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The Media Depiction of the Kinder Chocolate
Salmonella Outbreak Case

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Abstract

Food hygiene poses importance on today's society and supports quality and safety assured food, supplied by food operators. *Salmonella* Typhimurium is a bacterium present in contaminated food products. It causes, primarily, gastrointestinal issues in children, elderly, pregnant and immunocompromised individuals. On the 15th of December 2021, a positive test for *Salmonella* Typhimurium was obtained in Ferrero's factory in Arlon, Belgium. The factory, that produces Kinder chocolate products, temporarily shut, however, following negative tests for the bacterium days later, production restarted. Later, in April 2022, cases of Salmonellosis began to emerge reaching over 150 total cases detected in over 11 countries. The Arlon factory was ordered to cease production and the company announced the biggest recall of products in 20 years. Kinder chocolate products were found to be the cause of *Salmonella* Typhimurium cases reported in, ultimately, 455 children over this period. The problem was identified in a filter in the buttermilk tank in the factory. Possible contaminated products were asked to be removed from shelves and not consumed in homes in affected countries. The recall cost the company millions of euro and sales decreased by approximately 30%, overall. Chat GPT was the method of processing used in this paper to summarise key points from British, Belgian and Hungarian newspaper articles. Results from Chat GPT proved to be similar to the details of the case, researched using global media, found in the literature review.

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List of Abbreviations	
DALYs	Disability-adjusted life years
WHO	World Health Organisation
HACCP	Hazard analysis and critical control point
FSA	Food Standards Agency of Britain
UKHSA	United Kingdom Health Security Agency
UK	United Kingdom
U.S.	United States
CDC	Centers for Disease Control and Prevention
ECDC	European Centre for Disease Prevention and Control
FASFC	Federal Agency for the Safety of the Food Chain in Belgium
FSN	Food Safety News
UN	United Nations
MOI	Month of Interest

1. Introduction

Have you ever pondered the journey your food has taken before arriving on your plate? What happens to your food before it is displayed on a shelf in the supermarket or served with a symphony of ingredients to you in a restaurant? We, as consumers, do not tend to realise the magnitude of trust that we place in our food providers, along the food chain, to keep us safe and free from hazards and food-borne illness.

When discussing the topic of food safety, the World Health Organisation claims that access to a sufficient amount of safe and nutrient dense food is the key to a healthy and sustainable lifestyle. The organisation explains that 1 in 10 people are affected by consuming contaminated food each year, resulting in the forfeit of 33 million healthy life years (DALYs). Safety, nutrition and security of food are important and interlinked aspects of food safety. Hazardous food leads to malnutrition, especially in young children, elderly, pregnant and immunocompromised individuals. Economies, trading, tourism and sustainable development are affected by the level of safety of food supply (1). Cheftel states in an article that 'Global food security and safety are threatened by a number of fast-occurring changes'. These changes are observed as overpopulation, urbanisation, pollution, climate change, animal breeding, trade and travel, novel food borne diseases, antimicrobial resistance, increased costs, the complexity of the food chain, risky behaviour and malnutrition (1,2). WHO have established their intention to identify, react to and prevent global food safety issues, to create a safer food supply for the public (1).

The food chain, also known as, the 'Farm to Fork' concept, is the process that occurs beginning with the primary producer and finishing with the final consumer. The operation of producing food is comprised of individual processes and operators, that are linked together 'like a chain', to produce safe food for consumers. 'Farm to Fork' strategy, an approach curated by the European Commission, aims to create a safe and sustainable food system. The EU Commission states that it 'recognises inextricable links between healthy people, healthy societies and a healthy planet.' The purpose of creating this strategy, around the food chain, is to increase food security, to reduce costs for producers and consumers, and to neutrally and/or positively impact the environment, preserving natural resources (3). Food chain safety guarantees that processes and products, involved in the food chain, will cause no health or economic threat to consumers (4).

Regulation (EC) No 178/2002 provides protection around consumer health and interest through formulation of the basic principles of food law. It applies to all stages of the food chain, from production to distribution. This law enforces food business operators to comply

with the principles of the law as primary responsibility holders (5). The regulation is responsible for establishing the European Food Safety Authority and outlines procedures that food operators must participate in, to ensure food safety (6).


Food hygiene is a valuable concept in households, equally to businesses, and poses relevance in everyday life. When preparing meals for our loved ones and ourselves, we are unknowingly participating in food hygiene practices. These practices can appear as, the use of separate chopping boards for raw meats and vegetables, storing food at their optimum conditions in the fridge or cupboard and sanitising work tops with anti-bacterial spray and hot water. Listed above are few of the everyday good hygiene practices majority of people engage in. Solveig et al analyse the ‘five keys to safer food’, created by the World Health Organisation (7). These key points highlight the ‘take home’ messages about food safety, mainly targeting domestic cooks. WHO’s ‘five keys to safer food’ are listed in table 1 below.

Table 1: ‘WHO’s Five Keys to Safer Food (8)’

World Health Organisation’s Five Keys to Safer Food	
1.	Keep Clean
2.	Separate raw and cooked
3.	Cook thoroughly
4.	Keep food at safe temperatures
5.	Use safe water and raw Materials

It is stated by Solveig et al that ‘As the last line of defence, safer consumer behaviours could have a substantial impact on mitigating the risk of foodborne infection’ (7). As it is unattainable to place legislation around domestic food practices, an adequate method to target consumers in their homes is through information and communication. The authors explain that communication of terminology and the indication to change behaviour can pose a challenge on consumer understanding (7). It is critical, when fabricating these messages, to be specific with the aim of addressing and reducing the most important issues, keeping the message short and not to exclude other safe alternative practices. The former qualities can be observed in WHO’s five key points (8). These techniques have been proven to be successful in achieving household food safety. Figure 1 below highlights WHO’s five keys to safer food.

Five keys to safer food



Keep clean

- ✓ Wash your hands before handling food and often during food preparation
- ✓ Wash your hands after going to the toilet
- ✓ Wash and sanitize all surfaces and equipment used for food preparation
- ✓ Protect kitchen areas and food from insects, pests and other animals

Why?

While most microorganisms do not cause disease, dangerous microorganisms are widely found in soil, water, animals and people. These microorganisms are carried on hands, wiping cloths and utensils, especially cutting boards and the slightest contact can transfer them to food and cause foodborne diseases.




Separate raw and cooked

- ✓ Separate raw meat, poultry and seafood from other foods
- ✓ Use separate equipment and utensils such as knives and cutting boards for handling raw foods
- ✓ Store food in containers to avoid contact between raw and prepared foods

Why?

Raw food, especially meat, poultry and seafood, and their juices, can contain dangerous microorganisms which may be transferred onto other foods during food preparation and storage.

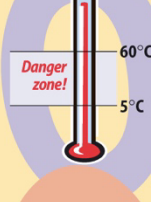


Cook thoroughly

- ✓ Cook food thoroughly, especially meat, poultry, eggs and seafood
- ✓ Bring foods like soups and stews to boiling to make sure that they have reached 70°C. For meat and poultry, make sure that juices are clear, not pink. Ideally, use a thermometer
- ✓ Reheat cooked food thoroughly

Why?

Proper cooking kills almost all dangerous microorganisms. Studies have shown that cooking food to a temperature of 70°C can help ensure it is safe for consumption. Foods that require special attention include minced meats, rolled roasts, large joints of meat and whole poultry.



Keep food at safe temperatures

- ✓ Do not leave cooked food at room temperature for more than 2 hours
- ✓ Refrigerate promptly all cooked and perishable food (preferably below 5°C)
- ✓ Keep cooked food piping hot (more than 60°C) prior to serving
- ✓ Do not store food too long even in the refrigerator
- ✓ Do not thaw frozen food at room temperature

Why?

Microorganisms can multiply very quickly if food is stored at room temperature. By holding at temperatures below 5°C or above 60°C, the growth of microorganisms is slowed down or stopped. Some dangerous microorganisms still grow below 5°C.



Use safe water and raw materials

- ✓ Use safe water or treat it to make it safe
- ✓ Select fresh and wholesome foods
- ✓ Choose foods processed for safety, such as pasteurized milk
- ✓ Wash fruits and vegetables, especially if eaten raw
- ✓ Do not use food beyond its expiry date

Why?

Raw materials, including water and ice, may be contaminated with dangerous microorganisms and chemicals. Toxic chemicals may be formed in damaged and mouldy foods. Care in selection of raw materials and simple measures such as washing and peeling may reduce the risk.



Food Safety
World Health Organization

Knowledge = Prevention

WHO/FOOD/FIVE KEYS 1
Distribution: General
Original: English

Figure 1: ‘World Health Organisations five keys to safer food’ (9)

This paper will highlight the importance of food hygiene in society and the negative repercussions derived from oversights in processing through the depiction of the Kinder chocolate *Salmonella* Outbreak Case that occurred in 2022.

2.1 The Importance of Food Hygiene

2.1.1 Definition of Food Hygiene

WHO describes the concept of One Health as ‘an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems.’ This concept acknowledges that humans, animals and the environment have a close interdependent relationship, and attending to one of the components, in turn, benefits the entire system and offers increased protection for human health (10). Figure 2 below illustrates the concept of One Health (11). Food hygiene is essential in the processing of food from farm to fork. Food hygiene, by definition, is the necessary measures and conditions fundamental for safety and suitability of food, during all stages of the food chain (4). It is the assurance that food will cause no harm to consumers. WHO reported data that highlights the occurrence of food-borne illness. It stated that 600 million cases of food borne disease, caused by unsafe food, occurs each year with 420,000 resulting in death. 30% of these deaths occur in children under 5 years of age (12). Understanding the significance of this data is crucial. Food borne diseases are preventable provided food hygiene is taken seriously and put into practice globally. Countries around the world, especially developing countries, need to improve their food safety systems in order to decrease adverse health effects originating from food. World Health Organisation takes responsibility for providing food fit for human consumption to consumers by investigating and implementing methods of good hygiene practices around the world (12). Lives can be saved through increased awareness of food hygiene and safety worldwide.



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Figure 2: 'One Health' (11)

2.1.2 Hazards

In the occurrence of malpractice, including the lack of ability to prevent contamination, the presence of harmful substances is often observed in food. Food hazards fall into three main categories; physical, chemical and biological. The most prevalent hazards that occur in food are biological hazards (4). The Food Safety Authority of Ireland lists examples of chemical hazards as water, food contact materials, cleaning agents, pest control substances, environmental, agricultural and process contaminants, pesticides, biocides and food additives. Physical hazards are physical objects that commonly appear as glass, packaging, jewellery, pest droppings and screws (4,13). Allergens are an important additional type of food hazard. There are 14 allergens that must be declared in the EU when using them as ingredients in food, under Regulation (EU) No 1169/2011 (13,14). These allergens are listed as cereals containing gluten, crustaceans, eggs, fish, peanuts, soybeans, milk, nuts, celery, mustard, sesame seeds, sulphur dioxide and sulphites, lupins and Molluscs (14,15). Biological hazards are categorised into the following groups; bacteria, yeasts, moulds, viruses, prions and parasites (4). Bacteria and viruses are the most prevalent biological hazards inhabiting food. *Campylobacter Jejuni* and *C. Coli*, *Escherichia Coli*, *Salmonella Enterica*, *Listeria Monocytogenes* and *Clostridium Perfringens* are named the most common food-borne species. *Norovirus* is as common as the bacteria mentioned above (16). In an article written by Newell et al, it is stated that there are many identified parasites capable of infecting food, for example *Ascaris*, *Cryptosporidium* and *Trichinella*, however, due to poor monitoring in foods and livestock and a poor understanding of their epidemiology, regarding the food chain, they are not effectively detected in food (17).

In general food poisoning manifests as diarrhoea, stomach cramps, nausea, vomiting and fever. However, some food-borne pathogens may cause more specific symptoms, accompanying the general signs listed above, and a variation in incubation time. *Salmonella spp.* usually propagates in raw meat, eggs and unpasteurized milk and causes bloody diarrhoea. The bacterium takes between 6 hours and 6 days to incubate. *Campylobacter spp.*, similar to *Salmonella spp.*, causes bloody diarrhoea, however, differs slightly in incubation time of 2 to 5 days. *Clostridium Botulism*, a severe disease, proliferates in improper canned or fermented food. This bacterium causes unique symptoms, such as, muscle weakness, blurry vision, speech impairment, drooping eyelids and movement problems. Symptoms usually initiate in the head and move down towards the feet and typically appear 18 to 36 hours after infection. *E. Coli* causes severe cramping, bloody diarrhoea and rarely haemolytic uraemic

syndrome, a long-term effect in 5-10% of cases. It is present in raw beef, milk and vegetables. It takes near 3 to 4 days for symptoms to appear. Finally, *Listeria Monocytogenes* causes flu-like symptoms and central nervous system signs. These CNS signs present as stiff neck, balance issues, confusion, and seizures. In pregnant women it induces miscarriage, still birth or serious infection of newborn. *Listeria sp.* can be contracted from soft cheese, smoked fish, raw milk and deli meats. It has an incubation time of 2 weeks (18). Author Fong, of '*Animals and Mechanisms of Disease Transmission*', states that 'more than 60% of human infectious diseases are shared with domestic or wild animals, with over a billion illnesses in the global population and millions of deaths each year. It is estimated that 75% of emerging infectious diseases are zoonoses' (19). As discussed above, food borne pathogens lie on a spectrum of symptoms, ranging from mild to increased severity of their effects. It is essential that the aetiology of food hazards is understood to reduce the risk they pose on human health.

2.1.3. *Salmonella* Typhimurium

Salmonella spp. is a gram-negative bacterium found in the *Enterobacteriaceae* family. There exist two species of *Salmonella*; *Salmonella Enterica* and *Salmonella Bongori* (20).

Salmonella Enterica holds the highest significance to humans, and within it are six subspecies. To further distinguish between the subspecies, there are serovariants. A serovar is a classification of a microorganism based on their cell surface antigens i.e., their ability to cause disease or their virulence factors. The virulence factors belonging to *Salmonella spp.* are adhesins (fimbriae), lipopolysaccharides, acid-shock proteins and pathogenicity islands (20). The species that is of importance to this title is *Salmonella Enterica* subspecies *Enterica* serovar Typhimurium. Animal products maintain the source of infection, however; it can be present on faecal contaminated fruit and vegetables as well. The bacteria's main point of entry is oral. Once gaining access to this route, it reaches the gut. It is a facultative pathogen, meaning that predisposing factors, such as age, overcrowding, pre-existing infection etc., must be present in the host in order to cause infection. Following this, it replicates in the gut wall tissue and moves to the surrounding mesenteric lymph nodes. In more severe cases, the bacterium can cause bacteraemia or septicaemia and infiltrate the parenchymal organs, causing focal inflammation and necrosis. The clinical signs typically appear between 6 to 72 hours after infection, as watery or mucoid-bloody diarrhoea, accompanied by a fever, stomach cramps and headaches. The illness usually eventuates within 4 to 7 days (18,20,21). However, the Health Protection Surveillance Centre states that 'diarrhoea can occasionally be severe enough to warrant hospital admission.' The infection can lead to very severe complications including arthritis, severe dehydration and death. Young, old, pregnant and immunosuppressed individuals are a lot more susceptible to Salmonellosis and will usually require treatment and hospitalization (20,21). The infection is diagnosed by testing stool samples in a laboratory or culturing the pathogen on selective enrichment media. Treatment includes rehydration via intravenous fluids and less frequently antibiotics such as tetracyclines, polymyxins and fluoroquinolones. Some resistant serotypes of *Salmonella spp.* have emerged, making it our responsibility to prudently use antimicrobials when treating cases of Salmonellosis. Infection can be prevented by cooking raw poultry, meat and eggs thoroughly, to the correct core temperature, washing all utensils, worktops and hands with soap and hot water immediately after preparing food with raw poultry, meat and eggs, wash hands before preparing food and after the toilet to avoid faecal contamination and take extra caution when preparing food for infants, elderly, pregnant women and immunocompromised persons (20,21). The seriousness and relevance of Salmonellosis in our world can be truly

comprehended from the following statement by Ferrari et al; ‘Salmonella spp. are among the most important foodborne pathogens and the third leading cause of human death among diarrheal diseases worldwide’ (22). *S. Typhimurium* is the third most prevalent serovar in the United States, the second most prevailing in the European Union and worldwide the most prevalent and disseminated (22).

2.1.4. Contamination

Many authors, when speaking about contamination methods, deal with food quality decrease. In this instance, food contamination is identified as undesired smell, flavour, colour, texture or break down of nutrients in food and consequently a decrease in food quality (23). This type of contamination occurs from non-microbial sources. Non-microbial sources include, chemical reactions, for example, aerial oxidation of unsaturated fats in food, enzymatic reactions such as, proteinase in eggs or pectinase in vegetables and Maillard reaction resulting in the browning of fruit and vegetables. Physical methods such as, mechanical action, for example, eggs cracking, moisture loss and gain and elevated temperatures resulting in melting of solids to liquids e.g., butter are also non-microbial contamination methods (23). Microbial contamination, of course, causes spoiling of food and decreases food quality, however, it also jeopardises food safety and creates a hazard for public health (23). Speaking about contamination methods, that challenge food safety, is of more relevance to this topic, in this case, using the Australian Institute of Food Safety's definition of food contamination, that it 'happens when something gets into food that shouldn't be there, rendering it unsafe to eat' (24). Newell et al makes a compelling statement, that 'Food is an excellent vehicle by which many pathogens (bacteria, viruses/prions and parasites) can reach an appropriate colonisation site in a new host' (25). The Australian Institute of Food Safety states that there are 3 types of food contamination; biological, chemical and physical contamination (24). Certain foods, known as 'high-risk foods', provide excellent conditions for pathogens to colonise and multiply. To slow down replication of microorganisms and decrease the chances of biological contamination, food handlers, must keep food out of the 'temperature danger zone', 5-60 degrees Celsius, and properly acquire, store and prepare food (24). Chemical contamination occurs when chemicals enter food. Common sources of chemical contamination include, cleaning agents, pesticides from unwashed fruit and vegetables, unsafe food contact materials and pest control agents (24). Physical contamination is a result of physical objects accessing the food. The most common objects include, hair, glass, metal, pest droppings, jewellery, dirt and fingernails (24). Preventative measures, such as, wearing a hair net, removing all jewellery, pest control, washing fruit and vegetables and keeping nails short, can reduce physical contamination significantly. It is important that food handlers keep up a high standard cleaning and sanitising routine to prevent all contamination methods (24).

The Canadian Institute of Food Safety lists cross-contamination methods as the following; improper food handling techniques, such as reusing cutting boards, utensils and raw food, unsatisfactory hygiene standards of food handlers, for example sneezing or coughing on food or absence of hair nets, improper cleaning and sanitizing of surfaces, dishware, glassware and equipment, improper storage equalling storing raw meat above cooked food, improper waste disposal and pests (26). Allergens are an additional critical aspect of food processing that must not be disregarded. Traces of allergens in food are liable to cause lethal reactions in individuals suffering from a specific allergy. Contamination methods for allergens are interchangeable with those of microbes (26). It is crucial for food processing establishments to compose a HACCP plan to prevent cross contamination methods of food in favour of public health. At home, it is possible to prevent spoilage of food by correct storage of raw and cooked foods at the correct temperatures, using separate equipment for preparing raw and cooked foods of different types, storing and preparing allergen free food in separate areas, ensuring proper hygiene standards such as washing hands frequently and disposing of food waste in a proper manner (26). WHO's 'five keys to safer food', as discussed above, must also be mentioned here, as great methods of preventing contamination at home (8). Cheftel expressed, in an article, that 'The production, processing, transportation, storage and/or distribution stages of modern food supply chains remain exposed to various types of biological or chemical contaminants' (2). He explains that emerging cases of illnesses caused by food-borne pathogens, such as, BSE, melamine and common bacteria, provide evidence of this statement (2). Risks are emerging from food technology, despite its advantageous use for extending product shelf life using methods such as, food irradiation, providing 'fresher' produce, ready to eat pre-cooked convenience and milder treatment such as, low-heat-treatment-based procedures. The risks involved in the use of food technology include incomplete inactivation of microbes, inadequate storage conditions and expiration dates, undercooking and creating of stress-resistant microbes (2). Advanced technology, such as the use of nanoparticles in food and the development of food contact materials, for example, active, intelligent and sustainable packaging, genetically modified organisms, pose uncertainties for food safety (2,4).

The Food Standards Agency explains that radioactivity is naturally occurring in all food, as it has been on earth since the beginning of existence and is naturally occurring in soil, seas, rivers and the atmosphere. Radioactivity can occur in food, due to the transfer in soil from rocks to crops, drinking water from the earth and fish and shellfish being contaminated from

water and seabeds (27). Food may also be contaminated during the release of radionuclides during nuclear disasters. For example, the Daiichi Nuclear Power Plant in Fukushima, Japan was damaged by a large-scale earthquake on March 11th, 2011. This emergency led to continuous release of radioactive materials to the surrounding areas. Evidentially, radioactivity was detected in food in Japan and the surrounding areas. Radioiodine (I-131) and radiocaesium (Cs-134 and Cs-137) are the most dangerous radionuclides that cause damage to human health. The explosion of Chernobyl nuclear power plant in 1986, deposits of radionuclides were found to be on the surface water bodies, animals and agricultural products (28). The Centre of Food Safety says that ‘Foods collected from the wild, such as mushrooms, berries and game meat continued to be a radiological problem and high levels of radioactivity have persisted for more than two decades’ (28). Caesium-137 remained the most important contributor to human internal dose (28).

2.1.5. HACCP

HACCP, otherwise known as, Hazard Analysis Critical Control Point is by FDA definition ‘A systematic approach to the identification, evaluation, and control of food safety hazards.’(29). A HACCP team is appointed to fabricate a plan in which a written document is drawn up stating procedures subject to the principles of HACCP which must be carried out by a food processing establishment. The HACCP system forms when the HACCP plan is followed out in the correct manner. The FDA solicit that prerequisite programmes are the foundation of an effective HACCP system and are essential in obtaining a successful outcome (29). A list of the prerequisite programmes is illustrated in table 2 below.

Table 2: ‘HACCP Prerequisite Programmes’ (29)

HACCP Prerequisite Programmes
Good hygiene practices (GHP) and good manufacturing practices (GMP)
Facilities and equipment constructed according to sanitary design principles
Written specifications for packaging, products and ingredients
Written cleaning and sanitation documents and followed accordingly
Employees and other persons following personal hygiene requirements
All employees are trained in the prerequisite and HACCP programmes
Separation of proper use and non- food chemicals in the facility ensured by documentation
All raw materials stored under proper environmental and sanitary conditions
All raw materials and products should be traceable through lot-coding and a recall system
Effective pest control
Others; quality assurance checks, glass control, receiving, storage, labelling and shipping procedures, employee food handling practices

The difference between HACCP and prerequisite programmes lies in the stage of processing it is at. HACCP systems ensure food is fit for consumption, while prerequisite programmes provide protection of food in food processing establishments while under their control. When developing a HACCP system, each one will be specific to the plant, however generic ones offer a guidance for companies to follow (29).

Five preliminary tasks must be fulfilled before developing a HACCP plan (30). Figure 3 states the five tasks below.



Figure 3: ‘The 5 Preliminary tasks of HACCP’ (30)

A varied team of multidisciplinary individuals with expertise and specific knowledge about the product and process are fundamental for developing the HACCP plan. These individuals must be capable of conducting hazard analysis, identifying potential hazards and those hazards that must be controlled, recommending, monitoring and verifying controls and critical limits, advocating corrective action where necessary, researching information that may not yet be known and valuable for the HACCP plan and finally, validating the HACCP plan (29,30). Once the team is assembled the progression onto the next preliminary task of describing the food and its distribution is completed. A description of the food being produced, the ingredients and the process is listed as well as the distribution method and the state in which the food should be distributed in i.e. frozen, refrigerated or at ambient temperature. Then the intended use of the food and the targeted consumer type is listed, for example, infants or elderly people. A flow diagram is developed to clearly state the steps in which the food will be processed in. Lastly, an onsite review must then be completed by the team to verify the flow diagrams accuracy and modifications made if necessary. After these 5 preliminary steps are completed the 7 principles of HACCP can be applied to the processing (29,30).

The 7 principles of HACCP can be observed in figure 4 below. The first principle is identifying the hazard (29,31,32). This involves becoming aware of potential hazards within your line of processing, for example, cross contamination of raw and cooked meat. Principle

2 involves determining the critical control points of the hazards (29,31,32). Once the hazards are identified, the points in the operation where prevention of hazards is possible are recognised, for example, storing raw meat on a separate shelf in the fridge below cooked meat. Principle number 3 is establishing critical limits (29,31,32). Critical limits allow the establishment to be aware of when a critical control point has become out of control. For example, the minimum temperature of the core of a beef burger when cooked thoroughly should be 75 degrees Celsius. Therefore, if a cooked burger is tested and is only 60 degrees Celsius, it is acknowledged that it has dipped below its critical limit and is unsafe for consumption. Principle 4 states that a monitoring system should be created to observe the critical control points in the plant (29,31,32). This system should provide a way to monitor and record the critical control points. Monitoring involves measuring parameters such as time and temperature, for example probing refrigerated food regularly to ensure it is maintained under 5 degrees Celsius at all times. In this way, it is brought to the workers attention if a critical control point varies out of its limit. Principle 5 is establishing corrective actions (29,31,32). This translates to when a critical control point is out of its limits, action should be taken to repair the damage of this mistake. For example, if a fridge exceeds 5 degrees Celsius, the fridge inventory should be disposed of, and the fridge fixed to regain its optimum temperature. Principle number 6 states that procedures should be established to verify that the HACCP system is successful (29,31,32). This involves reviewing and correcting the system repeatedly. Finally, principle 7 states that documentation should be kept with all records and procedures correlating to the above principles (29,31,32). This acts as an incentive for and evidence of the establishment's compliance with HACCP (31,32). Of course, education of the HACCP principles and training of the necessary skills for the employees is essential to implement a successful system within the establishment as well (29).

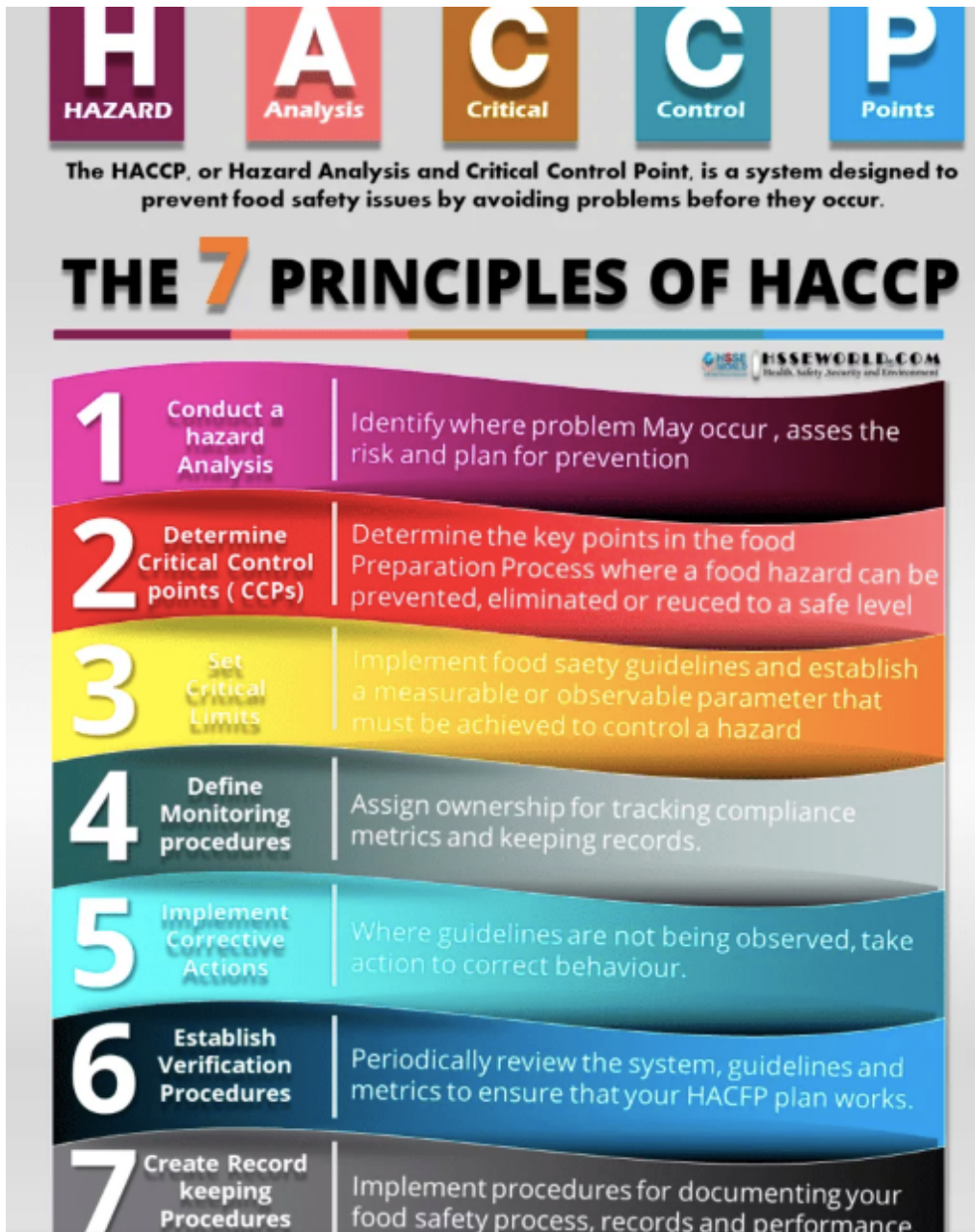


Figure 4: 'The 7 Principles of HACCP' (33)

2.1.6 Important Cases

Case 1: US Jack in the Box Outbreak (1993)

Following an unusually high incidence of haemolytic uremic syndrome in children in January 1993 in the Seattle area, an investigation was carried out into the source of the infection. Food Hygiene Magazine stated the outbreak as ‘at the time, the largest in U.S. history’ (34). The illness was a result of *E. coli* O157: H7 bacterium and was traced back to Jack in the Box hamburger patties. Over the following period the burgers would infect over 700 people in 4 different states. 171 hospitalizations and 4 deaths occurred from this figure (34,35). Further investigations confirmed 5 slaughterhouses in the USA and 1 in Canada as the source of the *E. Coli* in the meat. The hamburgers were not being cooked to the optimum temperature sufficient to kill the pathogen, as the parent company of Jack in the Box claimed they were too tough at this temperature (34). *E. Coli* O157:H7 usually causes gastrointestinal signs and rarely haemolytic uremic syndrome. The destruction of red blood cells and further kidney damage are characteristic of the illness (36). In the severe cases involved in this outbreak, paralysis, multi-organ failure and brain damage could be seen (35). Bill Marler, an attorney for a few of the victims affected by this outbreak, uncovered that there was a similar outbreak of *E. Coli* O157: H7 in 1982 in 2 states that was traced to undercooked McDonalds hamburgers (35,37). The attorney eluded on his blog that if this event had not been covered up at the time, it could have saved and aided many of the affected lives involved in the Jack in the Box epidemic through prevention (37). In the beginning, Jack in the Box did not take full responsibility for this incident, however, took steps to ensure the safety of the preparation of their products by following an advisory issued by the Washington State Department of Health (38,39). On January 21, 1993, the company finally claimed full responsibility for the tragedy, when they could no longer deny it was from their food sources. This delayed crucial information about the bacterial contamination that needed to be instantaneously communicated for protective and preventative measures to be taken (39).

Case 2: US Blue Bell Creameries Outbreak (2015)

Centers for Disease Control and Prevention reported that ‘A total of 10 people infected with several strains of *Listeria* were reported from 4 states: Arizona (1), Kansas (5), Oklahoma (1), and Texas (3). Illness onset dates ranged from January 2010 through to January 2015.’ (40). ‘PulseNet’, a national database created by public health and food regulatory agency laboratories coordinated by CDC, performed DNA ‘fingerprinting’ on *Listeria monocytogenes* isolates from sick individuals using techniques termed ‘pulsed-field gel electrophoresis’ (PFGE) and ‘whole genome sequencing’ (WGS) (40). They matched PFGE patterns collected from Blue Bell ice cream samples with the affected people involved in this outbreak. 100% of the individuals were hospitalized and 3 cases from Kansas resulted in death (40,41). In February 2015, the South Carolina Department of Health and Environmental Control and the Texas Department of State Health Services identified *Listeria Monocytogenes* contamination in the facilities and products of Blue Bell Creameries (40). It was reported in Food Safety News that the company had released a statement claiming that the bacterium had entered the facility through potential sources and eventually infiltrated the draw system (41). X-talks claim that the *Listeria sp.* contamination was a result of lack of cleaning and sanitation practices on equipment at the Blue Bell Creameries facilities (42). Between March 13, 2015, and April 20, 2015, Blue Bell Creameries recalled all products, made in every factory location, from the market. This incident cost Blue Bell Creameries millions of dollars and criminal penalties for food adulteration and manufacturing in insanitary conditions were given to the company. Blue Bell Creameries resumed production in late 2015 after closing for sanitation and cleaning of the establishment (41,43).

2.1.7 Definition of Risk

As discussed above, a hazard is the presence of a harmful substance or material in food. These fall into the 3 categories of physical, chemical, and biological hazards. Risk, in comparison, is the likelihood of a hazard to cause harm and depends on the situation. Risk assessment involves the observation of probability and the trend of hazards occurring in food (44). Therefore, it is important to analyse the nature of hazards, meaning, we must conduct studies on the level of exposure to populations. For example, pescatarians are at increased risk of methylmercury poisoning, from consuming high quantities of fish and seafood, causing severe neurological health effects (45,46). Vegetarians can also be exposed to higher levels of refined starch, sugar, salt, and saturated fats through meat alternative products leading to increased risk of insulin resistance, cardiovascular disease, inflammation, and cancer (45). We do this for many reasons, including, reducing risk in food, providing appropriate protection around food, the effective use of resources and hazard and money-based prioritization. These factors are used to evaluate risk and ensure a high standard of food safety for consumers (47).



HAZARD VS. RISK

HAZARD

is the potential to cause harm



when crossing a road, cars are a hazard

RISK

is the likelihood of harm taking place



when crossing a highway, the risk of an accident is high

when crossing a country road, the risk of an accident is low

HAZARD in foods can be...

-  physical
for instance pieces of bones in fish products
-  biological
for instance harmful bacteria, viruses or parasites
-  chemical
for instance mercury in fish or acrylamide in starchy food

RISK is determined by the exposure...



...to a hazard

Example: Salmonella in egg is a hazard



if eaten raw



the chance of exposure is high

the risk of food poisoning is high

correct food handling for instance cooking thoroughly kills Salmonella bacteria



the chance of exposure is low

the risk of food poisoning is low

www.eufic.org

Figure 5: 'Hazard Vs. Risk' (48)

2.1.8 Risk Analysis

‘Risk analysis is the process of assessing, managing and communicating food and animal feed safety risks’ (47). In other words, the identification, determination and provision of direction for methods to reduce risk in food. Commission Regulation (EU) No 1078/2012 establishes that a common safety method should be used by all food business operators for monitoring food processing (49). This includes effective management and maintenance of hazard prevention during operation and improving the management system where possible (50). This legislation mandates risk analysis as a food safety approach for food businesses. The primary step is the risk analysis process, this can be seen on the flow diagram in figure 6 below (51).

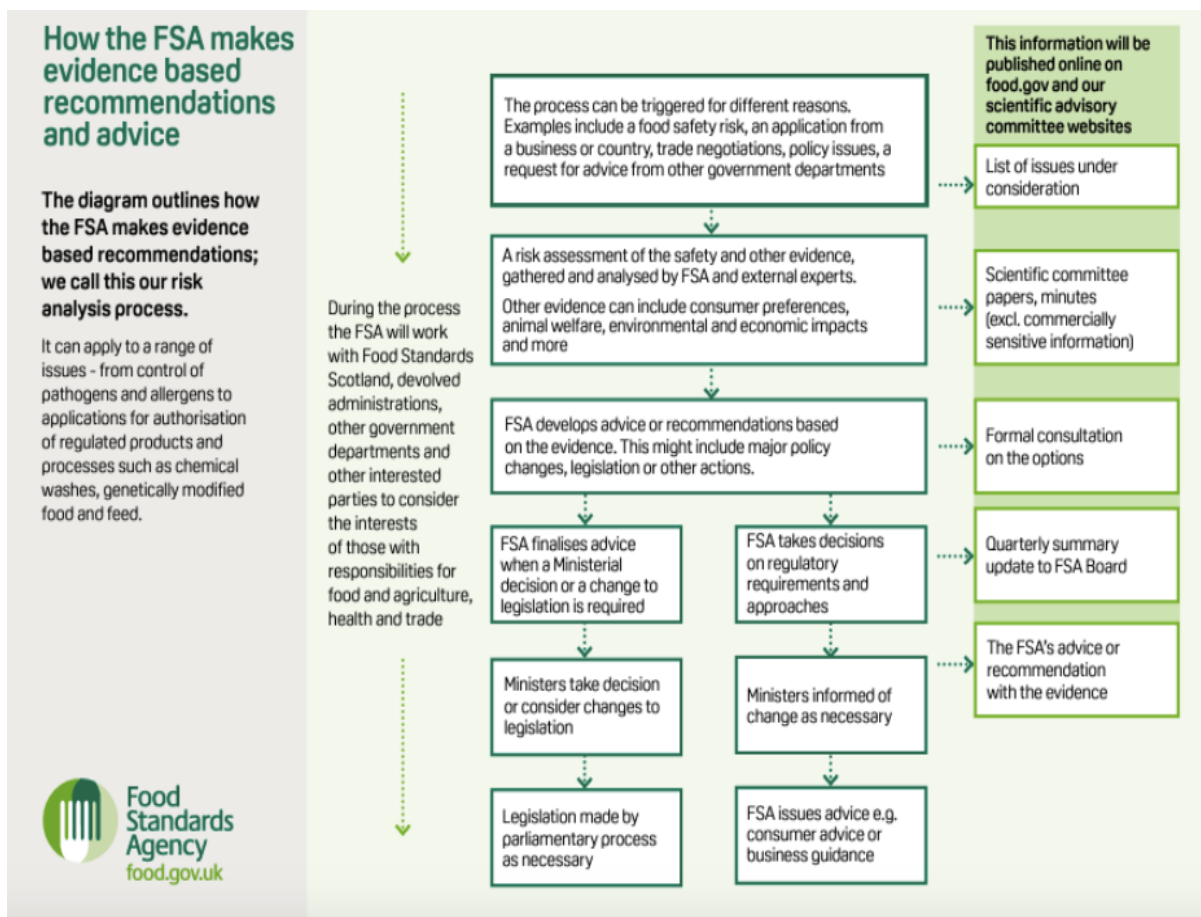


Figure 6: ‘Risk Analysis Process Flow Chart’ (51)

The risk analysis process can be triggered by potential hazards, applications from businesses or countries, trade agreements, policy issues, public conflicts or requests from government departments. Once the process is evoked, a risk assessment is carried out to evaluate the risk posed on human or animal health. There are 4 steps involved in risk assessment, listed in table 3 below (44,52).

Table 3: '4 Steps Involved in Risk Assessment' (44)

Step	Name of step	What is involved
1	Hazard Identification	Risk assessors collect data about the food to identify any potential hazards.
2	Hazard Characterization	Using evidence assessors determine the actuality of harm caused by these hazards and study the nature of these health effects and if possible, calculate a safe level of exposure.
3	Exposure Assessment	Assessors estimate the likelihood of populations and sub populations being exposed to the harm in real life, considering the duration and dose.
4	Risk Characterisation	Assessors conclude the level of risk. They compare the level of exposure that can cause harm to the level of exposure in reality.

EFSA's risk assessment of caffeine in EU member states, performed in 2015, demonstrates a practical example of the above four steps (52).

1. **Hazard Identification:** through data collected they stated caffeine as a naturally occurring compound in plants such as cocoa beans and tea leaves. It is also added to many products such as ice cream and energy drinks. A long history of human consumption is present (52).
2. **Hazard Characterization:** they acknowledged that caffeine has short-term effects, such as interrupted sleep, anxiety and behavioural changes, as well as long-term effects, such as cardiovascular problems and stunted foetal development in pregnant women (52).
3. **Exposure assessment:** they estimated that all populations are exposed to caffeine as it is present in a wide range of food on the market. Average daily intake reaches a maximum of about 320mg a day for adults and 360mg a day for the elderly (52).
4. **Risk Characterisation:** they concluded that majority of the population are not at risk, however high consumers of over 400 mg per day increase their risk with their exposure (52).

After Risk assessment is performed by risk assessors, control of the risk is determined by risk managers. Many factors are taken into consideration when making this decision, the main one being food safety, but also factors like animal welfare, environment, and economic impact, etc. These controls are practices to decrease hazards such as, refrigerating perishable foods to inhibit bacterial growth, sterilizing preparation knives at a temperature above 82 degrees Celsius and many more (47). Risk managers have the power to make decisions and change legislation if necessary, and in turn communicate this knowledge to businesses and the public to improve food safety issues (47,52).

2.1.9 Risk Communication

The World Health Organisation describes risk communication as ‘the real-time exchange of information, advice and opinions between experts or officials and people who face a hazard or threat to their survival, health, or economic or social wellbeing’ (53). Risk communication accommodates protective and preventative measures to be put in place to alleviate harmful effects of hazards posed on food and provides education and skills for individuals to make accurate decisions in the case of other risks. Internal communication occurs within a company, or an organisation and external communication occurs between a wider group, such as, the public or companies (54). It is important that risk communication is initiated at the earliest possible stage of a food safety issue for a successful outcome. It is important for the public to be able to place a high level of confidence, trust, and transparency into the food safety authorities as issues and matters related to food safety directly affects them and their health (55). A Venn diagram, in figure 7, illustrates the relationship between risk assessment, risk management and risk communication.

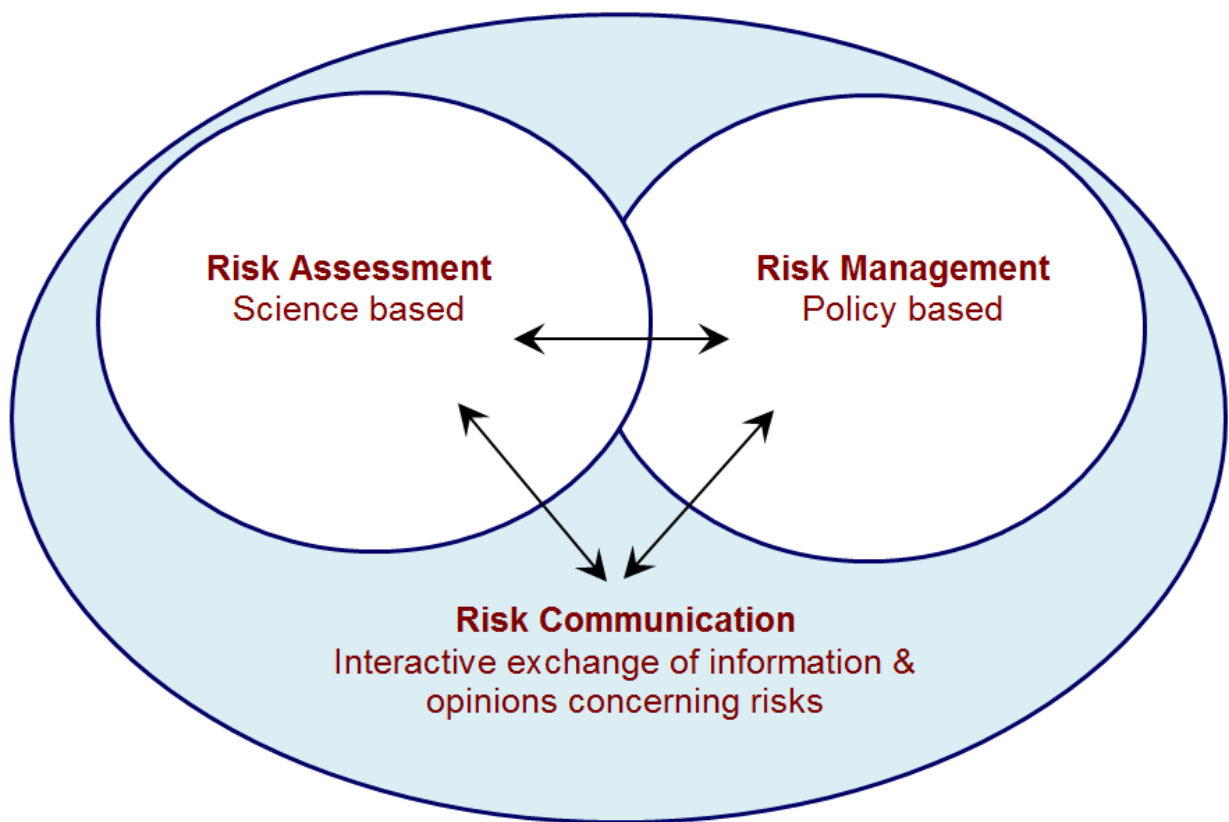


Figure 7: ‘Risk Communication’ (55)

Risk communication comes under 3 categories; institutional, corporate, and non-profit communication. Institutional, also known as authority, is independent and credible, having its own data and acts in public interest. Corporate communication more often occurs in a crisis type situation. They act in the interest of their own company and product when communicating risk. Finally non-profit type communication acts in public interest and looks at a risk through their own perspective, however, sometimes not balanced. Sometimes these non-governmental organisations can in fact be bias for a business or a political party (54). Risk communication can be relayed through many platforms, for example, press releases, websites, publications, two-way communication, social media, conferences and advertisements. An appropriate message should be short, clear and honest while focusing on the goal i.e. the event itself, the cause, the population it effects and the action to be taken. It is apparent from the information above that risk communication is a critical step in risk analysis, as it is the response to assessment that protects consumers (54).

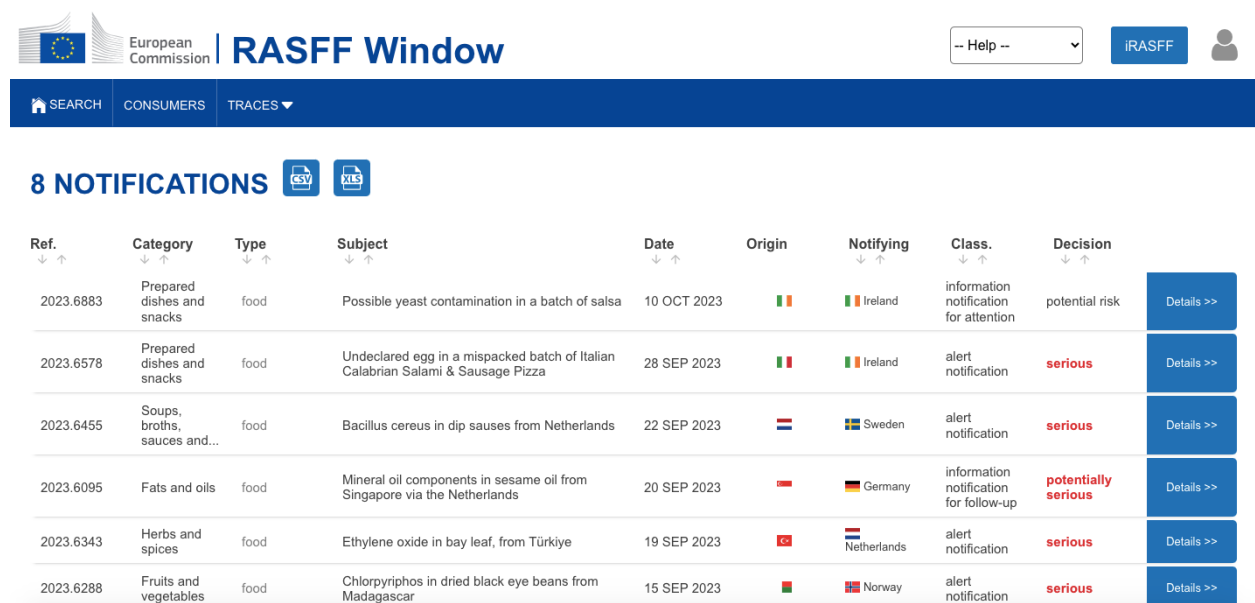
As risk assessment is being improved by scientists over time, simultaneously, risk communication is evolving alongside it (56). The development of social science has allowed risk communication to become better understood and in turn, better articulated to the public. There are various types of communication models that have evolved over the past years, to efficiently and successfully convey risk to consumers, in order to diminish risk (56). In the 1940s food safety began as purely technological focused with no exchange of risk information between authority and the public. This period is known as the pre-risk communication period (56). Later, in the 1980s, as the food sector was becoming more industrialised and knowledge was increasing about risk, the deficit model was introduced. This communication type worked to bridge the gap between experts and citizens, by offering the public factual, scientific information and education in food safety, to prevent crisis situations. This type of communication was one-way, from authority to the public, through media press releases and fact sheets, with no intervention from the public. This model led to negative depictions from the media, and consequently, public misunderstanding and distrust in authorities (56). In the mid 1990s, the dialogue model was created to restore consumer confidence. This involved participation from society, via focus groups and surveys, in risk management. A disadvantage of this model was that risk managers had all the control over the conversation and consumers had little input overall (56). The partnership model, introduced during the late 1990s, used the same concept of consumer involvement as the dialogue model however, developed it further. It permitted consumers to be involved in all

stages of risk assessment and communication, through citizens' juries and panels, deliberative opinion polling, consensus conferences and study groups. It acknowledged citizens contribution to public risk perception, using their own experience (56). The partnership model evolved into the behavioural model in 2010, with the intervention of consumer behaviour knowledge, identifying 'bias consumer routine and misbeliefs'. This model utilised the development of easy-applicable risk prevention methods, without changing deep-seated consumer habits. This integrated two-way communication with the understanding of consumer behaviours to reduce risk (56). This model is the most present, up to date model. The controlled risk environment model is suspected to be the future of risk control and communication. Assistant technology maintained and advanced by artificial intelligence, will detect and alert consumers of contamination, with the aid of various functions, such as databases and algorithms, to mitigate risk (56).

2.1.10 RASFF

The Rapid Alert System for Food and Feed was a system established by the European Union to accommodate the swift and speedy communication between member states and alert food authorities of any risks to the public to allow immediate action to be taken (57). This tool developed by the European Commission, along with legislation, ensures the highest level of food safety standards. As they proclaim, ‘The EU has one of the highest food safety standards in the world’ (57). It is a full-time service that sends and responds to urgent notifications in a brisk manner, as well as being an interface that connects a huge population, permitting products to be recalled and withdrawn from the market in the aim to prevent potential harm that could be caused to consumers. The ‘RASFF window’ grants public access to all information contained in RASFF notifications in the past and present. RASFF does not list the name of brands or businesses. Although non-member countries cannot input into RASFF, they can access information regarding food produced in that country that was exported to the EU or food that was imported to that country from the EU. The ‘RASFF Consumer’s Portal’ offers information about recent recalling of products and public health warnings within the European Union member states (57).

An example of the RASFF Window appears in figure 8 below. Information about the product being recalled can be observed in the notification i.e. the product category being recalled, the hazard involved, the severity of the risk, the country of origin of the product, the affected country, the date and the reference number of the recalled product (58).



Ref.	Category	Type	Subject	Date	Origin	Notifying	Class.	Decision	
2023.6883	Prepared dishes and snacks	food	Possible yeast contamination in a batch of salsa	10 OCT 2023		Ireland	information notification for attention	potential risk	Details >>
2023.6578	Prepared dishes and snacks	food	Undeclared egg in a mispacked batch of Italian Calabrian Salami & Sausage Pizza	28 SEP 2023		Ireland	alert notification	serious	Details >>
2023.6455	Soups, broths, sauces and...	food	Bacillus cereus in dip sauces from Netherlands	22 SEP 2023		Sweden	alert notification	serious	Details >>
2023.6095	Fats and oils	food	Mineral oil components in sesame oil from Singapore via the Netherlands	20 SEP 2023		Germany	information notification for follow-up	potentially serious	Details >>
2023.6343	Herbs and spices	food	Ethylene oxide in bay leaf, from Türkiye	19 SEP 2023		Netherlands	alert notification	serious	Details >>
2023.6288	Fruits and vegetables	food	Chlorpyrifos in dried black eye beans from Madagascar	15 SEP 2023		Norway	alert notification	serious	Details >>

Figure 8: ‘RASFF Window’ (58)

2.2 Kinder Chocolate *Salmonella* Outbreak Case as Told by The Media

During the period of December 2021 and April 2022, contamination of *Salmonella* Typhimurium occurred in Ferrero's factory, producing Kinder products, in Arlon, Belgium. In April 2022, it was confirmed that the high-volume of *Salmonella* Typhimurium outbreaks, occurring in several countries at the time, were in fact linked to Kinder chocolate products (59). This led to a product recall of an enormous scale for potential infected products. In an interview with Le Parisien newspaper, the general manager of Ferrero France, Nicolas Neykov, describes the event as the 'the biggest product recall of the last twenty years' (60). Genetic sequencing was the method used to link the strain of *Salmonella sp.* from sick individuals to the contamination in the butter milk tanks in the company's factory in Arlon (59,61–63). The *Salmonella sp.* was initially detected in a filter in a buttermilk tank in December 2021 during a routine hygiene check carried out by FASFC (59). Neykov explains that on December 15th, 2021, they ceased all production, disposed of all finished products and closed down the factory(59,60). Following the implementation of sanitation measures and negative *Salmonella sp.* of a batch of final products the following day, the company resumed production as normal (59–61).

The first case of Salmonellosis, linked to the factory, appeared on January 7th, 2022. As the average time for Kinder products to arrive at retail from production is 60 days, it is unlikely that this case was linked to the primary positive sample taken in the factory on the 21st of December 2021, therefore, previous contamination in the factory could be possible (64). The UK issued their first warning on a 'European platform' on February 17th, 2022, followed by a second one on March 25th, of the same year. These alerts notified WHO of the specific *Salmonella sp.* cluster. (64)

Towards the end of March, links were made between human cases and Kinder products. This, of course, resulted in the considerable recall, right before Easter at their busiest time. The Brussels Times states, 'Over the Easter period alone, usually a peak period for the Italian manufacturer, the brand lost 40% of its usual turnover' (59,61).

The factory was ordered by Belgian Authorities to cease production in early April (63–66). At this time, 7 products tested positive for *Salmonella* Typhimurium, leading to the closure of the factory. The production line was sanitized, all positive items were thrown away and an investigation was launched (64). In May, the company requested permission to resume production and in June the FASFC granted 3 months provisional permission to restart manufacturing (62). In September 2022, Ferrero were granted approval to resume production as normal, due to the lack of issues during the probation period (67).

2 strains were identified in the factory in articles written by The Irish Times and Food Safety News (64,68). FSN, reports that 2 types of monophasic *Salmonella* Typhimurium strains were identified in a buttermilk tank in the factory between December and January. The buttermilk was sourced from an Italian company, however, neither the supplier nor other vendors supplied with this buttermilk tested positive for *Salmonella sp.* (64). Both strains are multi-drug resistant and resistant to disinfectants containing quaternary ammonium compounds and hydrogen peroxide (63). The strains are currently susceptible to 3rd generation Cephalosporins, Azithromycin, Ciprofloxacin and Meropenem (63,64,68). In an article published by United News, it is stated that over 113 countries were affected globally by the epidemic, preceding receiving Kinder products in this risk period (69). In figure 9, the afflicted legal countries are coloured in on a world map, constructed by WHO (70).

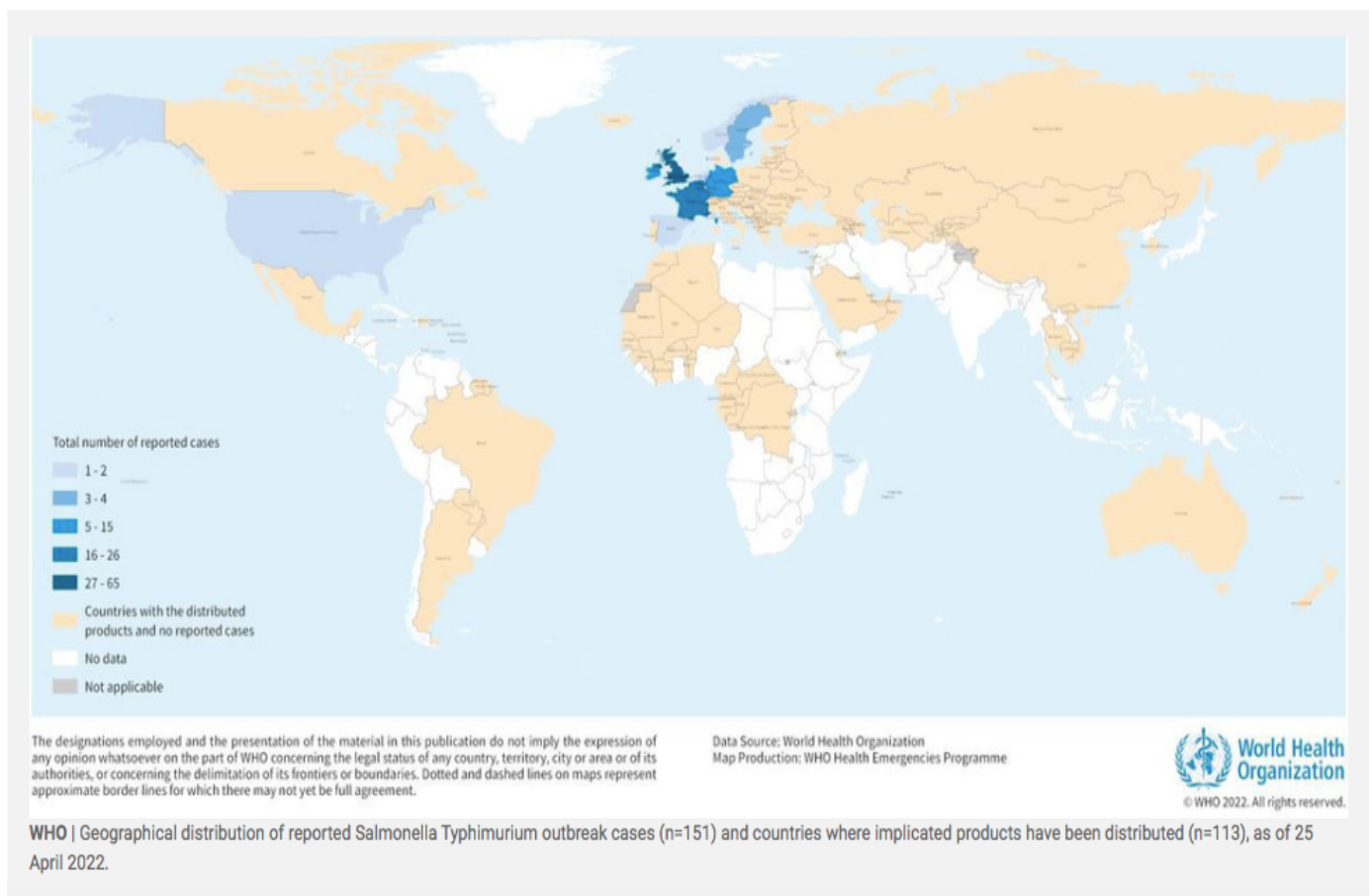


Figure 9: ‘Geographical distribution of reported *Salmonella* Typhimurium outbreak cases (n=151) and countries where implicated products have been distributed (n=113), as of 25 April 2022’ (70)

WHO described the bacterium to be resistant to 6 types of antibiotics (70). The population affected by the outbreak were primarily children under 10 years old (61,66,69,70). Overall,

455 confirmed individuals were affected by the outbreak over the period of December 2021 to June 2022, (62,66,67,71). Symptoms that individuals suffered with include, bloody diarrhoea, vomiting, high temperature and stomach cramps. In severe cases, as symptoms deteriorated, life-threatening, extreme dehydration and hospitalisation occurred (61,66,69,70). Let's take a closer look at the details of the case to discover the significance of this global monstrosity.

2.2.1 February 2022

The first glimpse of the outbreak can be observed through the media on the 19th of February 2022. Health and Wellness Canada released an article announcing that Ferrero USA had recalled some of their Kinder products due to possible *Salmonella sp.* contamination (72). The products being recalled included ‘Kinder Mix Chocolate Treats Basket’ and ‘Kinder Chocolate and Wafer Treats Assortments’. The cause for recall followed the identification of *Salmonella* Typhimurium, by the FDA, in one of their factories in the United States. The article also included information about the product recall in Europe. It explains that the British company had recalled their ‘Kinder Surprise’ chocolate, manufactured in the company's headquarters factory in Arlon, Belgium. Following 4 days later, the recall was extended to include ‘Kinder Mini Eggs, Kinder Egg Hunt Kits, and Kinder Schokobons’ (72). The article labels the event as ‘A multi-country outbreak of *Salmonella* Typhimurium’, that was reported by the Centers for Disease Control and Prevention. Brown declares that the outbreak began in January 2022, in the United Kingdom and spread to 7 additional EU countries, including, Ireland, Germany, France, Luxembourg and Belgium. Several countries recalled their products in precaution of possible contamination (72).

2.2.2 April 2022:

On the 6th of April 2022, Euro News reported that the European Centre for Disease Prevention and Control released a statement defining the outbreak by the significant rate of children being hospitalised following infection (65,73). Apparent in figure 10 below, a total number of 134 cases of *Salmonella* Typhimurium, from countries all over Europe, were suspected and confirmed (65,73). This multitude of people were, majority, children under 10 years of age. Similar to the article published by Health and Wellness Canada, released in February, Euro News stated that the first suspected case, linked to Kinder products, occurred in January, in Britain (65,72,73). ECDC stated that children were suffering with ‘severe clinical symptoms such as bloody diarrhoea.’ (73).

Number of confirmed and probable cases* with monophasic *S. Typhimurium* infection by country, EU/EEA and the UK, as of 5 April 2022

Country	Confirmed cases	Probable cases	Total cases
Belgium	0	26	26
France	20	0	20
Germany	4	3	7
Ireland	10	0	10
Luxembourg	1	0	1
Netherlands	2	0	2
Norway	1	0	1
Sweden	4	0	4
Total EU/EEA	42	29	71
United Kingdom	63	0	63
Total	105	29	134

*According to the international outbreak case definition

Figure 10: ‘Confirmed and suspected *S. Typhimurium* cases as of 5th of April 2022’ (70)

Euro News also specifies that this recall follows rapidly after Nestlé's Buitoni brand frozen pizzas are linked to *E. Coli* cases (65). In an article published by BBC News, on April 8th, 2022, readers are given further detail into the action that is being taken following the confirmation of contamination (74,75). They say that the FASFC has ordered Ferrero to shut down their factory in Arlon (74,75). Ferrero released a formal apology and recognised their

‘internal failure’, as stated in the article (74). It is explained that the order to close the factory follows Ferrero’s incapacity to provide the FASFC with information necessary to complete their investigation. It is stated that Ferrero would receive permission to reopen once they could display their guarantee of compliance with food safety regulations (74). It was reported that the FASFC appealed that vendors remove all recalled Kinder products from their shelves and advised consumers not to eat said products.

Earlier that week, the Food Standards Agency in Britain warned consumers to avoid eating all Kinder products produced in their factory in Arlon, following the ‘precautionary’ recall from Ferrero. These products included ‘Kinder Surprise 20g and 20g x 3, Kinder Surprise 100g, Kinder Mini eggs 75g, Kinder Egg Hunt Kit 150g and Kinder Schokobons 200g’ (76). The FSA also cautioned consumers that the packaging of the recalled items may not link them to the Arlon factory, thus, being important to ensure products matched the additional information in the recall notice, especially information about the ‘best-before’ date (76). BBC News included a statement from Tina Potter, Head of Incidents at FSA, expressing the importance of taking precautionary moves simultaneous to Ferrero and the Belgian Authorities to ensure that consumer safety and needs are the primary concern (74). Information about compensation that Ferrero provided affected consumers, included a full refund. Along with reindorsing consumers, affected shops where consumers bought recalled products were notified to prohibit products from being sold and notices were displayed in these towns (74). The newspaper made a statement that ‘Ferrero has previously described the recalls as "precautionary" and said none of its Kinder products released for sale had tested positive for salmonella’. Following this statement, the author explains that the ‘precautionary’ recall occurred after 60 cases, majority children, of *Salmonella* Typhimurium emerged linked to Kinder Surprise chocolate eggs (74).

Further investigations were being carried out by the European Health Agency following suspected *Salmonella sp.* cases linked with chocolate in at least 9 more countries (73). In an article written by the Irish Times, Shauna Bowers described the increase of positive cases ‘most notable’ in the United Kingdom, Ireland and France, having ‘more than doubled in three weeks, from 57 cases in five countries on March 18th to 150 cases in 10 countries on April 8th’ (61). In a different article written by BBC News, it is stated that on Monday, the 4th

of April, the FSA reported that no deaths had yet occurred, however, most cases involved children under 5 years old (75).

BBC News mentions recalls in the United States and Asia, including, Hong Kong and Singapore (74). In the U.S., ‘Kinder Happy Moments Chocolate Assortment’ and ‘Kinder Mix Chocolate Treats basket’ were ‘voluntarily’ recalled by the North American company, at a similar time to the UK (75). In the article and a statement made by Ferrero U.S, it is emphasised that there were no confirmed cases of *Salmonella* Typhimurium in the U.S, however, following the outbreak in Europe, Ferrero were working with the FDA to prevent possible contamination in North America and therefore, voluntarily recalled the 2 above listed products (75,77). Table 4 below contains data from UKHSA about the number of cases linked to the outbreak in the UK during April 2022. Most of the cases were children under 5 years of age (78).

Table 4: ‘UKHSA Data on Total Number of Cases Linked to Kinder *Salmonella* sp. Outbreak in April 2022’ (78)

Date (2022)	No. Of Cases
April 13 th	67
April 15 th	70
April 20 th	73
April 29 th	76
May 5 th	101

On the 27th of April 2022, UN News reported that 150 cases of Salmonellosis, from Belgium to the U.S., had been confirmed by WHO. This number emerged since the initial outbreak of the bacterium linked to Kinder chocolate products, in the United Kingdom, resulting in the worldwide recall (69,70). The data indicates that 89% of the cases were children under 10 years of age. A total number of 9 children were hospitalised, however, no fatalities were reported as of that date (69,70). The article gave information from a UN agency, describing the ‘risk of spread’ as ‘moderate’. UN News reported data from the 25th of April, 2022, created by WHO stating ‘a total of 151 genetically related cases of *S. Typhimurium* suspected to be linked to the consumption of the implicated chocolate products have been reported from 11 countries: Belgium (26), France (25), Germany (10), Ireland (15), Luxembourg (1 case),

the Netherlands (2), Norway (1 case), Spain (1 case), Sweden (4), the United Kingdom (65) and the United States of America (1 case)' (69,70). Kinder released a statement on the 25th of April 2022, announcing their continued cooperation with the Food Safety Authority of Ireland and the Food Standards Agency in England, in the ongoing investigation into the *Salmonella sp.* contamination in Arlon. They reiterate that the products being recalled are 'Kinder Surprise 20g, Kinder Surprise 20g x 3 multipack, Kinder Mini eggs 75g, Kinder Egg Hunt Kit 150g, Kinder Surprise 100g and Kinder Schokobons (all pack sizes) made in Arlon, Belgium'. The statement finishes expressing regret and sorrow for those affected by the outbreak (79).

2.2.3 May 2022:

On May 19th, 2022, Food Safety News declared that over 300 cases of Salmonellosis linked to Kinder chocolate, from 16 different countries, had emerged (64,68). These countries included ‘Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Spain, Switzerland, Sweden and the United Kingdom’, Canada and the United States (64). This number was double the previous figure obtained in ECDC’s survey in April. FSN claim that the UK was the highest effected country at the time, with 109 cases, followed closely by France, Belgium and Switzerland (64). In the United States and Canada, only a singular case occurred in each country. Most of this data is children under 10 years of age, majority being female. Thus far, no deaths were reported, however, a proportion of the cases were hospitalised (64).

Confectionary News reports information on the company's request to the FASFC to reopen their factory on the 13th of June, after the plants authorisation to produce food products was stripped in April when the factory shut down (80). The plan that Ferrero presented to the authorities, on the 4th of May, to increase food safety within the factory, entails the transfer of 50% of their health checks to an external laboratory and employing 1,000 employees, 7 days a week, to dismantle and clean 10,000 parts of machinery, ‘one by one’ once the factory reopens (59). It is stated that following a successful assessment, executed by the FASFC, a provisional license will be granted to the company to resume production (80).

Whitworth affirms in his article that, with information given by Lockton insurance company, the event has cost Ferrero 60 million dollars (64). Belle de Jong, states that the company launched a platform for complaints, allowing consumers to write to Ferrero to receive compensation for purchasing recalled products. 90% of customers claimed to be satisfied by their compensation. The cost of reimbursements to consumers cost the company less than 2 million euro. It was revealed that Ferrero were going to ‘play the transparency card’, to gain back over 60% of their clientele, lost to mistrust (59).

2.2.4 June 2022:

Lund et al stated that on the 3rd of June 2022, 445 cases of Salmonella linked to kinder products had emerged (63). The Brussels Times reports that, following the commencement of an investigation by Luxembourg prosecutor's office in April 2022, into the reason behind the contamination, police raided 6 Ferrero offices including, the company's headquarters, 'Casa Ferrero', in Luxembourg and the factory in Arlon (81). The raid was conducted by the FASFC and the federal judicial police. The organisation ceased documents and computer equipment, owned by Ferrero, in hope of providing evidence to conclude if the company was in fact guilty of breaching food safety regulations and having responsibility in the contamination of the production line. The authorities were further investigating the communication between Ferrero and The Food Safety Authorities, at the occurrence of the breakout (81). Anne-Sophie Guilmot, a representative for the public prosecutor's office in Belgium issued a statement explaining the reasons for the investigations, as of which, are listed above. Ferrero issued a statement to Just Food explaining, "We continue to fully cooperate with the authorities as they continue to conduct their investigation. As part of this, we can confirm there have been visits by the authorities to the Arlon plant and Luxembourg and Belgium office" (82).

The article claims that prosecutors in Paris were launching an investigation under the accusation of 'deception' against Ferrero (82). This investigation follows a high number of cases arising in France, being one of the worst hit countries from the outbreak. The charges being brought against Ferrero by the public prosecutor's office include 'deception aggravated by the danger to human health, involuntary attacks on physical integrity and endangerment of the lives of others' (82).

The article informs that the factory in Arlon was granted provisional permission to restart production at this time. The probation period, established to allow resumption of production, is stated to last 3 months from the permission date. The conditions in which the factory was allowed to operate under are; testing raw materials and product batches and once negative results are obtained these products are allowed to be sold to the public (62). An estimate of 1,000 employees and specialists were involved in the reopening of the factory, with 10,000 parts taken apart and sanitised. Over 1,800 quality tests were carried out and the replacement of multiple parts of machinery and 300 meters of new pipeline were installed on the production line (62).

2.2.5 July 2022:

On July 15th, 2022, ECDC released data displaying that a total number of 455 cases of *Salmonella* Typhimurium resulted from the Kinder outbreak. Although the agency did not include the name of the company that produced the affected products, they did mention the country and place of origin of the bacterium sample, being Arlon, in Belgium (66). In figure 11 below, a frequency chart illustrates the distribution of positive cases, in each affected country, over a risk period of 27 weeks. France and the UK maintained the highest number of cases, overall (62,66).

Figure 1. Distribution of confirmed and probable monophasic *S. Typhimurium* cases by week-year in 13 EU/EEA countries and the UK, as of 15 July 2022

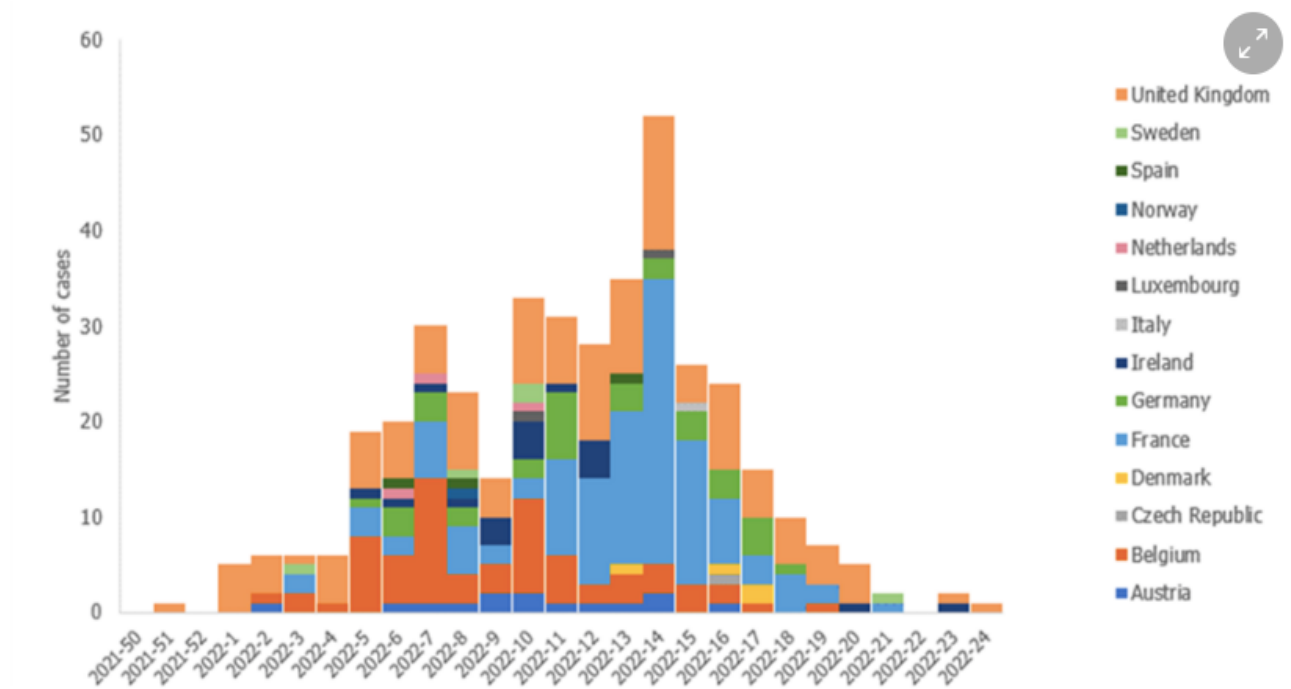


Figure 1. Distribution of confirmed and probable monophasic *S. Typhimurium* cases by week-year in 13 EU/EEA countries and the UK, as of 15 July 2022

Figure 11: ‘Distribution of confirmed and probable monophasic *S. Typhimurium* cases by week-year in 13 EU/EEA countries and the UK, as of 15 July 2022’ (66)

ECDC state that approximately 40% of cases involved in the epidemic were hospitalised and restate that the average age of children affected was under 10 years of age, some cases suffering with severe symptoms, such as, bloody diarrhoea (66).

2.2.6 August 2022:

Food Safety News released a report on the 2nd of August 2022, confirming that no new cases had emerged since ECDC's report in July, confirming 455 cases (62).

2.2.7 March 2023:

On March 17th, 2023, Food Safety News released an article on the statistics of the rise in public questions (83). The period of risk was finalised as the duration between December 2021 and June 2022. The article confirms that Ferrero's factory in Arlon was granted permission to resume normal productions in September 2022 (71,83). It is explained that, on average, the FASFC receives about 45 complaints a day. A record was set at 5,000 complaints in 2022, the same year as the Kinder Salmonella event. It is stated that a sharp incline of inquiries occurred after the Kinder recall had been published, with more than 2,000 questions being submitted the week before Easter (83). There were other companies involved in the overall statistics, however, a correlation can be seen between the increase in questions and the outbreak.

2.2.8 July 2023:

Written in a News Paper article by News Desk in July 2023, Ferrero identified a new *Salmonella sp.* contamination in their factory, in Arlon, at the same site that it was found in during the outbreak in 2022 (67). In an article by Just Food, the site is specified as a skirting board (71). There is no further information known about the newly discovered *salmonella sp.* contamination. The time it was identified, the time that the authorities were notified, and the type of *Salmonella sp.* was not confirmed (67). An investigation by the FASFC and Luxembourg Public Prosecutor's Office was initiated following the alert, however, no products tested positive for *Salmonella sp.* and consumers had not been affected by products on the market (67). Ferrero temporarily stopped the affected production line while the cause was being further investigated. Just Food remarks on the previous outbreak in 2022 claiming 'The confectionery maker had delayed reporting the salmonella outbreak before initiating a worldwide recall of Kinder products'. However, the author includes that Ferrero has 'promptly' informed the FASFC this time (71).

3. Methodology

3.1 Collection of the Articles

3.1.1 Choosing the Months of Interest

Google Trends was used to illustrate a frequency chart of the media interest on the Kinder chocolate *Salmonella* outbreak case from all of the months of interest (MOIs). This was done by typing in key words ‘Salmonella’ and ‘Kinder’ into the search term bar. The time range was customised to the 1st of December 2021 to present, and the search was restricted to a news search. The information mentioned above can be observed in figure 12 below (84).

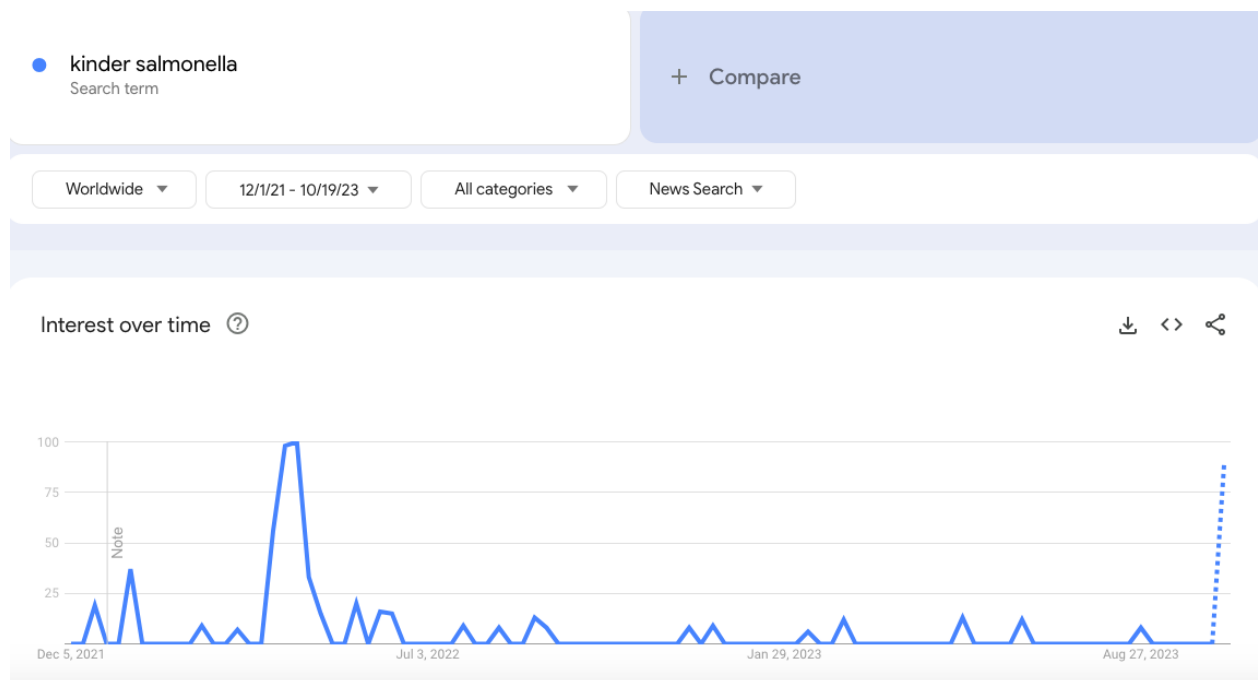


Figure 12: Frequency Chart of Media Interest for Key Words ‘Kinder and Salmonella’, over the period of the 1st of December 2021 to present (84)

In table 5 below, the top 5 MOI’s can be observed signifying the highest media searches from each month. The top 5 MOI’s were reduced to the top 3 MOI’s as there were insufficient articles available for January and September, using this method of processing. These MOI’s included April 2022, May 2022 and June 2022.

Table 5: Top 5 MOI's obtained from figure 12 (84)

MOI (2022)	Frequency
January	37
April	287
May	35
June	31
September	21

3.1.2 Choosing the articles for MOI'S

The key words 'Kinder + Salmonella' were entered into the Google search bar. Using the 'tools' option, the range on google search was customised to restrict each search to their MOI i.e., 01/04/2022-30/04/2022, for April, 01/05/2022-31/05/2022, for May and 01/06/2022-30/06/2022, for June. To restrict each MOI to each country of interest, the correlating domain for each country was entered into the search bar beside the key words at separate occasions i.e. 'site:hu' for Hungary, 'site:uk' for the UK and 'site:be' for Belgium. This generated the top articles available for each specific country for each MOI. Two articles from the UK, two articles from Belgium and one article from Hungary were nominated out of the top five articles generated from each respective country's search, in each month of interest.

3.2 Methods of Processing

Chat GPT was used to summarise each article. In the beginning, the chosen five articles, as mentioned above, from the first MOI, April 2022, were read by the author to ensure that the key points from these articles matched that of the summary of the five key points formulated by chat GPT. Chat GPT's summary was found to be satisfactory, hence, the author proceeded to use Chat GPT as the method of processing the articles to summarise the key points of the remaining articles from the other two MOI's.

The information inputted into Chat GPT was the following sentence; 'summarise the 5 key points of this article:', followed by the article copied and pasted from its website.

The outputs created by Chat GPT are listed in the results section.

3.3 Limitations

1. Some of the articles from Belgium and Hungary had to be translated to from their native language to English.
2. Copyright on some articles prohibited copying and pasting the article into chat GPT to process it. Therefore, this article could not be used (85).
3. This search is limited to 3 countries. A global search would offer a lot more articles and therefore, possibly more detail and coverage of the event.
4. Some popular English and Belgian newspaper companies have 'site:com' instead of 'site:uk' and 'site:be', for example, BBC.com and The Brussels Times. These sites were not included in the search.
5. Some of the top searches were not newspapers, but government websites with statements about the recall and not sufficient information about the events of the outbreak, therefore these articles were not included.
6. For the third MOI June, in the UK, there was a separate, large-scale *Salmonella sp.* scandal in Barry Callebaut's chocolate factory, therefore, the results for this event infiltrated the top five searches for Kinder searches.
7. The search is limited to three months.
8. The MOI, January 2022, could not be used, as there were insufficient articles available for Belgium and Hungary.
9. There were no articles presenting for the month of June 2022 for Hungary. An extra article from Belgium was substituted for a Hungarian article for this month.

4. Results

4.1 Summary of MOI 1: April 2022

Title of Article:	Every Kinder Product That Has Been Recalled Due to Salmonella Concerns (86)
Date of Published:	13/04/2022
Medium:	The Independent
Type of Medium:	Newspaper
Country of Origin:	United Kingdom
<p>The article reports on the extended recall of Kinder chocolate products due to salmonella concerns at a manufacturing site in Belgium. Here are the key points:</p> <ul style="list-style-type: none">• Ferrero, the chocolate firm, has expanded the recall to encompass all Kinder products made at their Arlon site from June to the present date, as per the Food Standards Agency (FSA) update on Friday night.• The initial recall only applied to products with best-before dates up to October 7, 2022, but the new extension includes all products from the mentioned manufacturing site, irrespective of their best-before date.• The UK Health Security Agency (UKHSA) revealed that 63 people, mostly young children, have been infected with Salmonella in the UK, linked to the implicated Kinder products.• Tina Potter, head of incidents at the FSA, emphasized the importance of following the latest recall notice and underscored the necessity for a precautionary approach by the company and Belgian authorities. The collaboration between international partners, including the UK Health Security Agency and Food Standards Scotland, is ongoing to determine the source of the outbreak and prevent further illnesses.• Symptoms of salmonella infection include diarrhea, stomach cramps, nausea, vomiting, and fever. The UKHSA advises anyone concerned about potential salmonellosis to consult their GP or call NHS 111 for guidance. <p>The article provides crucial information regarding the recall and the ongoing investigation into the outbreak of salmonella cases linked to Kinder products.</p>	

Table 6: Summary of article ‘Every Kinder Product That Has Been Recalled Due to Salmonella Concerns’ created by chat GPT (86)

Title of Article:	Boy, Three, is Hospitalised With 'Salmonella Poisoning After Eating a Kinder Egg' As Parents are Warned NOT to Give Children the Chocolate Over Easter as 70 Kids Fall Ill (87)
Date of Published:	16/04/2022
Medium:	The Daily Mail
Type of Medium:	Tabloid
Country of Origin:	United Kingdom
<ul style="list-style-type: none"> • Three-year-old Billy Way from Barry, Wales, was hospitalized after consuming a Kinder egg and was diagnosed with suspected salmonella poisoning. His mother, Kasey Cooke, was shocked when tests revealed traces of salmonella in his feces, leading her to suspect the chocolate as the source of his illness. • The article highlights a UK-wide recall of specific chocolate products, including those manufactured at a Belgian factory since June, which was subsequently closed down, regardless of their best-before date. More than 100 cases of salmonella have been reported, with the majority in children under five. • European health officials suspect that the contamination could have occurred during the processing of buttermilk at the Belgium factory. Cooke is demanding compensation from Ferrero, the company that owns Kinder, but has not yet received a response. • A Ferrero spokesperson expressed regret over the situation and detailed the recall of specific Kinder products. Health agencies, including the Food Standards Agency (FSA) and the UK Health Security Agency (UKHSA), have warned against consuming certain Kinder products, especially over the Easter weekend, emphasizing the severity of salmonella infection. • Dame Jenny Harries, chief executive of the UKHSA, urged caution during the Bank Holiday weekend, reminding people not to consume the recalled products. The article also highlights the severity of salmonella infection and advises anyone with concerns to contact their GP or call NHS 111. 	

Table 7: Summary of article 'Boy, Three, is Hospitalised With 'Salmonella Poisoning After Eating a Kinder Egg' As Parents are Warned NOT to Give Children the Chocolate Over Easter as 70 Kids Fall Ill' created by chat GPT (87)

Title of Article:	Salmonella Alert: Ferrero Chocolate Eggs Being Recalled (88)
Date of Published:	05/04/2022
Medium:	VRT
Type of Medium:	Public Broadcaster
Country of Origin:	Belgium
<ul style="list-style-type: none"> • The FAVV (Federal Agency for the Safety of the Food Chain) has cautioned against the consumption of specific products, including Kinder Surprise, Kinder Surprise Maxi, Schoko-Bons, and Kinder Mini Eggs, all with certain best before dates between July 11, 2022, and October 7, 2022. • Ferrero has agreed with the FAVV's advice that the mentioned products should be returned to the shop, likely for a refund or replacement. • The article discusses the global link between salmonella infections and Ferrero eggs, connecting reported cases in Sweden, the UK, Ireland, France, and Germany to chocolate eggs produced by Ferrero in its plant located in Arlon, Luxembourg Province. • Although the link between salmonella infections and Ferrero eggs is still being investigated in Belgium, the Flemish Care and Health Agency is examining 16 cases identified by the National Reference Lab for Salmonella, analyzing recent samples possibly linked to chocolate products. • The FAVV provided a contact number (0800 13 550) for any inquiries or concerns related to the mentioned products, encouraging individuals to reach out for further information or assistance. 	

Table 8: Summary of article ‘Salmonella Alert: Ferrero Chocolate Eggs Being Recalled’ created by chat GPT (88)

Title of Article:	Salmonella in Kinder Products: 29 Infections Connected to Ferrero Arlon in Belgium (89)
Date of Published:	13/04/2022
Medium:	The Bulletin
Type of Medium:	Magazine
Country of Origin:	Belgium
<ul style="list-style-type: none"> • The Belgian food safety agency, FASFC, has linked 29 cases of salmonella infections in Belgium to the Ferrero factory in Arlon, which produces Kinder Surprise and other popular chocolate products for children. • FASFC reported an additional 20 suspected contamination cases in Belgium in recent months that are under investigation. • In-depth genetic analyses of stool samples by Sciensano, along with patient questionnaires, are underway to determine the link between the cases and Ferrero in Arlon, according to FASFC. • Over 100 cases of salmonellosis related to the Belgian Ferrero site have been reported in various European countries, confirmed through DNA analyses and patient questionnaires, prompting further investigations into suspected cases, primarily among children under 10 who consumed the products. • In response to the situation, production at the Arlon factory has been halted, and a recall has been issued for all Kinder products manufactured between June and the present date. Symptoms of salmonella infection include diarrhea, fever, abdominal pain, and vomiting. 	

Table 9: Summary of article ‘Salmonella in Kinder Products: 29 Infections Connected to Ferrero Arlon in Belgium’ created by chat GPT (89)

Title of Article:	Kinder Chocolate Products in Hungary Recalled Over Potential Salmonella Contamination (90)
Date of Published:	07/04/2022
Medium:	Hungary Today
Type of Medium:	News Portal
Country of Origin:	Hungary
<ul style="list-style-type: none"> • Ferrero has issued a recall of several of its "Kinder" brand products across Europe due to potential contamination with salmonella. Hungary is also affected, with a suspected link to a salmonella outbreak. The recall includes products commonly sold during the Easter season. • The products in question were manufactured at the Ferrero plant in Arlon, Belgium. The Hungarian National Food Chain Safety Office is conducting an investigation into the traceability of the affected products, with specific details available on the agency's website and official Facebook page. • Ferrero Magyarország Kereskedelmi Kft. has identified six products affected by the recall in Hungary, including Kinder Schoko-Bons, Kinder Surprise Maxi, Kinder mix, Kinder Maxi Mix, Kinder Mini-Eggs, and Kinder Happy Moments. • Similar recall campaigns have been initiated in various other European countries, such as Great Britain, France, Luxembourg, and Belgium, particularly affecting Kinder Surprise eggs. • Although no positive salmonella tests have been reported in the products put on the market, Ferrero initiated the voluntary recall as a precautionary measure. Consumers are advised not to consume the recalled products and are encouraged to contact Ferrero's consumer protection team. The typical symptoms of a salmonella infection include diarrhea, vomiting, high fever, and in mild cases, fever and lethargy. 	

Table 10: Summary of article ‘Kinder Chocolate Products in Hungary Recalled Over Potential Salmonella Contamination’ created by chat GPT (90)

4.1.1 Conclusion of the events of MOI 1:

In April 2022, the severity of the contamination can be observed through the media, to a higher extent than other months. These articles focus solely on the events that occurred in April 2022 and do not include information from previous months about the unfolding of the event. The information offered on the events in April 2022, included the name of the recalled products and their best-before dates (86–90). The symptoms of Salmonellosis to be aware of and advice on action to be taken if readers children are displaying them was also reported. The countries with confirmed and suspected cases of Salmonellosis, linked to Kinder products were highlighted, including the population affected, being, children under 10 years of age (86–90). Ferrero's response to the ongoing situation was disclosed in the articles (86,87,89,90). In a Belgian article, we are told about the closure of the factory due to the contaminated products (89). The UK media took a more shocking approach in its articles, as it included pictures of a sick 3-year-old boy and expressed an outraged theme on the events (87). Statements were also included from a political figure, highlighting the seriousness of the consequences involved in the outbreak (86,88–90). Hungarian and Belgian media took a more balanced and factual approach to their article writing. The facts of the matter are relayed, without a prominent emotion running throughout the article.

4.1.2 Similarities in MOI 1:

- All countries included the name of the products being recalled, their best-before dates, symptoms of Salmonellosis, described the link between Salmonellosis and Ferrero's factory in Arlon (86–90).
- All countries mentioned that the recalled products are a popular purchase during the Easter period and should not be consumed (86–90).
- The affected countries were listed in all articles and claimed that over 100 cases had emerged in children under the age of 10 years old (86–90).

4.1.3 Differences in MOI 1:

- VRT News and Hungary Today articles were published on an earlier date than the other articles (88,90). The dates of publishing of these articles are between the 5th and the 7th of April. Due to the difference in publishing dates, to other articles later in April, there was a slight difference in the information reported by the newspapers. Hungary today stated that there had been no positive Salmonella testing of the

products, making the Ferrero recall ‘voluntary’. They used words ‘potential’ and ‘suspected’ when describing the link between the factory and the cases (90). VRT News explained that there was no definite link between the cases in Belgium and the Kinder products, however, the cases were being investigated in a laboratory (88).

- VRT News stated the best before date for the products being recalled was between July 11th and October 7th, 2022 (88). However, in the other articles it was warned that all products, regardless of their best-before dates, should not be consumed. This is due to the difference of timelines between their publishing date (86,87).
- In an article published by The Bulletin on the 13th of April, 29 cases of Salmonellosis in Belgium were confirmed and linked to the outbreak (89). This number differed to the VRT News article, only 8 days prior, reporting that there were no confirmed cases in Belgium linked to Arlon (88).
- The Daily Mail article, published on the 16th of April 2022, told the story of a young boy that was hospitalised from Barry, Wales (87). His symptoms, along with his mother's surprise that the severity of the illness could be caused by the popular Kinder product, were detailed in the article. It was also mentioned that his mother had applied for compensation, however, had not yet received a reply from Ferrero at the time. Ferrero had issued a formal apology to the family (87).
- The British media reported that sixty-three confirmed cases were in their country (86,87).

4.2 Summary of MOI 2: May 2022

Title of Article:	229 Children Contracted Salmonella Linked to Kinder Egg Products (91)
Date of Published:	19/05/2022
Medium:	Metro
Type of Medium:	Tabloid
Country of Origin:	United Kingdom
<ul style="list-style-type: none"> • A significant number of salmonella cases, up to 324, in Europe and the US have been linked to Kinder Egg products. Ferrero withdrew five different products from shelves in April due to suspected connections with the illness. • New data indicates 266 confirmed cases and 58 suspected cases related to the implicated chocolate, with the majority of the affected individuals being children aged 10 and under, accounting for 86.3% of confirmed cases. • Several disturbing cases were highlighted, including that of a three-year-old girl and a three-year-old boy, both of whom were severely ill after consuming Kinder chocolate. The boy's condition was so critical that doctors feared he might slip into a coma due to dangerously low blood sugar levels. • Belgium authorities ordered the closure of the factory in question after discovering salmonella in the buttermilk and certain semi-finished and finished products at the site. However, no traces of the bacteria were found at the Italian company that supplies the buttermilk. • Health officials are closely monitoring the situation and maintaining collaboration with food safety authorities in the affected countries. Metro.co.uk has sought comments from Ferrero regarding the situation. 	

Table 11: Summary of article ‘229 Children Contracted Salmonella Linked to Kinder Egg Products’ created by chat GPT (91)

Title of Article:	Kinder Easter Sales Plunge After Salmonella Scare (92)
Date of Published:	05/05/2022
Medium:	The Grocer
Type of Medium:	Magazine
Country of Origin:	United Kingdom
<ul style="list-style-type: none"> • Kinder's Easter chocolate sales experienced a substantial decline of 58.9% over the four-week period ending on April 16 compared to the corresponding period last year. This drop contributed to a broader 30.1% decrease in total Kinder brand sales, likely due to the recent salmonella-related recalls. • The recall initially involved a range of Kinder Surprise products, which was then expanded to include Mini Eggs, Egg Hunt Kits, and Schoko-Bons, amplifying the impact on sales. • Sales of Kinder's Easter range were severely affected in the two weeks leading up to Easter Sunday, with declines of 70.8% and 85.9% in the weeks ending April 9 and April 16, respectively, compared to the same weeks last year. • A Ferrero spokesperson acknowledged the temporary impact on the Kinder seasonal portfolio due to the recall, expressing confidence in a strong recovery. They highlighted the positive performance of the Kinder brand overall, particularly mentioning Kinder Bueno and Kinder Chocolate. • The article also noted that the decline in sales wasn't exclusive to Kinder, as both Easter and total chocolate sales were down compared to the previous year, likely influenced by consumer concerns about spending and a different shopping environment. 	

Table 12: Summary of article ‘Kinder Easter Sales Plunge After Salmonella Scare’ created by chat GPT (92)

Title of Article:	62 Salmonella Infections Linked to Ferrero Factory in Arlon, Company Apologizes (93)
Date of Published:	13/05/2022
Medium:	RTBF
Type of Medium:	Television Broadcaster
Country of Origin:	Belgium
<ul style="list-style-type: none"> • The Federal Agency for the Safety of the Food Chain (Afsca) in Belgium has identified 62 cases of salmonella contamination linked to the Ferrero factory in Arlon. The survey conducted by Sciensano and the Communities confirmed the connection. • These findings will be reported to the European Center for Disease Prevention and Control (ECDC), which is tracking confirmed cases of salmonellosis in Europe and the UK associated with the Ferrero factory in Arlon. • The Ferrero factory was closed on April 8 following the salmonella contamination incident, prompting Afsca to recall all Kinder products manufactured there and withdraw the site's production authorization. • Ferrero has submitted a new authorization request to restart production at the site, presenting a plan for significant interventions and a reinforced security protocol. Afsca is currently evaluating this plan and is expected to respond by June 3, with a provisional authorization potentially granted, subject to further evaluation after three months. • Ferrero expressed regret over the incident and emphasized its commitment to consumer safety, highlighting the proposed measures to ensure product safety, which are being discussed with Afsca. The company also mentioned the ongoing judicial investigation by the Luxembourg public prosecutor's office related to the matter. 	

Table 13: Summary of article ‘62 Salmonella Infections Linked to Ferrero Factory in Arlon, Company Apologizes’ created by chat GPT (93)

Title of Article:	Salmonella in Kinder Products: Origin of Contamination Determined (94)
Date of Published:	27/05/2022
Medium:	Le Soir
Type of Medium:	Newspaper
Country of Origin:	Belgium
<ul style="list-style-type: none"> • The French general manager of Ferrero acknowledges the massive scale of the product recall, the largest in the last twenty years, due to the health scandal surrounding the salmonella contamination of Kinder products. • More than 3,000 tonnes of Kinder products have been recalled in France, with 81 cases of salmonellosis reported, predominantly among children under ten years old, resulting in significant financial losses for Ferrero, estimated to be in the tens of millions of euros. • The contamination is traced back to a filter in a dairy butter tank at the Arlon factory in Belgium, with the factory being shut down in early April. Ferrero maintains that no contaminated product was put on the market initially and highlights ongoing investigations by the Belgian justice system. • Despite receiving over 150,000 compensation requests, the company has managed to satisfy 90% of them through various vouchers, representing a cost of less than two million euros. Ferrero aims to rebuild consumer trust and plans to reopen the Belgian factory from June 13 with enhanced safety measures and increased external health checks. • In response to the legal action initiated by the consumer defense association Foodwatch France, Ferrero continues to address its failures and implement rigorous safety protocols, alongside efforts to improve its internal monitoring system and quality control measures. 	

Table 14: Summary of article ‘Salmonella in Kinder Products: Origin of Contamination Determined’ created by chat GPT (94)

Title of Article:	An Incredible Amount of Kinder Products Were Destroyed (95)
Date of Published:	27/05/2022
Medium:	RTL
Type of Medium:	Television Channel
Country of Origin:	Hungary
<ul style="list-style-type: none"> • The director of the Ferrero company in France, Nicolas Neykov, addressed the salmonella scandal, which led to the recall of more than three thousand tons of Kinder products in Europe, resulting in a substantial financial impact, estimated to be several tens of millions of euros. • The contamination, caused by Salmonella Typhimurium, was traced back to a filter in a butter tank at Ferrero's Belgian factory in Arlon. The outbreak resulted in numerous children falling ill across Europe, with 81 cases reported in France, 22 of which required hospitalization. • Despite the significant economic losses and damage caused, the company has taken responsibility for the issue, emphasizing that it was not a result of negligence but rather a malfunction in the production process. • Ferrero plans to make significant changes within its operations and has committed to more stringent inspection measures, with 50% of the inspections set to be conducted by an external certified laboratory, including those at its French plant based in Normandy. • The director expressed a willingness to engage with consumer organizations and the government to implement changes in the food industry to prevent such incidents from happening in the future. He underlined the importance of taking proactive measures to ensure consumer safety and rebuild trust in the brand. 	

Table 15: Summary of article ‘An Incredible Amount of Kinder Products Were Destroyed’ created by chat GPT (95)

4.2.1 Conclusion of the events of MOI 2:

In May 2022, a description of the events, that occurred up to that point, were reported. These events are listed as follows; the contamination of *Salmonella Typhimurium* was traced back to the buttermilk filter leading to the closure of factory in April. Nicolas Neykov, the general manager of Ferrero, stated that the Kinder crisis was the biggest product recall in history in 20 years with 3,000 tonnes of products recalled (94,95). The company was estimated to suffer an economic loss of tens of millions of euro, with a decrease in Easter sales of 58.9% and a decrease of 30% in overall sales (92). 150,000 compensation forms were submitted by consumers, costing the company approximately 2 million euro. 90% of consumers were satisfied with their compensation (94). The company requested to reopen in June (94). Confirmed cases rose to 324 since April (91). Ferrero issued an apology and highlighted their commitment to consumers to regain trust, using an external laboratory to execute 50% of their routine quality checks (95). An investigation was initiated by the Belgian authorities to uncover the true responsibility of the contamination, however, the company highlighted that the contamination was due to a mistake in processing and not negligence on their behalf (95). The UK takes a more evocative approach to the story and highlights 2 cases with informative pictures, of a young girl and boy, sick in hospital (91). The remaining two countries keep their descriptions more factual and don't include much detail about affected cases (94,95).

4.2.2 Similarities in MOI 2:

- Belgium and Hungary both relayed Neykov's statement about the event labelling it the biggest product recall in the past 20 years, with 3,000 tonnes of products being recalled (94,95). They both reported the 81 confirmed cases in France (94,95). They addressed Ferrero's request to reopen their factory in June, after the source of contamination was located in a filter in the buttermilk tank, leading to the closure of the factory in April. The ongoing investigation commenced by the Belgian judicial system, in response to the consequences of the event, was mentioned. The company's response to the outbreak is communicated, expressing deep regret and commitment to consumer health and satisfaction. Both newspapers highlighted the economic loss of tens of millions of euro that Ferrero suffered (94,95).
- The UK similarly reported on the closure of the factory due to the infected buttermilk filter and highlighted the company's economic loss, however, gave more detail about their decrease in sales (92).

4.2.3 Differences in MOI 2:

- British media reported that the confirmed number of cases had increased to 324 since April (91).
- Metro, a British newspaper, reported two cases of a young girl and a young boy, being hospitalised due to Salmonellosis from contaminated Kinder products and included shocking photos of the children in their ill states (91).
- Belgian media confirmed 62 cases of Salmonellosis linked to Kinder in their country (93).
- Hungarian media included that Ferrero described the contamination being a result of a mistake in the processing line and not negligence on their part. They reported that Ferrero were taking preventative measures and rebuilding consumer confidence by employing an external laboratory to complete 50% of their safety and quality checks, when the factory reopens (95).

4.3 Summary of MOI 3: June 2022

Title of Article:	WON'T SHELL OUT Furious Parents Still Waiting for Kinder Refunds MONTHS After Recall (96)
Date of Published:	27/06/2022
Medium:	The Sun
Type of Medium:	Newspaper
Country of Origin:	United Kingdom
<ul style="list-style-type: none"> • Parents are expressing frustration over not receiving refunds for their Kinder Eggs following the salmonella contamination incident. • Some customers have criticized Ferrero for providing compensation vouchers that are of lesser value than the products purchased, leading to dissatisfaction among affected individuals. • Despite warnings to avoid consumption due to possible salmonella contamination, more than 150 cases of illness have been linked to Kinder products, mostly affecting young children who experienced symptoms like vomiting, diarrhea, and high fevers. • Customers who purchased the affected products were instructed to take photos and email customer service for a promised refund in the form of vouchers within 28 days. However, numerous complaints have surfaced from individuals who claim to have received no compensation despite disposing of the recalled items. • Disgruntled customers have taken to social media to voice their concerns and criticize Ferrero's response, demanding the return of their money spent on Kinder products. Some have highlighted what they perceive as poor customer service and the company's apparent lack of concern for their issues. 	

Table 16: Summary of article ‘WON'T SHELL OUT Furious Parents Still Waiting for Kinder Refunds MONTHS After Recall’ created by chat GPT (96)

Title of Article:	FERRERO PLANT IN ARLON AUTHORISED TO RESTART PRODUCTION (97)
Date of Published:	17/06/2022
Medium:	Ferrero
Type of Medium:	Food Company
Country of Origin:	United Kingdom
<ul style="list-style-type: none"> • The Ferrero plant in Arlon, Belgium, has received conditional authorization from the Belgian food safety authority (AFSCA) to resume its production lines, following its closure in April due to Salmonella detection. • Ferrero has implemented various measures to prevent a similar situation from occurring again, including extensive cleaning, food safety controls, and the installation of new equipment and pipeline at the factory. • Lapo Civiletti, CEO of Ferrero, expressed regret over the incident and extended apologies to those affected, emphasizing that such an occurrence had never happened in the company's 75-year history. • Philippe Steyaert, Ferrero's Regional Director for the UK and Ireland, reiterated the company's commitment to consumer safety, expressing gratitude to the food safety authorities for their support and guidance throughout the process. • The company encourages consumers who believe they have fallen ill after consuming the recalled products to file a complaint on their website, assuring them that their cases will be carefully assessed and addressed promptly. 	

Table 17: Summary of article ‘FERRERO PLANT IN ARLON AUTHORISED TO RESTART PRODUCTION’ created by chat GPT (97)

Title of Article:	Salmonella in Kinder Products: the Ferrero Factory in Arlon will be able to Produce Again, Under Certain Conditions (98)
Date of Published:	17/06/2022
Medium:	La Libre
Type of Medium:	Newspaper
Country of Origin:	Belgium
Chat GPT Output:	<ul style="list-style-type: none"> • Belgian health authorities have granted conditional approval for the Ferrero factory in Arlon to resume production for a three-month trial period, with strict testing and analysis requirements for all batches of food produced. • Ferrero confirmed the receipt of this conditional authorization and emphasized the extensive cleaning and food safety checks conducted in collaboration with the regulatory agency (Afsca) before the reopening process began. • The company's director of external affairs acknowledged the seriousness of the contamination issue and extended apologies to consumers, highlighting the significant measures taken to prevent a recurrence of such an incident. • The recall of over 3,000 tonnes of Kinder products in France led to substantial financial losses for Ferrero, with the European Center for Disease Prevention and Control reporting several hundred confirmed and probable cases of Salmonella Typhimurium across EU countries and the UK. • Legal investigations have been initiated in multiple countries, including Belgium and France, focusing on issues such as traceability obligations, food safety violations, and endangerment of human health, while Ferrero's management attributed the contamination at the Arlon site to a filter in a dairy butter tank.

Table 18: Summary of article ‘Salmonella in Kinder Products: the Ferrero Factory in Arlon will be able to Produce Again, Under Certain Conditions’ created by chat GPT (98)

Title of the Article:	Salmonellosis in Kinder Products: a Preliminary Investigation is Opened in Paris (99)
Date of Published:	09/06/2022
Medium:	RTBF
Type of Medium:	Television Broadcaster
Country of Origin:	Belgium
Chat GPT Output:	<ul style="list-style-type: none"> • The Paris prosecutor's office opened a preliminary investigation on May 25 into complaints related to salmonella contamination associated with the consumption of Kinder products manufactured by the Ferrero group in a Belgium factory. • The investigation covers charges including "deception aggravated by the danger to human health," "unintentional attacks on physical integrity," and "endangering the lives of others," following complaints from multiple victims' families and a complaint filed by the consumer protection association Foodwatch. • Ferrero recalled all products made in its Arlon, Belgium factory in early April after numerous cases of salmonellosis were reported in various European countries, impacting Kinder Surprise, Kinder Mini Eggs, Kinder Surprise Maxi 100 g, and Kinder Schoko-Bons, regardless of their expiration dates. • The European Center for Disease Prevention and Control (ECDC) recorded a total of 324 confirmed and 58 probable cases of monophasic Salmonella Typhimurium across EU countries and Britain as of May 18, with 118 cases and 22 hospitalizations reported in France by June 2, according to Public Health France. • The investigation reflects concerns over potential health risks and regulatory violations associated with the contamination, prompting legal action and thorough scrutiny of the situation surrounding the Kinder product recalls

Table 19: Summary of article ‘Salmonellosis in Kinder Products: a Preliminary Investigation is Opened in Paris’ created by chat GPT (99)

Title of the Article	Paris Prosecutor’s Office Opens Preliminary Investigation into Salmonella at Ferrero (100)
Date of Published	09/06/2022
Medium	De Tijd
Type of Medium	Newspaper
Country of Origin	Belgium
Chat GPT Output:	
<ul style="list-style-type: none"> • A preliminary investigation has been initiated by the French judiciary, following the outbreak of salmonella at the Ferrero factory in Arlon, which was previously under investigation by the Luxembourg public prosecutor's office. • The shutdown of the Arlon factory on April 8 was due to salmonella contamination, leading to numerous complaints from affected individuals who fell ill as a result. • The French investigation, commenced on May 25, involves charges such as 'deception aggravated by the health risk', 'unintentional damage to bodily integrity', and 'endangering the lives of others'. • The European Center for Disease Prevention and Control (ECDC) has reported a total of 324 confirmed and 58 probable cases of salmonella across Europe, with Belgium accounting for 62 cases linked to the contamination. • Recent developments include searches conducted at six locations by federal judicial authorities and the federal food safety agency, and a delayed restart of production at the Arlon factory. The factory's significance to Ferrero is underscored, with the majority of its products being exported and the employment of 900 workers. 	

Table 20: Summary of article ‘Paris Prosecutor’s Office Opens Preliminary Investigation into Salmonella at Ferrero’ created by chat GPT (100)

4.3.1 Conclusion of the events of MOI 3:

In June 2022, the articles detailed the French judiciary investigation that was initiated in May into Ferrero's company and the charges that were being brought against the company (98–100). The total number of cases were confirmed at 324 across Europe (96,99,100). The company published more apologies about the crisis and urged affected consumers to claim compensation (97). However, there was an increase in consumer complaints about not receiving their refunds or receiving a refund of lesser value than what they were owed (96). There was also coverage on permission being granted to the factory to open under a provisional period (97).

4.3.2 Similarities in MOI 3:

- Both countries reported on the number of cases that were confirmed at the time (96,99,100).
- Both countries included Ferrero's apology and information about compensation for affected consumers (96–98).
- Both countries reported that authorisation had been granted to the factory in Arlon to resume production under conditional circumstances and listed information about these conditions (97,98).
-

4.3.3 Differences in MOI 3:

- The British media covered more in-depth information about the aspect of compensation in relation to the event and gave detail about consumer satisfaction following refund requests(96).
- The Belgian media, in contrast, provided a detailed description about the legal aspect of the event and the way in which the authorities were handling the outbreak (98–100).

4.4 Infographics illustrating the Kinder Chocolate Salmonella Outbreak Case

4.4.1 Line Chart on the Media Interest on the Kinder Chocolate *Salmonella* Outbreak Case

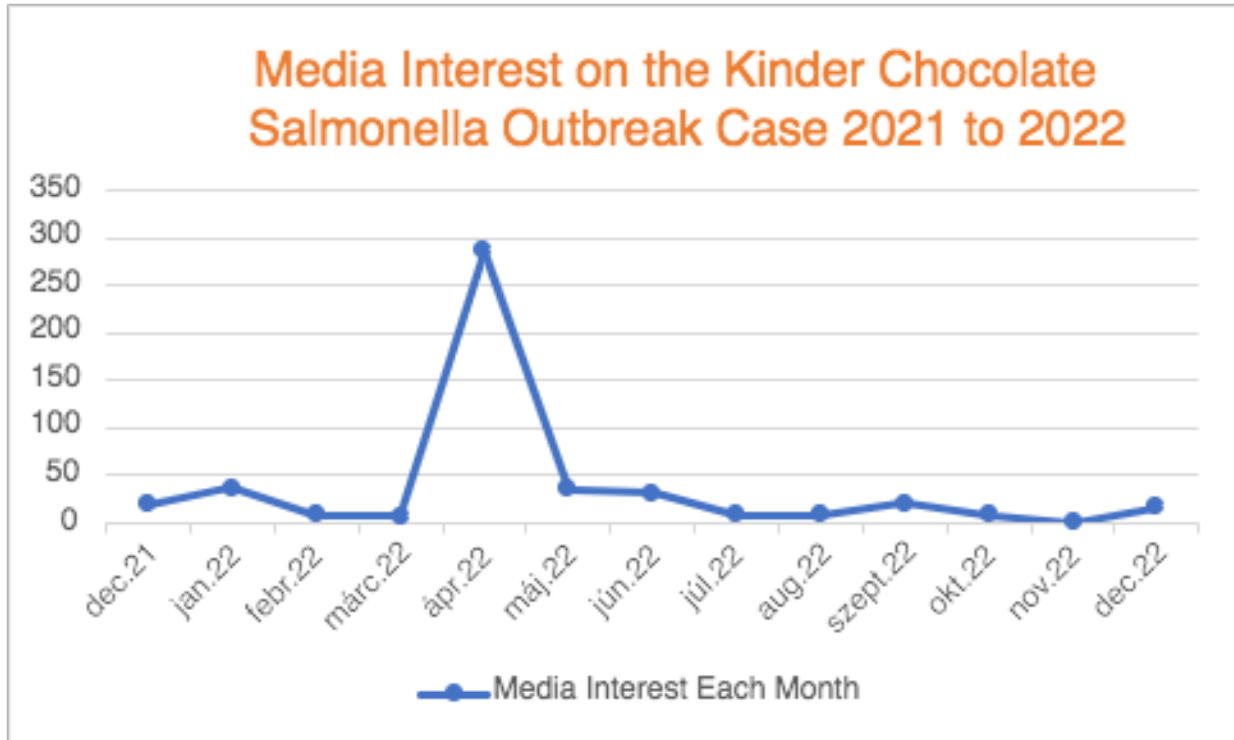


Figure 12: ‘Line Chart Representing the Media Hits on the Kinder chocolate *Salmonella* Case’

The figure above shows that the media interest in the Kinder Chocolate Salmonella Outbreak case peaked in April 2022 with 287 searches. This was an enormous surge in media interest, in comparison to previous months, for example, February 2022, averaging 9 searches. In the months after, similarly, the interest was much lower, however, there remained some media interest until October 2022, where the searches dropped to near zero again.

4.4.2 Timeline of the milestones of the Kinder Chocolate *Salmonella* Outbreak

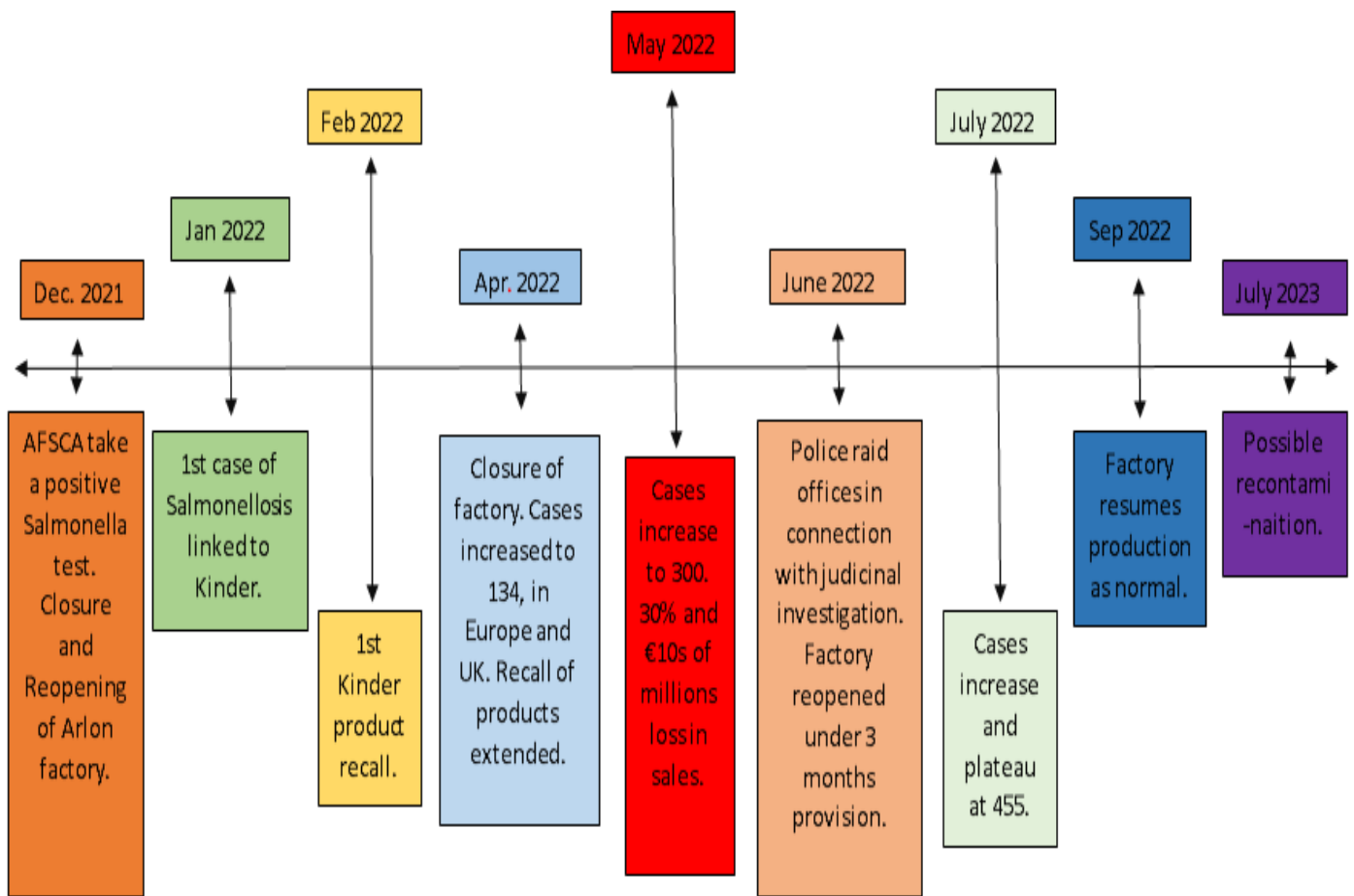


Figure 13: ‘Summary of the Milestones of the Kinder Chocolate *Salmonella* Outbreak Case’

Figure 13 displays the important milestones in the media depiction of the Kinder chocolate *Salmonella* outbreak, throughout the period from December 2021 to July 2023.

4.4.3 Table representing number of cases involved in the Kinder Chocolate *Salmonella* Outbreak Case

Table 21: ‘Number of Cases Each Month Between February and July 2022’

Number of Cases Each Month Between February and July 2022	
February	18 (101)
March	57 (61)
April	151 (70)
May	266 (91)
June	445 (63)
July	455 (66)

5. Discussion:

The Kinder chocolate *Salmonella* outbreak case affected a total of 455 confirmed people, in over 16 countries, by the end of July 2022 (66). Ferrero's general manager, Neykov, labelled it the largest food product recall in over 20 years (60). This recall shows that a simple hygiene error during production can cost company millions in cash, loss of consumer trust and damage to their reputation. The Kinder case highlights the importance of food safety and good hygiene practices within a food operation. Regular health checks are a necessity in the prevention of hygiene errors and damages. The priority of the safety and health of the public, especially when providing a service, should never be overlooked or taken for granted.

Although Ferrero closed their factory in Arlon in December 2021 to investigate the cause of the positive *Salmonella* test, the source was not identified, and production resumed after negative tests were obtained from a batch of end products (59,60). Even though it is unattainable to test every single end-product produced in a factory, this method of batch testing, evidently, was not meticulous enough to prevent the consequences to come from not taking the appropriate time to locate the source of the contamination. A well-maintained HACCP system is essential for the minimisation of food safety risk (29,31,32). HACCP is a process-oriented approach, in contrast to entirely relying on end-product testing. Ferrero needed to implement HACCP and identify the hazard along the production line and insert a new critical control point in the buttermilk tank, and possibly elsewhere. Authorities should acknowledge that in this case, solely testing end products after retrieving positive contamination tests is not sufficient to rule out contamination of the production line. More of an effort should have been made to locate the source along the line, thus the contamination could have been accurately eliminated from the process. Later, between the months of January and April, the repercussions of not sourcing the contamination can be observed as cases of Salmonellosis, mainly in children under 10 years of age, began to catapult (70). These cases of *Salmonella* Typhimurium were linked to that of the sample found in the factory. Some of these cases were severe enough to place children in hospital, the Daily Mail reporting that one mother proclaimed that her 3-year-old son 'looked like he was dying' (87). This boy almost slipped into a coma following low blood sugars after infection.

The Kinder case is not an exclusive incident of product contamination to occur in history. As mentioned previously, the Jack in the Box case and the Blue Bell Creameries case were likewise responsible for endangering public health following contaminations in their

production process (35,40,41,43). Primarily children, some long-term into adulthood, were affected by these contaminations of *E. Coli* and *Listeria Monocytogenes*. The significance of poor hygiene standards can pose a serious risk, even death, to people's health and should not be managed with negligence or imprudence. Food hygiene is a relatively new concept in society and is constantly evolving and improving (56). This also means that there is much room for improvement, therefore, it is important to observe past mistakes that have led to recalls and public health implications, to learn from them and mitigate the likelihood of reoccurrence across food operations.

In this case, Ferrero took the case seriously when it was too late, and a large number of contaminated products had already reached the market (70). The positive Salmonella test, in December 2021, was a warning sign for the company and if treated to the same extent as it was in April 2022, the source could have been located sooner and possibly a much lower scale product recall would have preceded (67). Ferrero could have recalled the products much sooner, when the first positive test was realized in December 2021. Their method of communication should have also been much more affirmative and serious, instead of a 'voluntarily' recalling the products in February 2022 (90). As written in an article by Just Food, in June 2023, a delay occurred between the report of the contamination in Ferrero's factory and the worldwide product recall (71). RASFF, as mentioned above, is a rapid alert system that accommodates swift communication between authorities and food business organizations to allow immediate action to be taken when a hazard is detected in a food processing plant (57,58). This in turn allows the public to be alerted as quickly as possible of possible dangers to their health. The health implications suffered by many children could, have been avoided if all of these issues had been addressed and should be acknowledged by other food operators. Early intervention may have cost the company in the short term, however, prevented the millions of euros spent on the cost of the product recall in the long term and consumer trust could have remained intact. Consumers generate the essential revenue that businesses need to survive, therefore, their needs and trust should take priority over expenditure.

The literature review and results of the summary from Chat GPT produced similar information about the Kinder chocolate *Salmonella* outbreak case. However, due to the limitations for processing of the articles by Chat GPT, restricting the search to 3 months and 3 countries revealed only a portion of the events that occurred throughout the recall. The

global search, completed in the literature review, covers a more comprehensive overview of the recall and acknowledges every step involved in the event from December 2021 to present. The author concludes that the events that were broadcasted in the articles, published by the local British, Belgian and Hungarian newspapers, in the results section, were slightly more detailed and covered a more in-depth representation of the individual events that happened in the period between April and June 2022. An example of this can be seen in the Daily Mail's and Metro's articles which present details about 2 specific cases of Salmonellosis, linked to Kinder products, including pictures (87,91). A deeper insight is reported into the French judiciary investigation that was initiated in June 2022 in local Belgian newspapers (99,100). The author observed that the British media sensationalised their articles through strong, emotive language, both in the title of the pieces and throughout the articles. An example of this is seen in the title of the article by the Sun, as follows, 'Won't shell out Furious parents still waiting for kinder refunds MONTHS after recall' (96). The newspaper uses evocative language, such as 'furious' in the title and capitalises the word 'MONTHS' to overemphasise parents' irritation over not yet receiving compensation from Ferrero (96). The author further notices that the UK media reported from a consumer's point of view and highlighted the complications that affected people suffered from, for example, the portrayal of individual's cases and updates on Ferrero's progression with compensation (87,96). All of these instances were reported by affected individuals. Both the local Belgian and Hungarian newspapers, offered a more neutral and factual based depiction of the events, their sources being mainly, Ferrero and the food safety authorities of each country (88–90,93–95,98–100).

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