

# Good food safety risk communication framework

Turnkey solutions for food chain safety authorities promoting  
multi-actor risk communication

**SAFE CONSUME**



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## 1 Introduction

Nowadays effective and credible food-related risk communication is far beyond informing the public about crises. Besides it establishing the basis for optimal consumer protection and improving the trust towards institutions dealing with risk assessment and management, successful risk communication also promotes the benefits of food and technologies, sustainable food consumption and production concerning food security, and gathering feedback for development in a broader sense. Authorities are in possession of first-hand, unique risk-related information and employ food safety specialists, therefore they should be the flagship of the risk communication activities on the subject and should support other actors. As the consumer trust in the information sources (namely the risk communicators) vary in different countries, a multi-actor risk communication policy model is recommended for ensuring the most widespread exchange of reliable information. Working with stakeholders and formulating a multi-actor risk communication policy model is therefore an efficient way of delivering information for risk mitigation.

Food safety-related consumer behaviour cannot be directly controlled by regulations, as authorities cannot audit the adequacy of food handling hygiene in private households. In order to impact consumer behaviour in private households, authorities apply risk communication tools to help people make more informed judgements about the food safety hazards and risks they face in their lives. Therefore, preventive risk communication toward consumers should be one of the most important responsibilities of food safety authorities. The Good food safety risk communication framework aims to support the work of risk communicators in governmental bodies responsible for the national food chain control. As the document summarises the evolutionary stages of food safety risk communication and helps the authorities to evaluate their current status, it can be a helpful tool to outline the possible ways of improvement on an institutional level. The framework also includes an easy-to-use risk communication toolbox, providing turnkey solutions and communication materials for the most frequently observed food safety-related consumer behaviours.



## 2 Evolution of food safety authorities' communication approaches

Risk management is contemporaneous with humanity, having different meanings over the centuries. The emergence of novel risks, new scientific findings and the recognition of the aspects of human risk perception paved the way for the evolution of food safety risk communication. Based on Kasza et al.<sup>1</sup>, the evolution of modern era food safety risk communication of authorities can be presented across five stages - focusing on the level of consumer involvement, the approach, the method, and the challenges of risk communication during the stages. As the more advanced risk communication models generally result in a more effective way of preventive and crisis communication, the modernity of the organisation's risk communication can be determined and upgraded based on the currently applied model. Despite the evolutionary process, the application of some previous models can be justified in certain risk management situations. It is important to note, that in practice, the different stages have no clear boundaries, and the models can overlap. An organisation can even move on to the next phase by skipping a previous evolutionary step.

### 2.1 The Pre-risk communication era - Rule of technocrats (before the 1980s)

In the beginning, as systematic - primarily preventive - risk communication did not exist, risk communication meant crisis management, aiming to minimise risks during a crisis<sup>2</sup>. However, the protection of human health was crucial even then, but it was targeted only by legislation and authority measures. During the pre-risk communication era, the public was ignored during the whole process of risk management, as long as the risk could be maintained at a tolerable level<sup>3 4</sup>.

### 2.2 The Deficit model - We know better what you need (the 1980s)

During the 1980s, our risk-related knowledge developed quickly, introducing novel chemical hazards (e.g., pesticide residues, polycyclic aromatic hydrocarbons, mycotoxins), which directed attention to the long-term effects of certain risks, therefore to the importance of risk communication also besides crisis situations. These findings indicated the adoption of some basic risk communication methods and principles from other sectors (e.g., from public health). Nonetheless, risk managers still considered that citizens are not capable of contributing to risk mitigation any other way than following the instructions of experts, because of their incompetence in understanding scientific explanations. In parallel, as an answer to the increasing social mistrust towards experts and science, risk-related initiatives started to narrow the "deficit gap" between citizens and experts. This principle is also supported by the

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<sup>1</sup> Kasza, G., Csenki, E., Szakos, D., & Izsó, T. (2022). The evolution of food safety risk communication: Models and trends in the past and the future. *Food Control*, 138, 109025.

<sup>2</sup> Heath, R. L., & O'Hair, H. D. (2010). *Handbook of risk and crisis communication*. Routledge.

<sup>3</sup> Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. *Risk analysis*, 15(2), 137-145. <https://doi.org/10.1111/j.1539-6924.1995.tb00308.x>.

<sup>4</sup> Covello, V., & Sandman, P. M. (2001). Risk communication: evolution and revolution. *Solutions to an Environment in Peril*, 164, 178.



presumption that consumers feel stronger sympathy for interventions that they have information about<sup>5</sup>. During this time, traditional one-way communication technologies were applied (e.g., press releases, fact sheets, open days and media events), also involving media representatives as a bridge, but for the time being only in passive form.

## 2.3 The Dialogue model - Inviting consumers to the table (the mid-1990s)

As the Deficit model did not solve the problem of social mistrust towards the scientific community, a novel approach was developed during the mid-1990s, which facilitated to the transformation of risk communication to be a bilateral process. During this time, plenty of research was published about risk perception and its essential role in understanding consumers' attitudes towards different risks<sup>6 7 8 9 10</sup>. In parallel, risk communication experts realised the importance of gathering information from the society, in the form of introducing basic public participation methods and consumer research (e.g., focus groups, surveys). Although the Dialogue model promoted consultation with consumers, it cannot be considered a genuine dialogue as the topic of the dialogues was still limited and initiated only by the experts. Consumers were only involved in the discussion at a certain point - according to the decision of the risk manager -, which often resulted that the invited representatives were not aware of future consequences of the pending topic. However, the novel risk communication principles introduced by the Dialogue model established the theory of public participation and were further developed in the next stages.

## 2.4 The Partnership model - From now on we do this together (the late 1990s to the 2010s)

The concept of the Dialogue model was revised several times during the 1990s and 2000s, aiming to approach public participation, which is designed to gather input for decision-making from those who will be affected by the decision. The main principle of the Partnership model is that even a lay consumer might deliver ideas and experiences that help experts and the authority to manage risks, therefore experts have to show a genuine interest in understanding consumer attitudes, motivations, perceptions and behavioural patterns. The democratisation of risk communication induced the introduction of novel public participatory methods and tools, such as citizens' juries, panels, consensus or search conferences, deliberative opinion polling and study groups<sup>11 12</sup>. Besides the collection of consumer feedback and experiences, the

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<sup>5</sup> Lewenstein, B. V. (2003). Models of public communication of science and technology.

<sup>6</sup> Wildavsky, A., & Dake, K. (1990). Theories of risk perception: Who fears what and why? *Daedalus*, 119(4), 41-60.

<sup>7</sup> Fischhoff, B., Bostrom, A., & Quadrel, M. J. (1993). Risk perception and communication. *Annual review of public health*, 14(1), 183-203.

<sup>8</sup> Weber, E. U., & Milliman, R. A. (1997). Perceived risk attitudes: Relating risk perception to risky choice. *Management science*, 43(2), 123-144. <https://doi.org/10.1287/mnsc.43.2.123>.

<sup>9</sup> Sjöberg, L. (1998). Worry and risk perception. *Risk analysis*, 18(1), 85-93. <https://doi.org/10.1111/j.1539-6924.1998.tb00918.x>.

<sup>10</sup> Hansen, J., Holm, L., Frewer, L., Robinson, P., & Sandøe, P. (2003). Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. *Appetite* 41(2), 111-121.

<sup>11</sup> Lewenstein, B. V. (2003). Models of public communication of science and technology.

<sup>12</sup> Rowe, G., & Frewer, L. J. (2000). Public participation methods: A framework for evaluation. *Science, technology, & human values*, 25(1), 3-29. <https://doi.org/10.1177/016224390002500101>.



different factors influencing human risk perception - identified by Fischhoff et al.<sup>13</sup>, voluntariness, immediacy, known to expose, know to science, controllability, newness, chronic or catastrophic nature of the risk, common or dread nature of the risk and severity of the consequences - were deeply studied and implemented in effective risk communication activities. Novel educational programs and preventive communication campaigns were launched this time, designed for the mitigation of certain risks. The institutionalised risk communication also roots back in this period, as institutions established dedicated units dealing with risk communication. Although the Partnership model involved stakeholders in the decision-making process from the beginning, the intention of fixing consumer behaviour still remained challenging as it requires active awareness from the consumers - also from those, who are not really interested in the certain topic.

## 2.5 The Behavioural insight model - If you can't change, live with it! (from the 2010s)

As the impact of the awareness-raising communication campaigns remained quite low, experts had to elaborate a novel approach to risk communication, which also considers the limits of human capacities and the irrational and hardly predictable consumer behaviour. The Behavioural insight model aims to “change people’s behaviour without changing their minds”<sup>14</sup>. A deeper understanding of consumer behaviour highlighted that human behaviour is strongly influenced by human nature, social environment<sup>15</sup>, consumer routines and misbeliefs. These findings open new horizons in risk mitigation practices<sup>16</sup>. After analysing human behaviour through observational studies (during shopping, food transporting, storage, cooking, eating, handling the leftovers etc.) easily-applicable solutions can be developed and integrated into consumer lifestyle without altering ingrained habits. In parallel, the application of creative media tools with behavioural insight elements (infographics, short videos, interactive applications, personalised tools etc.) can also contribute to effective and targeted risk communication.

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<sup>13</sup> Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy sciences*, 9(2), 127-152.

<sup>14</sup> Troussard, X., & van Bavel, R. (2018). How can behavioural insights be used to improve EU policy? *Intereconomics*, 53(1), 8-12. <https://doi.org/10.1007/s10272-018-0711-1>.

<sup>15</sup> Arcos Holzinger, L., & Biddle, N. (2016). Behavioural insights of tax compliance: An overview of recent conceptual and empirical approaches. Tax and Transfer Policy Institute - Working Paper, 8. <http://dx.doi.org/10.2139/ssrn.2854586>.

<sup>16</sup> Ueland, Ø. (2019). How to make risk communication influence behavior change. *Trends in Food Science & Technology*, 84, 71-73. <https://doi.org/10.1016/j.tifs.2018.02.003>.



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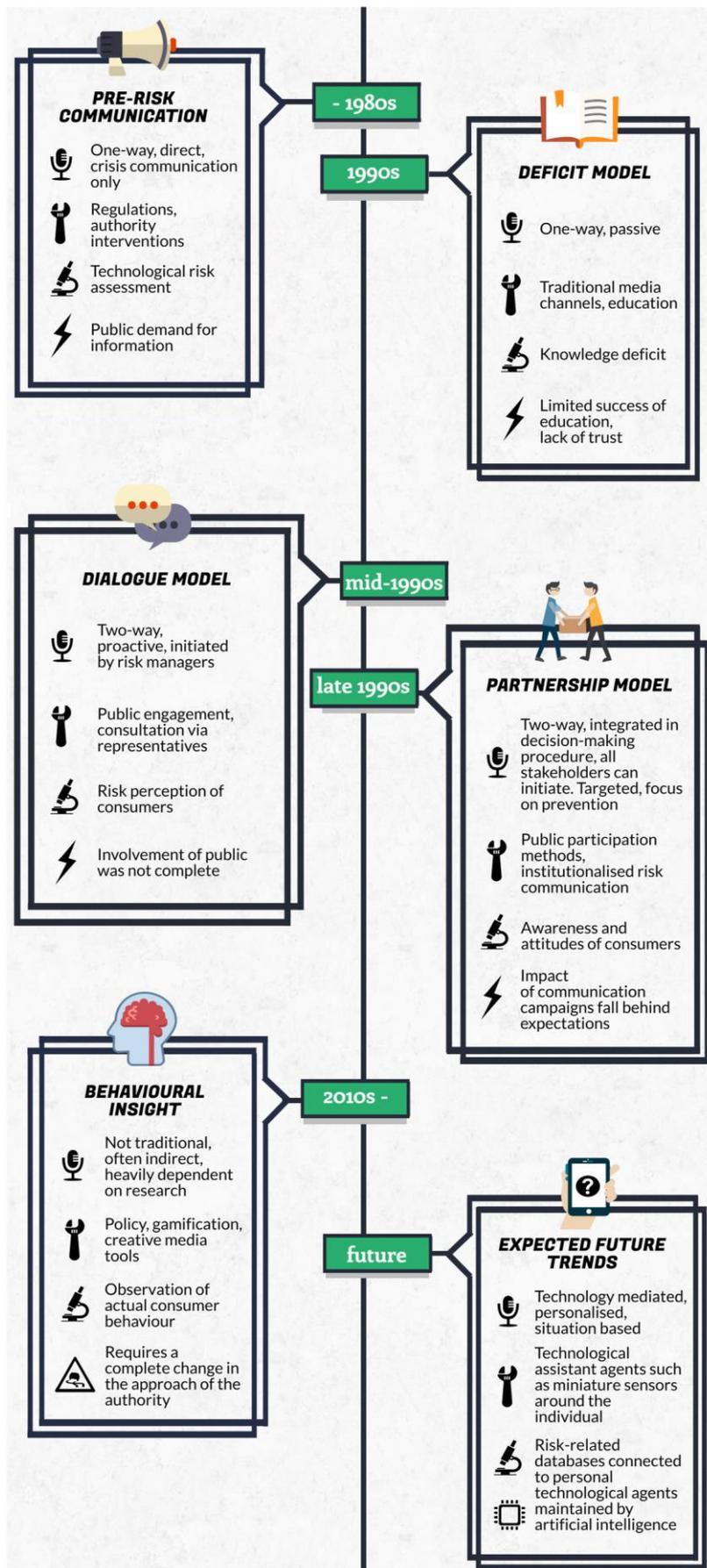


Figure 1. The evolution of food safety risk communication (Kasza et al., 2022)



## 3 Current situation of European and institutional food safety risk communication

In the previous session, we have presented the evolution of food safety risk communication models from the 1980s to nowadays, but the development of the applied model in everyday work on an institutional level cannot be identified within such a strict timeline. All organisations are moving forward through the different evolutionary stages considering their own possibilities, risk communication topics and target groups. In this chapter we will summarise the current situation of the European food safety authorities, analysing their risk communication approach, methods, tools, channels, and their personnel, dedicated to risk - and especially to crisis - communication. Besides that, we have also elaborated a Self-evaluation tool (SET) which can help authorities to evaluate their currently used risk communication, to determine their weaknesses and based on the assessment, shape the next steps.

### 3.1 Currently used risk communication models and practices in Europe

In the framework of the SafeConsume project, two online surveys were conducted between 2018-2020. The Policy Survey was participated by 76 organisations, including European food safety authorities, and additional institutions that have dedicated risk communication activities<sup>17</sup>. Additionally, 42 European food safety-related non-governmental organizations from 16 European countries responded to the NGO Survey, focusing on the applied risk communication practices and collaborations<sup>18</sup>. Besides that, we have also studied the communication reports of EFSA about the coordination and cooperation mechanisms of risk communication<sup>19</sup> and about benchmarking current practice in the EU<sup>20</sup>. We have summarized the conclusions of the above-mentioned surveys in the following sub-chapters.

#### 3.1.1 Institutional personnel dedicated to risk communication

59% of the Policy Survey respondents had risk communication with consumers as one of their responsibilities, of which 25% also had a dedicated risk communication group, 46% had a general communications department, whilst 30% had staff members who were engaged in risk communication although it was not their primary job function. On average, the dedicated risk communication groups had personnel resources of 4 full-time equivalents, mostly qualified in journalism or PR (64%), agricultural engineering or food technology (36%), veterinary medicine (27%) and microbiology (27%).

12% of the organisations that participated in the SafeConsume Policy Survey had a dedicated crisis or emergency management group. 15% only had general staff that was also responsible

<sup>17</sup> D7.1 Report on applied risk communication policy models

<sup>18</sup> D7.2 Report on non-authority initiatives and best practices

<sup>19</sup> EFSA (European Food Safety Authority), 2021. Mapping the coordination and cooperation mechanisms of risk communication on feed/food safety in the EU, Communication report, EFSA Journal 2021;19(4):e190401, 151 pp. doi:10.2903/j.efsa.2021.e190401

<sup>20</sup> EFSA (European Food Safety Authority), 2021. Catalogue of Communication Tools and Dissemination Guidelines: benchmarking current practice in EU and Member State bodies. EFSA Journal 2021;19(4):e190402, 180 pp. doi:10.2903/j.efsa.2021.e190402



for crisis or emergency management, while 21% had some staff members that were involved in crisis or emergency management although it was not their primary job function. In general, the dedicated crisis management groups had personnel resources of 14 full-time equivalents available, mainly with qualifications in veterinary medicine (67%), microbiology (67%) agricultural or food engineering (55%), human medicine (33 %) and toxicology (33%).

## 3.1.2 Currently used risk communication channels and tools

In the framework of the Policy survey, the currently used communication channels of the authorities were also mapped. The results show that most organisations mainly still rely on “passive” channels in their communication activities towards consumers. As these channels require interest and active information search from the consumers, it can only reach this segment of the society which is conscious of the certain topic. According to our survey, most of the organisations use their website (89%), and social media platforms (61%), which is in line with the results of the EFSA comprehensive benchmarking report on current best practices on communication tools and dissemination processes in the EU<sup>21</sup>. Posters and flyers (59%), traditional media such as TV (59%), radio (57%) and printed press (55%) are also widely used. 43% of the respondents have educational programs such as working with hygiene educators. Our results reflect well with the EFSA TOP 5 risk communication tools: social media content, video, press release, infographic, and news stories.

**Table 1. Currently used risk communication tools in the European countries (SafeConsume Policy survey)**

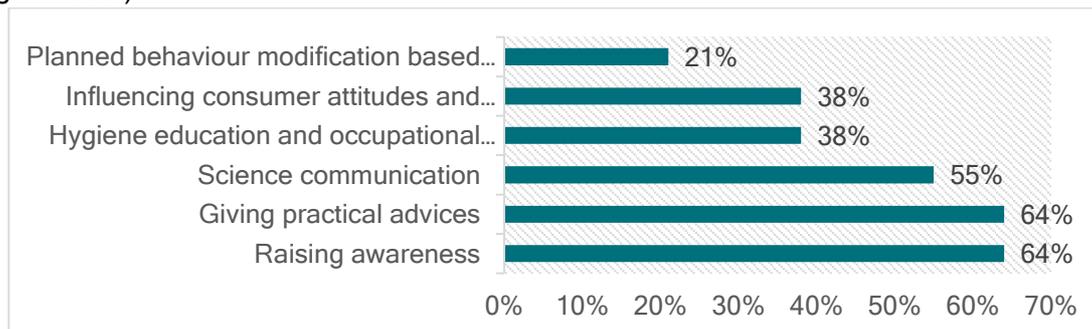
Risk communication tools	NO	DE	LV	LH	GB	AT	DK	EE	FI	IE	LU	NL	SE	BE	FR	IS	CH
Website, specific portals	+	+	+	+	+	+	+	+	+		+	-	-		+	+	+
Social media	+	+	-	+	+	+	+	+	+		-	-	-		+	+	+
Advertisements	-	-	-	-	-	-	+	+	-		-	-	-		-	-	-
Appearances in printed media	-	+	+	+	+	+	+	+	+		+	-	-		-	-	+
Appearances in TV	-	+	+	+	+	+	+	+	+		+	-	-		-	+	+
Appearances in radio	-	+	+	+	+	+	+	+	+		+	-	-		-	+	+
Own printed materials	-	+	+	+	+	-	+	+	+		+	-	-		-	+	+
Posters and flyers	-	+	+	+	+	-	+	+	+		+	-	-		-	+	+
Applications for cell phones	-	-	-	-	-	+	+	-	-		-	-	-		-	-	+
Education programmes	-	-	-	+	+	-	+	+	+		-	-	-		-	-	+
Risk communication tools	PL	PT	SI	HU	BG	CY	CZ	GR	IT	SK	AL	BA	HR	MA	RO	RS	ES
Website, specific portals	+	+	+	+	-	+	+	+	+	+	+	-	+	-	+	-	+
Social media	+	+	+	+	-	+	+	-	+		+	-	-	-	+	-	-
Advertisements	-	-	-	+	-	-	-	-	-		-	-	-	-	-	-	-
Appearances in printed media	+	+	+	+	-	+	-	-	-	+	-	-	+	-	+	-	-
Appearances in TV	+	-	+	+	-	+	-	-	-	+	-	-	+	-	+	-	+
Appearances in radio	+	-	+	+	-	+	-	-	-	+	-	-	+	-	+	-	+
Own printed materials	+	+	+	+	-	+	+	+	+	-	-	-	+	-	+	-	+
Posters and flyers	+	+	+	+	-	+	+	+	+	+	-	-	+	-	+	-	+
Applications for cell phones	+	-	-	+	-	-	+	-	+	-	-	-	+	-	-	-	-
Education programmes	-	+	+	+	-	+	+	+	+	+	+	-	-	-	-	-	-

<sup>21</sup> EFSA (European Food Safety Authority), 2021. Catalogue of Communication Tools and Dissemination Guidelines: benchmarking current practice in EU and Member State bodies. EFSA Journal 2021;19(4):e190402, 180 pp. doi:10.2903/j.efsa.2021.e190402



## 3.1.3 Currently used risk communication approaches

In parallel with the above-mentioned dominance of the “passive” communication channels, the risk communication approach of the participating organisations also reflects this orientation, mainly resulting in one-way communication. Most organisations focus on awareness-raising (64%), giving practical advice (64%) and science communication (55%). The frequency of the advanced approaches was lower, such as hygiene education in schools (38%), influencing consumer attitude and preferences (21%) and only 21% of the organisations' targets planned behaviour modification based on consumer insight (which is the principle of the Behavioural insight model).



**Figure 2. Currently used risk communication approaches in Europe (Source: SafeConsume Policy survey)**

In accordance with our results, the EFSA survey has also shown that the top objectives of risk communication are to inform/raise awareness, to produce content that complements other communications and to make scientific content easier to understand. An in-depth summary of the findings - including the top target groups and communication channels - is shown in Table 2.

**Table 2. Top 5 risk communication tools (Source: EFSA Catalogue of Communication Tools and Dissemination Guidelines: benchmarking current practice in EU and Member State bodies)**

Top 5 Tools	Impact and Cost-efficiency (scale 1 to 5)	% of mentions	Top Objectives	Top Targets	Top Channels
Social media content	Impact 3.9 / 5	66.7%	<ul style="list-style-type: none"> <li>• Inform/raise awareness (100%)</li> <li>• Produce content that complements other communication (61.5%)</li> <li>• Provide timely information about scientific outcomes (53.8%)</li> <li>• Make scientific content easier to understand (53.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• Consumers / citizens (100%)</li> <li>• Media (76.9%)</li> <li>• Policy makers at EU level (61.5%)</li> </ul>	<ul style="list-style-type: none"> <li>• Social media (100%)</li> <li>• Website (38.5%)</li> <li>• Internal communication (38.5%)</li> </ul>
	Cost efficiency 3.8 / 5				
Video	Impact 3.6 / 5	58.3%	<ul style="list-style-type: none"> <li>• Inform/raise awareness (100%)</li> <li>• Produce content that complements other communication (63.6%)</li> <li>• Explain complex processes or scientific concepts (45.5%)</li> </ul>	<ul style="list-style-type: none"> <li>• Consumers / citizens (90.9%)</li> <li>• NGOs (72.7%)</li> <li>• Industry (72.7%)</li> </ul>	<ul style="list-style-type: none"> <li>• Social media (90.9%)</li> <li>• Website (81.8%)</li> <li>• Email (36.4%)</li> </ul>
	Cost efficiency				



Top 5 Tools	Impact and Cost-efficiency (scale 1 to 5)	% of mentions	Top Objectives	Top Targets	Top Channels
	3.5 / 5		<ul style="list-style-type: none"> <li>Make scientific content easier to understand (45.5%)</li> </ul>		
Press release	Impact 3.9 / 5	50%	<ul style="list-style-type: none"> <li>Inform/raise awareness (100%)</li> <li>Make scientific content easier to understand (90%)</li> <li>Explain complex processes or scientific concepts (70%)</li> <li>Provide timely information about scientific outcomes (70%)</li> </ul>	<ul style="list-style-type: none"> <li>Consumers / citizens (90%)</li> <li>Media (90%)</li> <li>Policy makers at EU level (80%)</li> </ul>	<ul style="list-style-type: none"> <li>Email (100%)</li> <li>Website (100%)</li> <li>Social media (90%)</li> </ul>
	Cost efficiency 3.9 / 5				
Infographic	Impact 3.8 / 5	50%	<ul style="list-style-type: none"> <li>Inform/raise awareness (90.9%)</li> <li>Make scientific content easier to understand (81.8%)</li> <li>Explain complex processes or scientific concepts (81.8%)</li> </ul>	<ul style="list-style-type: none"> <li>Consumers / citizens (90.9%)</li> <li>NGOs (72.7%)</li> <li>Policy makers at EU level (72.7%)</li> </ul>	<ul style="list-style-type: none"> <li>Social media (90.9%)</li> <li>Website (81.8%)</li> <li>Physical event (54.5%)</li> </ul>
	Cost efficiency 3.5 / 5				
News story	Impact 3.3 / 5	50%	<ul style="list-style-type: none"> <li>Inform/raise awareness (100%)</li> <li>Make scientific content easier to understand (81.8%)</li> <li>Provide timely information about scientific outcomes (81.8%)</li> </ul>	<ul style="list-style-type: none"> <li>Media (81.8%)</li> <li>Consumers (72.7%)</li> <li>Industry (63.6%)</li> <li>Policy makers at EU level (63.6%)</li> </ul>	<ul style="list-style-type: none"> <li>Website (100%)</li> <li>Email (63.6%)</li> <li>Social media (54.5%)</li> </ul>
	Cost efficiency 3.4 / 5				

To sum up, the overview of the currently applied risk communication practices in the European food safety authorities shows that the traditional forms of risk communication still continue to dominate. In consumer-directed risk communication, the one-way deficit model is generally used, while in stakeholder communications some two-way models (especially the Dialogue model and the Partnership model) are used during the everyday risk communication.

## 3.2 Self-evaluation tool (SET)

As it was explored in the surveys previously presented, actors of the European risk communication scheme follow various approaches and are in different evolutionary stages both regarding their practices towards consumers and their cooperation activities with other organisations. The easiest way of defining the path of the development is to evaluate the currently used risk communication practices of the institution, determining the weaknesses and based on the assessment, shape the next steps. For this purpose, we present the Self-evaluation tool (SET), developed by risk communication experts in the SafeConsume project, by which the users (especially leaders and risk communicators of national authorities) can explore their readiness level in different aspects of risk communication by answering simple, closed-type questions. While SafeConsume demonstrated strong scientific ambition in the field of studying consumer insights, risky behaviours, risk ranking and risk communication, SET is designed for practical utilization and for providing immediate results with good accuracy as a decision-supporting tool. The SET identifies three fields of organisational risk communication



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as crucial during the evaluation of the organisation's current practices and the areas to be developed: Organisational management, human capacities and activities. A detailed description of the SET elements is included in the Risk communication guideline (composed in the framework of WP5 in SafeConsume project)<sup>22</sup>, giving a more comprehensive overview of the particular aspects of the above-mentioned fields.

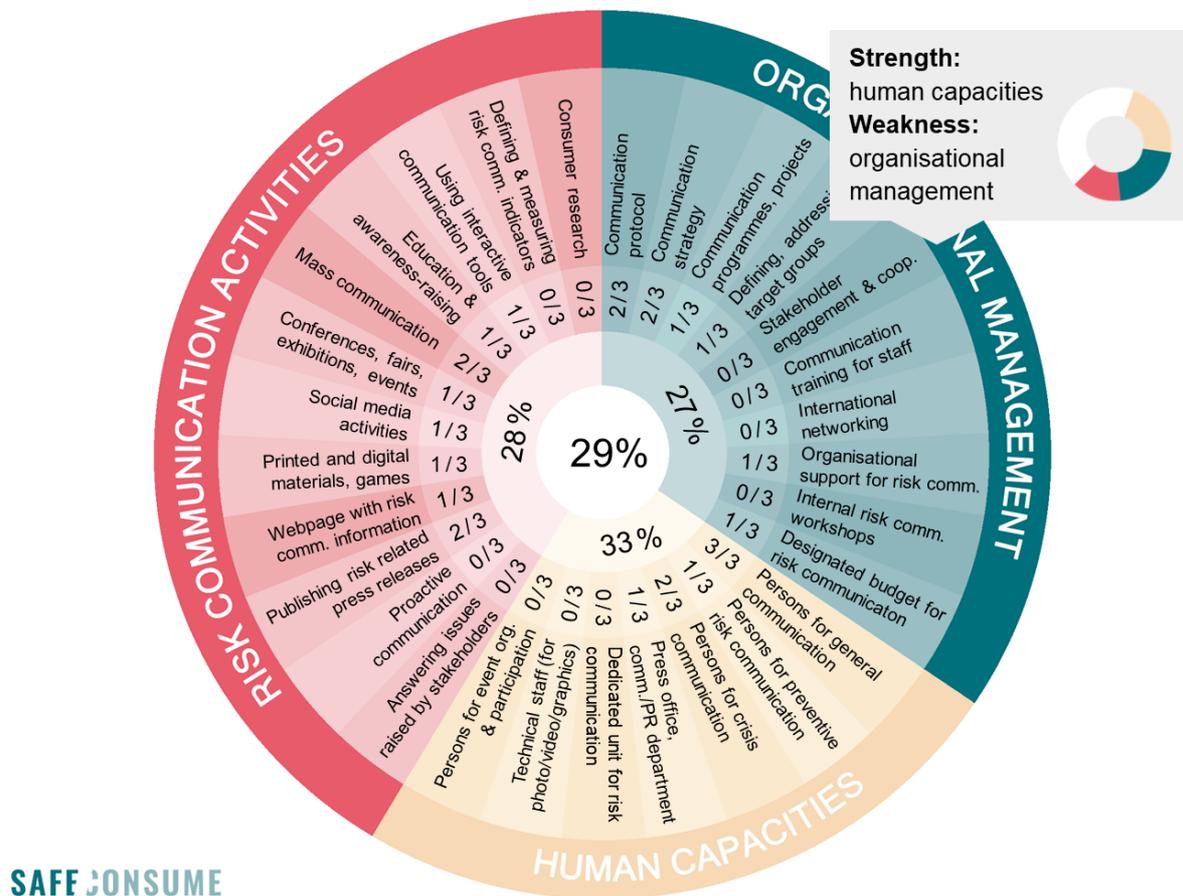


Figure 3. Self-evaluation tool (SET)

<sup>22</sup> D5.4 Communication strategy report



## 4 Ready-to-use risk communication materials for food chain safety authorities

The aim of this framework document is to provide turnkey solutions for food safety authorities for the most frequent consumer behaviours which pose food safety risks along the user journey. In this chapter, we have collected ready-to-use communication materials which can be used during authority risk communication, targeting specific consumer groups, especially the most vulnerable (elderly, children, pregnant women) clusters. Besides the materials and results of the SafeConsume project, outcomes of related projects (e.g., One Health, MATRIX project, FoodSafety4EU, BfR's RAKIP platform etc.) and communication materials of international organisations (e.g., WHO, EFSA, EUFIC, CDC, USDA) and national food safety authorities are summarised and recommended in the toolbox.

### 4.1 The user journey

In the framework of the SafeConsume project, the journey of food was mapped from buying, to preparing, cooking and consuming food, and managing leftovers, and the relevant risky consumer behaviours were investigated related to each stage. Consumer observations help reduce mist about actual consumer practices and are also a wonderful communication opportunity. Similar to the HACCP method used by the food business operators, the household HACCP approach was used to identify Critical Control Handling (CCH), where reducing hazards to foodborne illness is possible. The outcomes of the fieldwork study contribute to the development of behaviourally tested risk communication elements and processes.

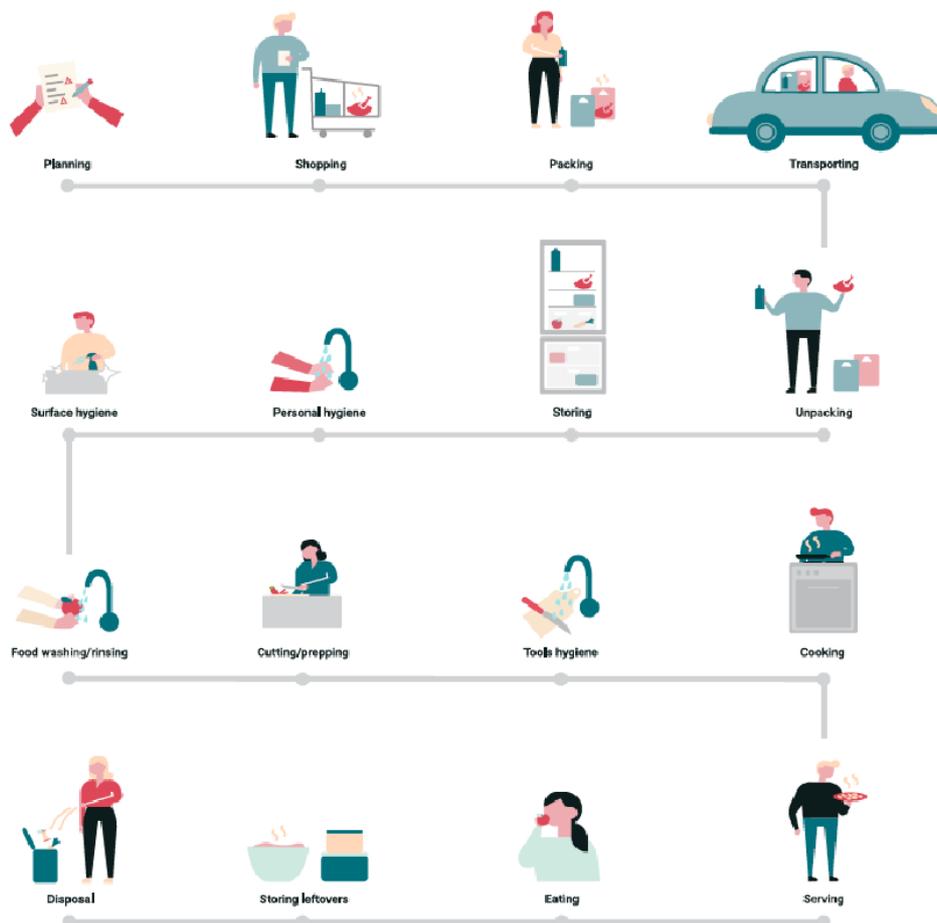


Figure 4. The user journey



## 4.2 Risk Behaviour Map

The Risk Behaviour Map is a transdisciplinary tool and communication device that has been developed in the SafeConsume project, combining data from microbiology, sociology, market and risk analysis. It aims to identify the most important strategies for helping consumers with the mitigation of foodborne infection, covering only those steps along the user journey - from retail to fork - where it is recognised that the consumer has the possibility to reduce the risk. The RB map is a large data matrix formulated into an excel file including more than 10000 observations from the fieldwork, several literature contributions and available tools and technologies on the market. The Risk Behaviour Map enables the sorting out of behaviours for specific target groups, specific pathogens, and for specific food categories. In the framework of the SafeConsume project, a more user-friendly visualization of the database will also be created.

## 4.3 Risk ranking

The qualitative risk analysis (carried out in SafeConsume project WP3) combined all the relevant output data from WP1 and WP2, defining the exposure and the hazard in a probabilistic manner. Each risk analysis focuses on a pathogen-food combination and uses a different mathematical approach, considering the nature of the pathogen (growth, survival, pathogenicity) and the consumers' food handling practices (storage time and temperature, preparation and consumption practices). Five risk analyses have been developed that focus on consumer behaviour, including *Listeria* in ready-to-eat (RTE) foods, *Salmonella* Enteritidis in eggs, *Norovirus* in shellfish and *Campylobacter* in chicken. The basis of the risk analysis was the data collected in SafeConsume's detailed survey of nearly 10,000 households across ten Member States. The conclusions of this risk ranking provide guidance on which changes in behaviour would be effective in reducing the foodborne illness burden in the EU; therefore it can be constructively used in policy-making as well. The visualized summary of the risk ranking data will be hosted by a common SafeConsume online platform.

## 4.4 Key messages

Summarising the finding of scientific research, fieldwork and risk ranking in key communication messages is an effective way of consumer-directed risk communication. In the framework of the SafeConsume project, several evidence-based key messages were formulated based on the scientific outcomes and conclusions of consumer observations. The short, clear and practical messages aim to mitigate the food safety risks regarding cross-contamination, personal hygiene, cooling, heating and leftover management. These messages can serve as an easy-to-use basis for risk communicators during developing communication materials. Based on an evaluation by the experts in the SafeConsume project, the following food safety messages were chosen to have the highest potential uptake to alter risky consumer behaviour:

1. Store ready-to-eat foods (e.g cold smoked fish, cooked meat, cut fruit, soft cheese, and raw egg dishes) in the refrigerator (below 5°C).
2. Purchase and eat ready-to-eat foods (e.g cold smoked fish, cooked meat, cut fruit, soft cheeses, or raw egg dishes) before the due-by-date
3. Cook ready-to-heat foods (e.g frozen fruit/berries/vegetables, dinner sausages and hamburgers) according to label
4. Cook pan-fried chicken on all sides and cook dishes with minced meat to 70°C in the centre
5. Mix well and cook clams and mussels 3-5 min after shells are open



6. Separate raw chicken from ready-to-eat foods, such as cooked chicken, salad vegetables and bread
7. Use a clean knife and cutting board when cutting fruit and vegetables for consumption
8. Wash fruits and vegetables, especially if eaten raw

## 4.5 Educational materials

In the framework of WP6 (Development of educational programmes for mitigating risk) in the SafeConsume project, several educational materials were developed for 11-18-year-old students. Childhood education has an outstanding role in preventive risk communication, as the entrenched bad consumer practices are really difficult to modify at later ages. Five lesson plans and several additional interactive educational materials were developed in the project, designed to be used by science teachers during classroom education. Supplementing the educational materials, a training module for the teachers was also developed, aiming to support educators and boost their knowledge and confidence in teaching food safety. The elements of the SafeConsume educational materials are detailed in the following sub-session. The SafeConsume educational materials are available in 6 languages (English, Hungarian, Greek, French, Danish, Portuguese) on the [e-bug website](#).

**User journey** (including a presentation, animation, teacher notes, student worksheet with answers): This activity includes comprehensive information about the journey of food from shop to plate - including shopping, transportation, food preparation, personal hygiene, cooking and leftover management - and the critical points where food hygiene and safety are key. The User journey lesson plan aims:

- To understand that there are harmful microbes in food that can cause food poisoning, where they can be found, and risks and consequences of food poisoning.
- To understand cross-contamination and how it occurs and develop and normalise skills for good hand and food hygiene and preparation in everyday life to remain in good health
- To understand the chain of infection and critical points for food hygiene.



*Figure 5. User journey animation*

**Food safety facts** (including a presentation, teacher notes, student worksheet with answers): The lesson features common scenarios children and young people, and their families may find themselves in, and discussion points in relation to each individual scenario, aiming:

- To understand that foodborne illness can have severe consequences and does not contribute to strengthening the immune system
- To understand the consequences of not following food hygiene rules at home, such as cross-contamination, and how to prevent this



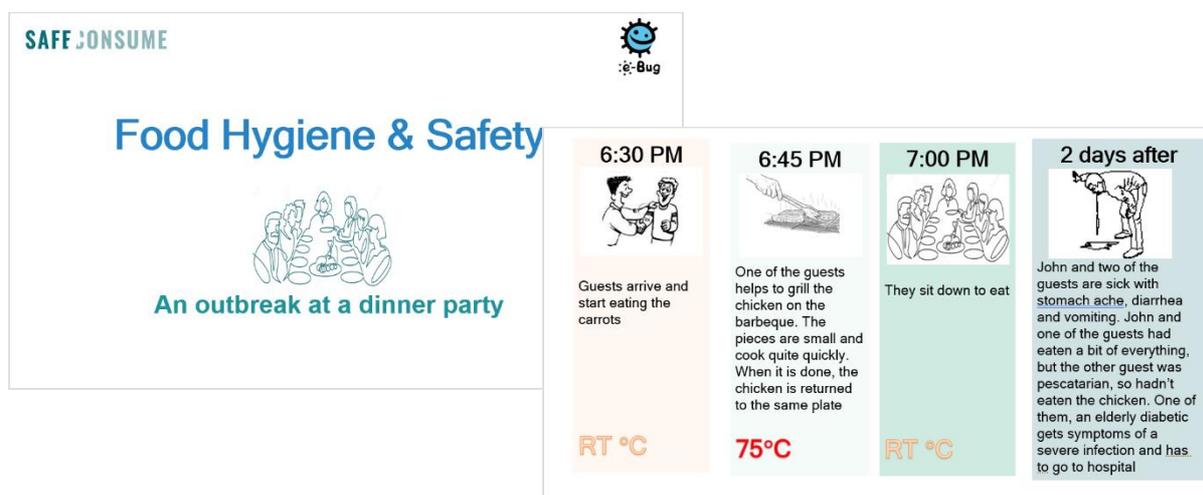
- To understand the types of food labels and why these are important
- To explain the difference between food safety and food quality
- To understand the food cooked at home is not necessarily safer than food eaten at restaurants

**Food safety VS food quality** (including a presentation, teacher notes, student worksheet with answers, data analysis activity): The lesson plan covers different date labels (use by, best before date) and the topic of food waste. The aim of this activity is:

- To understand the types of food labels and why these are important
- To understand the difference between food safety and food quality
- To understand how to store and use different types of food
- To understand the consequences of not following food labels properly

**Outbreak investigation** (including a presentation, teacher notes, student worksheet with answers): This activity shows an outbreak at a dinner party, and the events that unfold, as a result of not following food hygiene and food safety rules. The lesson learning outcomes of this activity are:

- To identify harmful microbes that are commonly found in food
- To identify conditions that promote the growth of harmful microbes and how to prevent this
- To understand how to safely transport, store and prepare food
- To understand the risks and consequences of food poisoning



**Figure 6. Outbreak investigation presentation**

**Useful and harmful microbes** (including presentations, teacher notes, student worksheet with answers, microbe match activity): This activity covers the four different microbes including bacteria, viruses, fungi and parasites, and how they might be present in food. Students will learn about both useful microbes and how they are used in the food industry, as well as harmful microbes and how they can lead to foodborne illness. The lesson also covers the top five foodborne pathogens in Europe: *Salmonella*, *Campylobacter*, *Toxoplasma*, Norovirus, and *Listeria*. The lesson plan gets children to know that:

- Foodborne illness is caused by microbes, of which there are four different types
- The difference between viruses, bacteria, parasites and fungi
- There are useful microbes in food
- The importance of handling food correctly to avoid foodborne illness



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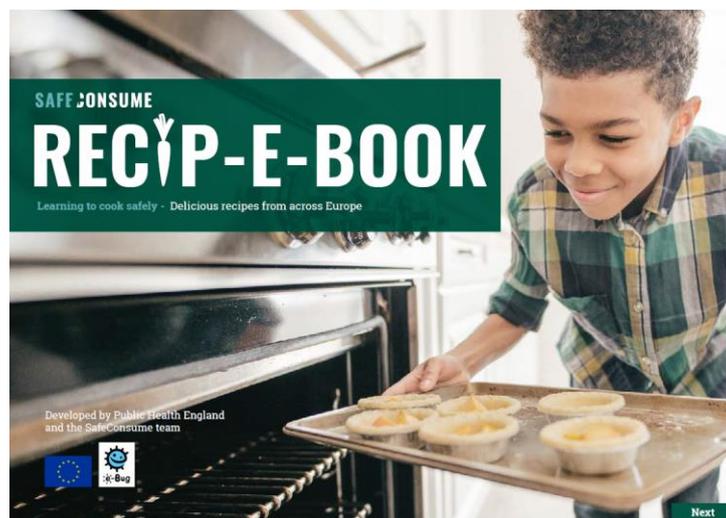
**Debate kit** (including teacher notes, debate characters): This interactive activity provides a perfect way to help students understand the issues surrounding food hygiene and safety, meet different viewpoints and opinions and practice their debating skills. The food safety debate kit aims:

- To practise discussing and debating issues and expressing an opinion
- To consider social, ethical and factual issues in an integrated way
- To think about different points of view
- To learn to back up their opinions with facts



*Figure 7. Food safety debate kit*

**Recip-e-book:** This recipe book is designed for children and young people to use at school, or alternatively at home, when cooking for friends, family, or themselves. It includes traditional recipes from Denmark, England, France, Greece, Hungary, Portugal, and Spain. Each recipe includes step-by-step instructions, with added food hygiene information in between each step.



*Figure 8. Recip-e-book with food safety instructions*

**Teacher training sessions:** Besides the educational materials for young students, a training module for the teachers was also developed to support educators with additional information aiming to boost knowledge and confidence in teaching about aspects of microbiology, foodborne infection and other aspect relating to food such as nutrition and food labels. The four-session teacher training module also includes links to the national curriculums, links to the



relevant student materials and pre- and post-knowledge tests to help the preparation of the teachers

- Session 1: Teaching food hygiene: An introduction
- Session 2: Microbiological aspects
- Session 3: Food labels
- Session 4: Infection transmission

Figure 9. SafeConsume teacher training module

**Food safety pledge:** The food safety pledge was developed with the intention of improving behaviour regulation, memory and the decision-making processes relating to better food safety behaviours. Consumers can choose a pledge based on the 21 risky behaviours, get reinforcement for positive behaviour change and become a food safety champion.



Figure 10. Visualization of the food safety pledges

## 4.6 Risk communication guideline

In the SafeConsume project, a Risk communication guideline was also elaborated, targeting food safety authorities and other actors involved in risk communication. The document includes several risk communication strategies, considering different aspects of risk, such as familiarity with the risk, predictability, urgency of the situation, level of potential harm, size of the audience, and specific consumer groups. The risk communication strategies are summarised in an easy-to-understand table format (Table 3-7), including the following attributes of risk communication in the different situations: timing, communication actors, communication channels, risk communication tools, and types of messages.



**Table 3. The attributes of risk communication depending on the familiarity to the risk**

Attributes of risk communication	Familiarity to the risk	
	Novel or emerging risks	Traditional risks
<b>Timing</b>	Ad hoc and continuous	Continuous
<b>Actors of communication</b>	Governmental agencies; NGOs; Risk managers/communicators; Other relevant stakeholders depending on the risk	Educators; Risk managers/communicators; Governmental agencies; NGOs; Other relevant stakeholders depending on the risk
<b>Communication channels</b>	Official web-sites; Traditional news media; Social media; Web-sites of relevant stakeholders depending on the risk	Social media; Podcasts; Web-sites; Traditional media; Health personnel
<b>Risk communication tools</b>	News bulletins; Articles; Contact information (Who and where to call for information)	Pamphlets; Teaching materials; Articles (in all media); TV- and radio programmes
<b>Types of messages</b>	What is the risk/hazard? Where to find information? Who may be risk? What to do?	What is the risk/hazard? Who is at risk? What to do? Where to find information?

**Table 4. The attributes of risk communication depending on the predictability of the risk**

Attributes of risk communication	Predictability, urgency of the situation	
	Crisis communication	Preventive risk communication
<b>Timing</b>	Immediately	Continuous
<b>Actors of communication</b>	Governmental agencies (Ministries; Food safety authorities; Public health institutions) Other relevant stakeholders depending on the risk	Educators; Risk managers/communicators; Governmental agencies; NGOs; Other relevant stakeholders depending on the risk
<b>Communication channels</b>	Traditional news media; Social media; Official web-sites; Web-sites of relevant stakeholders depending on the risk	Official web-sites; Social media; Podcasts; Web-sites of relevant actors; Traditional media; Health personnel
<b>Risk communication tools</b>	News bulletins; Articles; Contact information (Who and where to call for information)	Pamphlets; Teaching materials; Articles (in all media); TV- and radio programmes
<b>Types of messages</b>	What is the risk/hazard? Who is at risk? What to do? Where to find information? Who is responsible for risk communication?	What is the risk/hazard? Who is at risk? What to do? Where to find information?



**Table 5. The attributes of risk communication depending on the level of potential harm**

Attributes of risk communication	Level of potential harm	
	Only economic loss	Adverse health effects
<b>Timing</b>	Ad hoc	Continuous
<b>Actors of communication</b>	Risk managers/communicators; relevant stakeholders depending on the risk event	Governmental agencies (Ministries; Food safety authorities; Public health institutions); Health personnel; Risk communicators
<b>Communication channels</b>	Traditional and social media; Web-sites of relevant stakeholders depending on the risk	Official web-sites; Traditional news media; Social media; Web-sites of relevant stakeholders depending on the risk
<b>Risk communication tools</b>	News bulletins; Articles;	News bulletins; Articles; Contact information (Who and where to call for information)
<b>Types of messages</b>	What is the risk/hazard? What are the consequences of the risk for the individual, society? What mitigating measures are initiated?	What is the risk/hazard? Who is at risk? What to do? Where to find information? Who is responsible for risk communication?

**Table 6. The attributes of risk communication depending on the size of the audience**

Attributes of risk communication	Size of the audience	
	Small, specific target groups	Large target groups, whole populations
<b>Timing</b>	Ad hoc and continuous depending on the risk	Ad hoc and continuous depending on the risk
<b>Actors of communication</b>	Risk communicators; Health personnel	Governmental agencies (Ministries; Food safety authorities; Public health institutions); NGOs;
<b>Communication channels</b>	Personal communication; Courses; Social media (i.e. Facebook groups)	Official web-sites; Traditional news media; Social media; Web-sites of relevant stakeholders depending on the risk
<b>Risk communication tools</b>	Pamphlets; Courses; Personal communication;	News bulletins; Articles; Contact information (Who and where to call for information)
<b>Types of messages</b>	What is the risk/hazard? Who is at risk? What to do? Where to find information?	What is the risk/hazard? Who is at risk? What to do? Where to find information?



**Table 7. The attributes of risk communication depending on the target group**

Attributes of risk communication	Specific consumer groups			
	Pregnant women and young families	Elderly people	Young, single men	Children
<b>Timing</b>	Contextual	Contextual	Contextual	Contextual
<b>Actors of communication</b>	Health personnel; Governmental agencies; “Family and friends”	Health&welfare institutions and personnel; “Family”	Peers; Role models	Healthcare workers; Kindergarden & school personnel; Governmental agencies; “Family”
<b>Communication channels</b>	Social media; Personal communication; Courses	Personal communication; Traditional media	Social media Web-sites; Sports& fitness facilities etc.	Web-sites Social media; Personal communication; Courses
<b>Risk communication tools</b>	Pamphlets; Courses; Personal communication;	Personal communication; Articles; TV-Radio programmes	Social media posts/groups; “Word-of-mouth”	Pamphlets; Articles; Courses; Personal communication
<b>Types of messages</b>	What is the risk/hazard? Who is at risk? What to do? Where to find information?	What is the risk/hazard? What to do?	What is the risk/hazard? Who is at risk? What to do?	What is the risk/hazard? Who is at risk? What to do? Where to find information?



## 4.7 The toolbox for risk communicators

As a crucial part of the food safety risk communication framework, we introduce the food safety risk communication toolbox, presenting communication solutions for the identified risky behaviours/situations, in order of the user journey. The toolbox summarises several ready-to-use communication materials in an easy-to-understand format for risk communicators, also indicating the food safety problem, the priority of the particular risky behaviour mitigation and the corresponding research data highlights. The communication materials and recommendations in the toolbox serve a wide range of risk communication situations, considering different levels of public participation, risk perception of the population, and the human resources available in the organisation. Besides the outputs of the SafeConsume project, several communication materials were collected from European organisations, EU projects and national-level authorities in Europe, aiming to prevent a particular risky consumer behaviour and mitigate the risk of foodborne illness in the households. In this document, we have inserted the toolbox in a table format, but a more user-friendly version will be integrated into the SafeConsume project website ([www.safeconsume.eu](http://www.safeconsume.eu)).

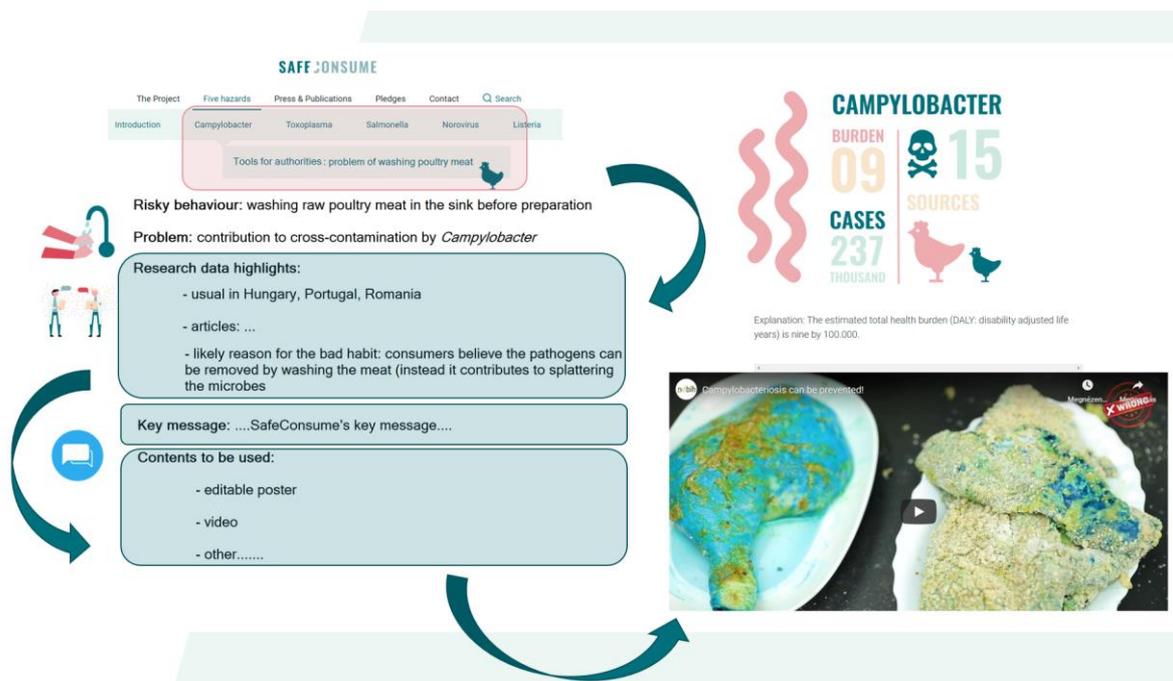


Figure 11. The structure of the toolbox at the [safeconsume.eu](http://safeconsume.eu) website

**Table 8. Food safety risk communication toolbox**

Risky behaviour	Problem	Priority	Research data highlights	Key message	Content to be used
<b>Buying food from unauthorised sources</b>	Potential risk of <i>Listeria</i> and <i>Salmonella</i> contamination	Medium	<p>Some consumers grow own vegetables and keep domestic animals at home. Consumers tend to prefer locally produced food (e.g., backyard eggs, unpasteurized milk) as it is believed to be more nutritious, safer and tastier.</p> <p>SafeConsume research data: This behaviour is especially usual in Hungary and UK. Consuming foods from untrusted sources is usual in Romania. According to SafeConsume results, 6 of the 200 backyard eggs analysed in Portugal (3%) and 4 of the 216 in Romania (1.9%) were contaminated with <i>Salmonella</i>, however differences in the prevalence were found among seasons (more positive cases in winter).</p>	<b>Buy food from reliable sources</b>	<p><a href="#">SafeConsume Debate kit</a></p> <p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">CDC infographic about raw egg</a></p> <p><a href="#">Ferreira, V., Cardoso, M. J., Magalhães, R., Maia, R., Neagu, C., Dumitraşcu, L., ... &amp; Teixeira, P. (2020). Occurrence of <i>Salmonella</i> spp. in eggs from backyard chicken flocks in Portugal and Romania- Results of a preliminary study. <i>Food Control</i>, 113, 107180.</a></p> <p>D2.5 - Results from experiments documenting effect of behaviour on hazard filled into Risk-Behaviour Map</p> <p>D4.1 - Opportunity Map</p>
<b>Buying RTE food, close to use-by-date</b>	Potential risk of <i>Listeria</i> contamination	Medium	Elderly people are especially vulnerable, as they tend to buy food close to use-by date, due to economic reasons (discount on food with close use-by-date). Buying RTE food close to the use-by date carries the risk that the food expires before consumption, generating household food waste. As the principles of sustainable consumption must not compromise food safety rules, consuming the expired food is not a solution. Instead, plan what you are going to cook to avoid wasting foods close to their use by date and buy these products only if you need them.	<b>Purchase and eat ready-to-eat food before due-by date</b>	<p><a href="#">SafeConsume "User journey" educational materials</a></p> <p>D1.4 - European food safety: Critical behaviour and cultural barriers in five countries of deliverable</p>
<b>Cross-contamination between poultry and vegetables when shopping</b>	Cross-contamination of <i>Listeria</i>	High	Cross-contamination can cause a problem even during shopping and transportation to home. Therefore, separating raw poultry and vegetables is important also in the shopping cart, on the conveyor belt and in the shopping bag to avoid cross-contamination.	<b>Keep raw chicken and other foods in separate shopping bags</b>	<a href="#">SafeConsume "User journey" educational materials</a>



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Risky behaviour	Problem	Priority	Research data highlights	Key message	Content to be used
					<a href="#">USDA infographic about separation during shopping</a>
<b>Too high fridge temperature</b>	Potential growth of <i>Listeria</i> and <i>Salmonella</i>	High	<p>The temperatures of domestic refrigerators are often too high and the users have limited possibilities to monitor and adjust the temperatures. The main reason for that might be the lack of knowledge, as consumers do not the ideal fridge temperature. Therefore, they think they are doing it right to keep the fridge at 5-10°C. The problem is aggravated by the fact that some fridges have no temperature display.</p> <p>SafeConsume research data: More than 40% of consumers never checked the temperature in their refrigerators, 38% rely on food coldness to evaluate if the refrigerator is running at adequate temperature and 65% lack knowledge on how to correctly assess temperature in the fridge. Too high temperature of the fridges is a usual problem in Romania, France and Portugal. The lowest temperatures were recorded in UK consumers' refrigerators, whereas the highest were in French households.</p> <p>The principles of proper storing in the fridge: Set the fridge to 4°C or below to reduce microbial growth. Remove out of date items from the fridge regularly, or anything growing mould, such as cheese. Avoid filling the fridge with items that do not need to be there, e.g., large bottles of water. Items that need to be kept refrigerated include meat and dairy products, and some foods that have been opened, e.g., jars of jam, and sauces.</p>	<b>Store ready-to-eat foods (e.g. cold smoked fish, cooked meat, cut fruit, soft cheese, and raw egg dishes) in the refrigerator (below 5C).</b>	<p><a href="#">SafeConsume "User journey" educational materials (presentation and animation)</a></p> <p><a href="#">SafeConsume NFCSO infographic about thermometer and food safety</a></p> <p><a href="#">Food Standards Scotland infographic about fridge temperature</a></p> <p><a href="#">EUFIC infographic about proper storage in the fridge</a></p> <p><a href="#">Borda, D., Mihalache, O. A., Nicolau, A. I., Teixeira, P., Langsrud, S., &amp; Dumitrascu, L. (2020). Using tactile cold perceptions as an indicator of food safety-a hazardous choice. Food Control, 111, 107069.</a></p> <p><a href="#">Dumitrascu, L., Nicolau, A. I., Neagu, C., Didier, P., Maître, I., Nguyen-The, C., ... &amp; Borda, D. (2020). Time-temperature profiles and Listeria monocytogenes presence in refrigerators from households with vulnerable consumers. Food Control, 111, 107078.</a></p>
<b>Eggs stored at too high temperature</b>	Potential growth of <i>Listeria</i> and <i>Salmonella</i>	High	Storing eggs in room temperature allow the rapid growth of Salmonella, resulting 3 log increase in 48h at 20°C according to ComBase.	<b>Store eggs in the fridge to prevent</b>	<a href="#">SafeConsume "User journey" educational materials</a>



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Risky behaviour	Problem	Priority	Research data highlights	Key message	Content to be used
			SafeConsume research data: Depending on the national pattern, eggs are stored in room temperatures even in the supermarkets (e.g., France, UK, mainly in Hungary). "Salmonella free" labelled eggs can be purchased in some countries (e.g., UK).	<b>the growth of <i>Salmonella</i>.</b>	<a href="#">SafeConsume NFCSO infographic about thermometer and food safety</a> <a href="#">SafeConsume Easter infographic about egg hygiene</a> D1.1 - Protocols for generic HACCP analysis for interviews and surveys
<b>RTE food stored past use-by-date</b>	Potential growth of <i>Listeria</i>	Medium	According to the observations, consumers tend to consume food after the use-by date. The main motivation is avoiding household food waste. Elderly people are especially vulnerable. Consumers often do not know the difference between "use-by date" and "best before" date, resulting risky behaviour, such as consuming RTE food after the use-by date. Due to poor fridge management, consumers often don't even know what's in their refrigerators, let alone the expiration dates. However, minimising household food waste is a crucial sustainability issue, the rules of food safety must not be compromised.	<b>Purchase and eat ready-to-eat foods (e.g cold smoked fish, cooked meat, cut fruit, soft cheeses, or raw egg dishes) before the due-by-date</b>	<a href="#">EUFIC infographic about use by and best before date</a> <a href="#">Swedish Food Agency infographic about use by and best before date</a> <a href="#">EUFIC infographic about the FIFO method</a> D1.4 - European food safety: Critical behaviour and cultural barriers in five countries of deliverable
<b>Preparing food for other when infected</b>	Potential transmission of <i>Salmonella</i> , <i>Campylobacter</i> and <i>Norovirus</i>	High	<p>In general, consumers are not concerned about infecting others when preparing food. Families with young children are particularly vulnerable.</p> <p>Consumer options to mitigate norovirus risk: Avoid handling RTE foods for others if a person has had gastroenteritis symptoms during the last 3 days. Follow strict hygienic measures during food handling (especially handwashing).</p>	<b>Avoid preparing food for others in the household when you are sick</b>	<a href="#">SafeConsume "User journey" educational materials</a> <a href="#">CDC infographic about vulnerable consumer groups</a> <a href="#">Guix, S., Pintó, R. M., &amp; Bosch, A. (2019). Final consumer options to control and prevent foodborne norovirus infections. <i>Viruses</i>, 11(4), 333.</a>



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Risky behaviour	Problem	Priority	Research data highlights	Key message	Content to be used
			<p>This risky behaviour includes no handwashing at all or insufficient handwashing as well. In general, the reported hand washing practices are more optimistic than the observed behaviour.</p>		<p><a href="#">SafeConsume cooking game</a></p> <p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">Infographic about handwashing</a></p> <p><a href="#">Mihalache, O. A., Borda, D., Neagu, C., Teixeira, P., Langsrud, S., &amp; Nicolau, A. I. (2021). Efficacy of Removing Bacteria and Organic Dirt from Hands—A Study Based on Bioluminescence Measurements for Evaluation of Hand Hygiene When Cooking. <i>International journal of environmental research and public health</i>, 18(16), 8828.</a></p> <p><a href="#">Cardoso, M. J., Ferreira, V., Truninger, M., Maia, R., &amp; Teixeira, P. (2021). Cross-contamination events of <i>Campylobacter</i> spp. in domestic kitchens associated with consumer handling practices of raw poultry. <i>International Journal of Food Microbiology</i>, 338, 108984.</a></p> <p><a href="#">Kasza, G., Csenki, E. Z., Izsó, T., &amp; Scholderer, J. (2022). Paradoxical risk mitigation behavior in private households. <i>Food Control</i>, 138, 109032.</a></p>
<p><b>Not / not properly washing hands after touching raw poultry</b></p>	<p>Cross-contamination by <i>Campylobacter</i> and <i>Salmonella</i></p>	<p>High</p>	<p>Consumers don't take the time to do it right, believing that "20 seconds of handwashing is a waste of time." Warm water and soap for 20 s was the most effective method investigated when hands are either dirty or greasy. Consumers also believe it is enough to only rinse hands quickly in cold water, without soap. SafeConsume laboratory tests proved that rinsing under running water for 5 s removes 90% of hands' dirt.</p> <p>SafeConsume research data: TOP 1 food safety risky behaviour in Portugal, Hungary, France, Romania and UK. Only a third of participants washed hands after handling raw chicken (100% in Norway, zero to 30% in other countries). Whenever they washed hands, a perception of dirtiness was associated with a feeling of greasiness on hands rather than with safety concerns (except in Norway).</p>	<p><b>Wash your hands with soap after touching raw poultry</b></p>	<p>D4.1 - Opportunity map</p>
<p><b>Using same towel for hand and surface hygiene</b></p>	<p>Cross-contamination of <i>Campylobacter</i> between hand and surfaces tools</p>	<p>High</p>	<p>The accidental mix-up of the towels can occur during food preparation. Some consumers do not even recognize the importance of separate towels for hand and surfaces. Old bad habits are especially hard to modify. "If it never happened to me yet, it won't happen in the future either."</p>	<p><b>Use a separate towel for hands</b></p>	<p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">SafeConsume infographic about separate towels</a></p>



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Risky behaviour	Problem	Priority	Research data highlights	Key message	Content to be used
			Separate cloths / dish brushes should be used for washing dishes, cleaning surfaces, and drying hands. Make sure to hang and dry them after use and replace regularly.		D4.1 - Opportunity map
Using the same utensils for raw poultry and vegetables	Cross-contamination of <i>Campylobacter</i> and <i>Salmonella</i>	High	<p>Some consumers are not aware of the potential risk of cross-contamination caused by using the same kitchen utensils for raw meat and RTE food. The transmission of invisible microbiological contamination is not in the focus of the consumers, moreover they believe that heating will kill all the bacteria, therefore cross-contamination during food preparation is not problematic. In addition, consumers tend to believe that it is enough to rinse the utensils only in cold water for some seconds and then use them for another type of food.</p> <p>According the fieldwork studies, cooking salt (used for seasoning) is a potential vehicle for <i>Campylobacter spp.</i> cross-contamination from raw chicken to lettuce, through unwashed hands after handling contaminated chicken.</p>	<p>Separate raw chicken from ready-to-eat foods, such as cooked chicken, salad vegetables and bread</p>	<p><a href="#">SafeConsume cooking game</a></p> <p><a href="#">SafeConsume "Food safety facts" educational resources</a></p> <p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">WHO infographic about separate kitchen utensils</a></p> <p><a href="#">Infographic about separate utensils</a></p> <p><a href="#">CDC infographic about separate cutting board</a></p> <p><a href="#">Santos-Ferreira, N., Alves, Â., Cardoso, M. J., Langsrud, S., Malheiro, A. R., Fernandes, R., ... &amp; Teixeira, P. (2021). Cross-contamination of lettuce with <i>Campylobacter spp.</i> via cooking salt during handling raw poultry. <i>Plos one</i>, 16(5), e0250980.</a></p>
Washing raw poultry meat before preparation	Cross-contamination by <i>Campylobacter</i>	High	<p>Rinsing raw poultry is one of the main risky consumer behaviours, considering food safety, as it spreads microbes around the sink and the kitchen. There were different explanations for the practice of cleaning and rinsing chicken. A high proportion of consumers learned about poultry washing from their parents and grandparents as part of family traditions, which possibly dates back to the time when poultry was slaughtered and cleaned at home. The general idea of cleaning and the juicy surface of the chicken intensifies the washing motivation further. This impulse</p>	<p>Instead of washing raw meat under running water in the sink, use paper towel for wiping juices</p>	<p><a href="#">SafeConsume cooking game</a></p> <p><a href="#">SafeConsume "Food safety facts" educational resources</a></p> <p><a href="#">NFCISO video for World Food Safety Day 2019 about the risk of <i>Campylobacter</i> cross-contamination</a></p>



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Risky behaviour	Problem	Priority	Research data highlights	Key message	Content to be used
			<p>could be even stronger for those consumers who have a higher level of consciousness of microbiological hazards and might have heard about cross-contamination from meat juices.</p> <p>Paradoxically, the more the conscious consumers are of microbiological hazards, the more likely they are to wash their poultry: most consumers believe that washing poultry before preparation is good hygiene practice and are not aware of cross-contamination risk.</p> <p>SafeConsume research data: Washing raw poultry is a usual risky food handling behaviour in Hungary, Portugal, Romania.</p>		<p><a href="#">Kasza, G., Csenki, E. Z., Izsó, T., &amp; Scholderer, J. (2022). Paradoxical risk mitigation behavior in private households. Food Control, 138, 109032.</a></p> <p><a href="#">Cardoso, M. J., Ferreira, V., Truninger, M., Maia, R., &amp; Teixeira, P. (2021). Cross-contamination events of <i>Campylobacter</i> spp. in domestic kitchens associated with consumer handling practices of raw poultry. International Journal of Food Microbiology, 338, 108984.</a></p>
<b>Not / not properly washing fruits and vegetables</b>	Risk of Norovirus, <i>Toxoplasma</i> and <i>Campylobacter</i>	High	<p>This risky consumer behaviour might root from the false belief about "little dirt only benefits your immune system". Consumers tend to wash off only the visible contamination - trusting their senses to determine cleanness. Pregnant women are especially at risk.</p> <p>SafeConsume research data: Washing in running tap water with scrubbing more than 30 s results high reduction of pathogens (&gt;2 log reduction). Addition of sodium hypochlorite, peracetic acid or chlorine dioxide significantly enhanced viral removal as compared with water alone. Not proper washing of fruits and vegetables is a usual risky behaviour especially in Hungary and Romania.</p> <p>Consumer options to mitigate norovirus risk: Wash vegetables with potable water supplemented with sanitizer (e.g., chlorine-based, PAA-based)</p>	<p><b>Wash fruits and vegetables, especially if eaten raw</b></p> <p><b>Use a clean knife and cutting board when cutting fruit and vegetables for consumption</b></p>	<p><a href="#">SafeConsume cooking game</a></p> <p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">SafeConsume infographic about washing fruit</a></p> <p><a href="#">NFCSO "Myth busting" video about washing fruits and vegetables</a></p> <p><a href="#">EUFIC infographic about handling vegetables and fruits</a></p> <p><a href="#">Anfruns-Estrada, E., Bottaro, M., Pintó, R. M., Guix, S., &amp; Bosch, A. (2019). Effectiveness of consumers washing with sanitizers to reduce human norovirus on mixed salad. Foods, 8(12), 637.</a></p> <p><a href="#">Guix, S., Pintó, R. M., &amp; Bosch, A. (2019). Final consumer options to control and prevent foodborne norovirus infections. Viruses, 11(4), 333.</a></p>



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					D2.3 - Published data on the link between behaviour and hazard reduction filled into Behaviour risk map
<b>Defrosting in room temperature or in warm water</b>	Risk of <i>Salmonella</i> , <i>Campylobacter</i> , <i>Listeria</i> growth in room temperature	High	<p>Bacteria can survive being frozen and can start to multiply again if desirable conditions return. It can cause problem if frozen leftovers are left to defrost at room temperature for too long. Although freezing hits the pause button on microbial growth, bacteria are not killed, and foods should be consumed within 24 hours of defrosting.</p> <p>Several unsafe ways exist for defrosting food, e.g., in room temperature, in the sink, in hot water. Time is a key factor in defrosting food at home. Consumers tend to prefer the more time effective method even if it poses food safety risk. Safe defrosting (in the fridge) requires conscious planning in advance.</p>	<b>Defrost your food in the fridge</b>	<p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">SafeConsume "Useful and harmful microbes" educational material - Harmful microbes presentation</a></p> <p><a href="#">EFSA infographic about safe defrosting</a></p> <p><a href="#">Fresh from the Freezer infographic about safe chicken defrosting</a></p> <p><a href="#">Food Standards Scotland infographic about defrosting</a></p>
<b>Consuming undercooked or raw egg (or dishes with raw egg)</b>	Potential risk of <i>Salmonella</i>	High	<p>Insufficient time and temperature heating promote the survival of <i>Salmonella</i>. The visual inspection for a firm white and yolk is a good method of monitoring to guarantee that <i>Salmonella</i> has been destroyed. If the yolk of the fried egg is liquid, it is not guaranteed that <i>Salmonella</i>-if present in the raw egg -may not be eliminated. Safety threshold temperature is to achieve 72°C in the core.</p> <p>SafeConsume research data: For all strains, egg yolk acidification with vinegar to pH 3.9 and storage at 25°C or 8°C resulted in &gt;4Log(cfu/mL) reductions within 2h or 24h, respectively. At pH 4.2, 2-3Log(cfu/mL) reductions were seen within 6h at 25°C. In contrast, acidification with lemon juice to pH of 3.9 allowed for growth at 25°C, while a pH of 2.9 ensured &gt;4Log(cfu/mL) reductions within 24h. Acetic acid and citric acid were both more effective at inactivating the <i>Salmonella</i> strains than the inorganic acid HCl, with acetic acid being the most efficient.</p>	<b>Cook eggs that may contain <i>Salmonella</i> thoroughly before consumption</b>	<p><a href="#">SafeConsume "Food safety facts" educational resources</a></p> <p><a href="#">Health Direct infographic about cooking egg</a></p> <p><a href="#">Mihalache, O. A., Monteiro, M. J., Dumitrascu, L., Neagu, C., Ferreira, V., Guimarães, M., ... &amp; Nicolau, A. I. (2022). Pasteurised eggs-a food safety solution against <i>Salmonella</i> backed by sensorial analysis of dishes traditionally containing raw or undercooked eggs. <i>International Journal of Gastronomy and Food Science</i>, 100547.</a></p>



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			Some traditional recipes contain raw or undercooked eggs (e.g., mayonnaise, tiramisu). Raw eggs can be replaced by pasteurized eggs without compromising expected organoleptic characteristics. When preparing home-made mayonnaise using raw eggs, use adequate amounts of acid, preferably vinegar, and store it at room temperature for at least 24 hours before moving it to refrigeration temperatures. The best advice to consumers would be to prepare hard boil eggs, with firm white and yolk, to guarantee complete inactivation of Salmonella survival. However personal taste for boiled eggs varies among consumers, and it is also possible to obtain safe undercooked eggs, as long as parameters as time/temperature are controlled. For recipes not heat treated (or lightly cooked), choose pasteurized eggs.		<p><a href="#">Nielsen, L., &amp; Knøchel, S. (2020). Inactivation of salmonella strains in acidified broth and raw egg yolk as a function of pH and acid type. Food Microbiology, 92, 103574.</a></p> <p>D1.1 - Protocols for generic HACCP analysis for interviews and surveys</p> <p>D2.5 - Results from experiments documenting effect of behaviour on hazard filled into Risk-Behaviour Map</p>
<b>Eating undercooked chicken</b>	Insufficient reduction of pathogens (less than 5 log) resulting the risk of <i>Campylobacter</i> and <i>Salmonella</i>	High	<p>Determining doneness is both a question of avoiding potential harm and achieving a pleasurable meal. Some consumers expressed concern about loss of juiciness if poultry was cooked thoroughly.</p> <p>Consumers trust their senses and their experiences when evaluating the doneness of chicken, but neither the common methods consumers use to monitor doneness or the advices from WHO will assure 5 log reduction of Salmonella in poultry meat. Relying of experience on how much time was needed to cook the poultry to the preferred level of doneness is very common.</p> <p>SafeConsume research data: The quantitative survey revealed that households prevalently check cooking status from the inside colour (49.6%) and/or inside texture (39.2%) of the meat. Young men rely more often on the outside colour of the meat (34.7%) and less often on the juices (16.5%) than the elderly (&gt;65 years old; 25.8% and 24.6%, respectively). The lab study showed that colour change of chicken meat happened below 60°C, corresponding to less</p>	<p><b>Cook pan-fried chicken on all sides and cook dishes with minced meat to 70°C in the centre</b></p>	<p><a href="#">SafeConsume cooking game</a></p> <p><a href="#">SafeConsume "Useful and harmful microbes" educational material - Harmful microbes presentation</a></p> <p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">Langsrud, S., Sørheim, O., Skuland, S. E., Almli, V. L., Jensen, M. R., Grøvlén, M. S., ... &amp; Møretrø, T. (2020). Cooking chicken at home: Common or recommended approaches to judge doneness may not assure sufficient inactivation of pathogens. PloS one, 15(4), e0230928.</a></p>



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			<p>than 3 log reduction of Salmonella and Campylobacter. Statistical analysis showed that a 5-log reduction was obtained at a core temperature of 70°C, but not at 65oC. At the surfaces that were not in contact with the frying plate, survival was observed, even when the core temperature reached 70°C.</p>		<p>D1.4 - European food safety: Critical behaviour and cultural barriers in five countries of deliverable</p> <p>D2.5 - Results from experiments documenting effect of behaviour on hazard filled into Risk-Behaviour Map</p>
<b>Elderly eating RTE food after expiration date</b>	Risk of <i>Listeria</i> contamination	High	<p>Consumers trust their senses: if it looks and tastes good, it is safe to eat even after the use-by date. Elderly people are especially vulnerable, although they do not consider it a real problem. Elderly people tend to think that since they have not gotten ill yet, there is no risk in the future.</p>	<p><b>Purchase and eat ready-to-eat foods (e.g cold smoked fish, cooked meat, cut fruit, soft cheeses, or raw egg dishes) before the due-by-date</b></p>	<p><a href="#">SafeConsume "Food safety facts" educational resources</a></p> <p><a href="#">SafeConsume "Food safety VS Food quality" educational materials</a></p> <p>SafeConsume NFCSO infographic about use-by date and best before date</p>
<b>Consuming raw shellfish</b>	Risk of Norovirus contamination	High	<p>Shellfish (mussels, oysters, clams) become contaminated with Norovirus when water is contaminated. Oysters may concentrate Norovirus through their filter feeding. The probability for Norovirus in the water varies for different areas. Several seafood is consumed without any heat treatment or undercooked. In some countries, oysters and mussels are parts of the traditional national cuisine. Old habits are hard to change.</p> <p>SafeConsume research data: Heat treatments of clams which cause reductions &gt;3.5 log<sub>10</sub> for Norovirus may be regarded as an acceptable inactivation treatment and could be set as a performance criterion to test the effectiveness of other time-temperature inactivation processes. Steaming until opening is not enough to protect against Norovirus if</p>	<p><b>Mix well and cook clams and mussels 3-5 min after shells are open</b></p>	<p><a href="#">New Zealand Food Safety infographic about eating raw mussels</a></p> <p><a href="#">FoodSafety4EU infographic about mussels</a></p> <p><a href="#">Fuentes, C., Pérez-Rodríguez, F. J., Sabrià, A., Beguiristain, N., Pintó, R. M., Guix, S., &amp; Bosch, A. (2021). Inactivation of Hepatitis A Virus and Human Norovirus in Clams Subjected to Heat Treatment. <i>Frontiers in Microbiology</i>, 11, 3504.</a></p>



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			present in shellfish. Norovirus may survive and low levels may be sufficient for illness.		<p><a href="#">Guix, S., Pintó, R. M., &amp; Bosch, A. (2019). Final consumer options to control and prevent foodborne norovirus infections. Viruses, 11(4), 333.</a></p> <p>D1.1 - Protocols for generic HACCP analysis for interviews and surveys</p>
<b>Poor handling and temperature abuse of leftovers</b>	Risk of <i>Bacillus cereus</i> and <i>Listeria</i>	Medium	<p>In 2008, a 20-year-old man in Belgium died 10 hours after consuming spaghetti with tomato sauce. It had been left unrefrigerated at room temperature for 5 days and reheated in the microwave before consumption. The culprit: a bacteria called <i>Bacillus cereus</i> which can commonly contaminate rice and pasta.</p> <p>Cool and place leftovers in the fridge as quickly as possible - this should be within two hours of cooking. This is especially important for rice which can contain <i>Bacillus cereus</i> whose spores can survive heat. <i>Bacillus cereus</i> can then multiply at low temperatures of 4 to 6°C. Consume chilled leftovers within two days to limit microbial growth. If in doubt, freeze leftovers as this pauses microbial growth. If storing at too long time <i>Listeria</i> may grow slowly at cooling temperatures (&gt; 0°C). Reheat leftovers thoroughly until piping hot throughout to kill any bacteria that may be present.</p>	<p><b>Freezing food if you are not going to eat it straight away</b></p> <p><b>Refrigerating food at 4°C or below</b></p>	<p><a href="#">SafeConsume "Useful and harmful microbes" educational material - Case study, Harmful microbes presentation</a></p> <p><a href="#">SafeConsume "User journey" educational materials</a></p> <p><a href="#">CDC infographic about leftover handling</a></p> <p><a href="#">NFCISO infographic about leftover handling</a></p> <p>D1.1 - Protocols for generic HACCP analysis for interviews and surveys</p>



## 5 Conclusions

According to the research results previously presented, most organisations with risk communication responsibilities have development potential in the evolutionary process of food safety risk communication. The SET model can help the organisations to define the next steps in developing organisational risk communication practices. The food safety risk communication toolbox gives turnkey communication materials for risky consumer behaviours, but traditional risk communication tools are not effective enough in some cases. As the last decades clarified that awareness-raising and communication campaigns are not effective enough in many cases, novel approaches are needed. Evidence-based key messages are often hard to insert into everyday life because of the ingrained consumer practices and a lack of technologies or products available (e.g., UV-treated eggs, pasteurised liquid eggs). Therefore, easy-to-use equipment needs to be developed (shelf-life indicator, refrigerator with integrated thermometer), which might aim to replace or complement consumer consciousness and reduce the number of foodborne illnesses in households. In the future, traditional risk communication is expected to be replaced by personalised services and intelligent technological assistant agents (e.g., smart kitchen equipment, smart sensors, AI-controlled smart homes, automatic product recalls, AR info system via QR codes). However, the controlled risk environment in the future is expected to surround consumers, the role of food control authorities will still remain crucial. The focus will shift from traditional regulatory work and authority measures to scientific research and developing new technologies, promoting food safety along the whole food chain. The future path of food safety risk communication is challenging to predict. One thing is sure: the future will hold a wide range of new strategies to mitigate foodborne illness in households.



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