These campaigns have been run in Norway and the UK. In
472 France, food safety is assumed. Concerns instead are linked to nutritional risks (Laporte,
473 2019). In addition, perceptions of the various food safety risks differed among EU countries
474 (Eurobarometer, 2019). French consumers were mostly aware of pesticides in food, whereas
475 food hygiene was paramount for UK consumers. The issue of food poisoning bacteria ranked
476 6th as a food safety concern in France, but was the 2nd ranked concern in the UK. Accordingly,
477 a study (Didier, 2019) reported appreciable concern about pesticides among French
478 consumers. More generally, education in food hygiene could explain the perceptions
479 associated with different behaviours. Presently, this was evident at the country level
480 (Norway and UK) and at the individual level (participants in the UK, Portugal, and France who
481 were trained in hygiene practices in restaurants).

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

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

492

493 ACKNOWLEDGMENTS

494 This work was supported by the Horizon 2020 project SafeConsume (Grant Agreement No.
495 727580). Joachim Scholderer and his team are acknowledged for designing and organizing
496 the consumer survey. We thank Flore Lourtioux, Rui Maia, Maria João Cardoso, Joana Feio,
497 Corina Neagu, Valerica Celmare, Răzvan Dinică, Therese Hagtvedt for their participation to
498 the fieldwork.

499

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637

638 **Table 1** - Occurrences of washing hands with soap during food preparation from the video recorded

639 observations in the qualitative fieldwork

	France	Norway	Portugal	Romania	UK
Observed participants who washed hands with soap/total participants	10/15	14/15	8/13	2/15	12/14
Total occurrences of washing hands with soap	23	28	10	3	37
<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

640

641

642

643 Figures Captions

644 **Figure 1** - Hand-chicken contact declared during food preparation. Results from the quantitative
645 survey in percentage per country. Fr: France, No: Norway, Pt: Portugal, Ro: Romania, UK: United-
646 Kingdom. *(print in color)*

647 **Figure 2** - How respondents declared cleaning and drying hands immediately after touching raw
648 chicken by country. Results from the quantitative survey in percentage per country. *(print in color)*

649 **Figure 3** – Observed hand washing with soap immediately after touching raw chicken among
650 participants by country. Results from the qualitative fieldwork. Green bars: participants who washed
651 hands with soap. Red bars: participants who rinsed hands with water, or only wipe hands or did
652 nothing. *(print in color)*

653 **Figure 4** – Duration of washing hands during food preparation among participants in five countries.
654 Results from the qualitative fieldwork. *(print in color)*

655

656

657 Figure 1

		countries				
		Fr	No	Pt	Ro	UK
	<i>number of respondents</i>	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
% per country	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

658

659

660 Figure 2

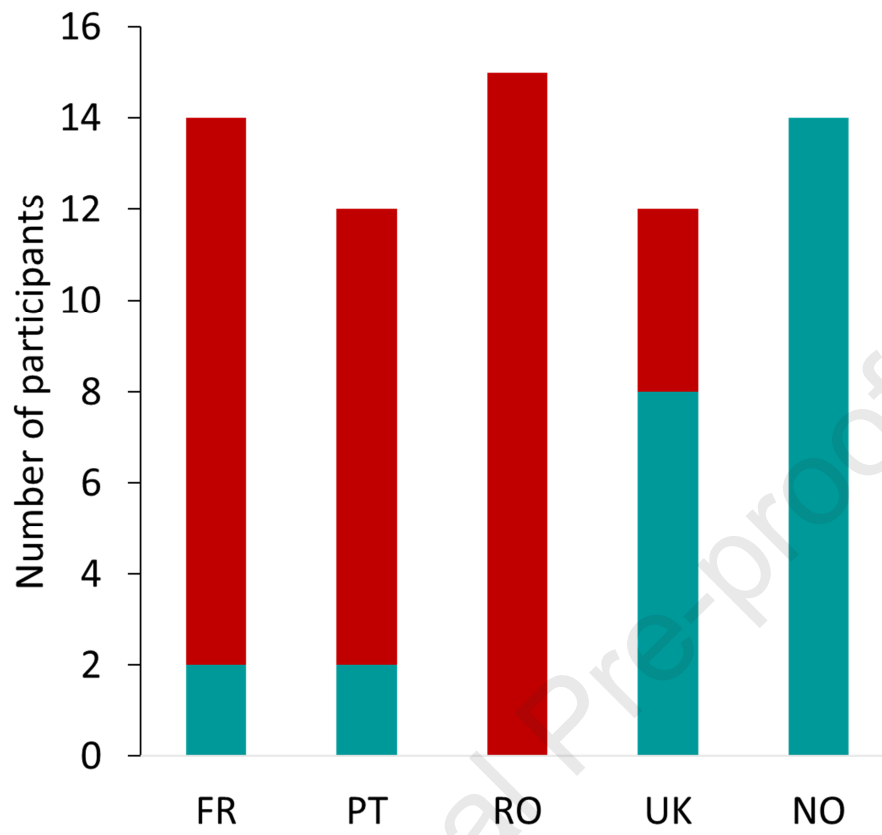
		countries				
		Fr	No	Pt	Ro	UK
	<i>number of respondents</i>	432	344	310	358	445
	cold water	10	7	16	8	6
	warm water	20	35	21	43	27
	running water	23	30	29	29	30
	with regular soap	29	44	28	40	31
% per country	with antibacterial soap	9	11	11	18	29
	make sure >21s	10	14	9	17	19
	dry with a cloth or towel	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

661

662

663 Figure 3

664



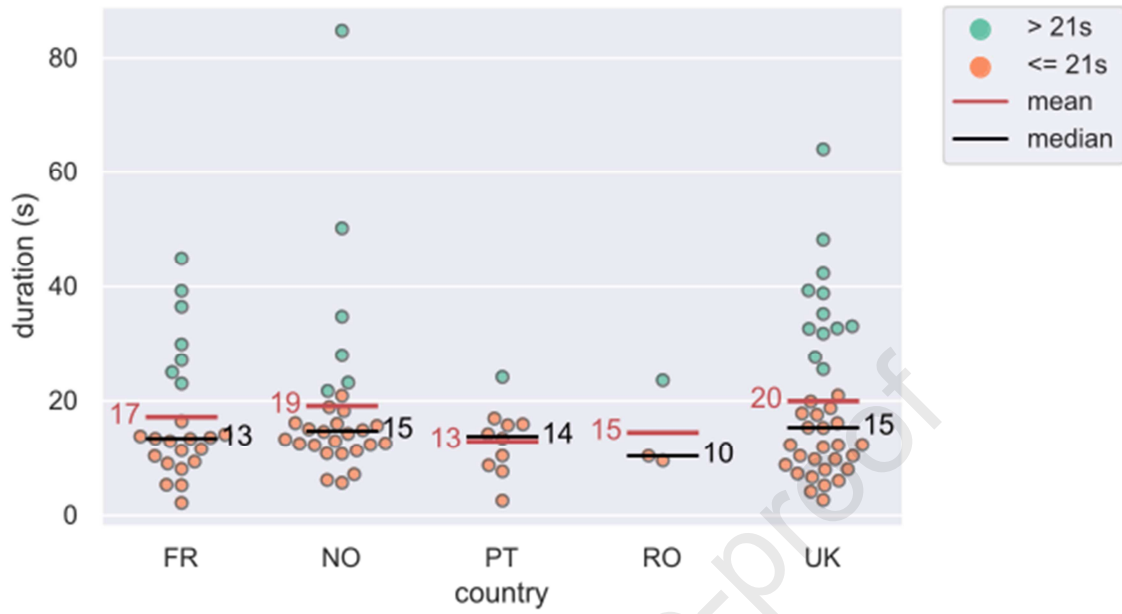
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668 Figure 4

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HIGHLIGHTS

- Differences among countries exist in the extend of touching raw chicken
- Washing hands with soap was more often observed in UK and Norway
- Washing hands was more often declared than observed in real situation
- Routines and barriers can prevent hand washing
- Routines, materials and knowledge were all involved in the observed practices

Conflict of interest form

Declarations of interest: none

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Submission of « Washing hands and risk of cross contamination during chicken preparation among domestic practitioners in five European countries »