

Analysis of food alerts in Italy and the European Union from 2019 to 2024: trends, risk categories, and implications for food safety

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ABSTRACT

Food safety alerts represent a crucial mechanism for identifying vulnerabilities and mitigating risks within the food supply chain. Analyzing data from national alerts is essential for improving targeted official controls and protecting consumer health. This study aims to assess the trends, distribution, and characteristics of food safety alarms in Italy over a seven-year period (2018-2024), focusing on food categories, types of hazards, and product origins. A comprehensive dataset of 2,572 food safety reports was extracted from the RASFF Annual Reports and the Official Controls of the Italian Ministry of Health. The data were systematically categorized and analyzed based on hazard classification (biological, chemical, and physical) and product origin. A total of 2,572 notifications were analyzed, showing a steady increase in alerts, peaking in 2024 with 441 cases. Biological risks were the main threat, making up 36.9% of all notifications, with *Salmonella* spp. (39.5%) and *Listeria monocytogenes* (25.5%) identified as the main pathogens. Chemical risks accounted for 25.8% of cases, mainly due to pesticide residues (34.3%), followed by physical risks (6.9%). The most frequently involved food category was 'Fish and seafood' (16.9%). Regarding origin, 43.1% of non-compliant products came from EU countries, 41.5% from non-EU countries, and 15.4% were of Italian origin. The results highlight the crucial role of continuous monitoring and show increased efficiency of the Italian food safety surveillance system. The persistent prevalence of biological contamination and the emergence of chemical risks emphasize the need to strengthen preventive measures and risk-based controls, especially for highly imported product categories like seafood.

INTRODUCTION

Food safety is one of the fundamental pillars of modern public health. Within this framework, the Rapid Alert System for Food and Feed (RASFF) is the primary mechanism for the rapid and coordinated exchange of information on direct or indirect risks to human health. Established under Article 50 of Regulation (EC) No. 178/2002, the system ensures an effective response at the European level by facilitating the circulation of information among the European Commission, the European Food Safety Authority (EFSA), and the Member States.

Article 50 states:

"Each Member State shall immediately notify the Commission of any information relating to food or feed that may present a serious risk to human or animal health."

Accordingly, whenever a food product or feed is considered potentially hazardous, the competent authority of the Member State is required to notify

the European Commission without delay. After verifying the completeness and consistency of the information received, the Commission disseminates the notification to all members of the RASFF network, thereby enabling a coordinated and timely response throughout the European Union.

The iRASFF information platform is the operational tool supporting the system, as it enables the electronic management of notifications and facilitates immediate communication among the European Commission, Member States, and the competent authorities.

In Italy, the operational implementation of the system is regulated by the Guidelines for the Management of the Food Alert System, most recently updated through the State-Regions Agreement of 5 May 2021. This document defines the communication flows among the national, regional, and local levels and clarifies the responsibilities of Food Business Operators (FBOs) and the Competent Authorities (Local Health Authorities – ASLs).



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The Italian system is organized through a network of Contact Points (CPs):

- National Contact Point: Ministry of Health, Directorate General for Hygiene, Food Safety and Nutrition (DGISAN), responsible for validating notifications before forwarding them to the European Commission.
- Regional Contact Point: Coordinates activities at the regional level and validates notifications submitted by Local Contact Points.
- Local Contact Point (ASL): Represents the operational core of the system. It enters notifications into the iRASFF platform and manages the information flows related to the activities of the prevention departments, including the Food Hygiene and Nutrition Service (SIAN) and the Veterinary Food Hygiene Service (SIAOA).

Food alerts may arise from official controls, food business operators' self-monitoring activities, consumer complaints, or investigations into Foodborne Diseases (FBDs).

Notifications are classified as follows:

- Alert notification: A notification concerning a risk that requires, or may require, rapid action in one or more Italian regions or Member States of the RASFF network.
- Information notification: A notification concerning a risk that does not require rapid action in other regions or Member States. This category is further divided into:
 - Information notification for follow-up: Relates to a product already on the market, or that may be placed on the market, in one or more regions or Member States.
 - Information notification for attention: Relates to a product present only in the notifying

region or Member State, or that has not been placed on the market or is no longer available at the time of notification.

- Border rejection notification: Concerns the refusal of entry into the European Union of a consignment, container, or shipment of food or feed due to a health risk, pursuant to Article 50 of Regulation (EC) No. 178/2002.
- News notification: A communication entered into the iRASFF system concerning a risk related to food, feed, or food contact materials (FCMs) originating from informal sources, containing unverified information or referring to products not yet unequivocally identified.

When a food product is considered potentially hazardous and an alert is issued, withdrawal and/or recall measures may be implemented, supported by the traceability requirements established under Regulation (EC) No. 178/2002.

Although often confused, withdrawal and recall are distinct procedures serving different purposes.

A withdrawal is intended to prevent the distribution, display, and sale of a non-compliant product to consumers. It is implemented when the food has left the manufacturing facility but remains within the distribution chain (e.g., warehouses, distribution centers, or retail shelves). The food business operator is required to inform the competent authorities, remove the product from the market, and notify downstream operators to stop further distribution and return the affected products.

A recall is the most stringent measure and is implemented when the product may already have reached the final consumer. In such cases, commercial withdrawal alone is insufficient to protect public health. The food business operator must therefore:

- Inform consumers effectively and accurately about the reasons for the recall (e.g., undeclared allergens, *Salmonella* contamination, or foreign bodies).



- Use all available communication channels, including in-store notices, websites, social media, and press releases.
- Provide clear instructions on how consumers should handle the affected product (e.g., “Do not consume the product and return it to the point of sale”).

In Italy, product recalls are also published on the Ministry of Health’s official website.

The effectiveness of the RASFF is challenged each year by emerging public health threats and structural changes within the agri-food supply chain. To understand the magnitude of these challenges, it is essential to examine the trends in original notifications submitted between 2021 and 2024, a period characterized by significant changes, including the post-COVID-19 pandemic phase, and by historically high numbers of notifications.

Although the operation of the RASFF is well established by legislation, the scientific literature indicates that the analysis of raw notification data alone does not accurately reflect the true level of food safety. Fluctuations in the number of alerts often mirror the effectiveness of national surveillance systems and the impact of global events—such as the SARS-CoV-2 pandemic—rather than genuine changes in biological or chemical hazards.

The present study was conceived to address this important knowledge gap. While annual institutional reports provide a quantitative overview of notifications (Italian Ministry of Health, 2024), no study has yet systematically examined the relationship between changes in the number of food alerts and fluctuations in sampling and inspection activities carried out across Italy. This article therefore seeks to overcome this fragmentation by integrating multiple data sources to determine whether the historically high number of notifications observed during the post-pandemic period reflects an actual increase in food safety risks or, rather, the enhanced sensitivity and effectiveness of the Italian official control system.

The study aims to answer the following research questions:

- Is the increase in the number of food alerts attributable to a higher number of samples collected?
- Is the increase in the number of food alerts attributable to a higher number of official inspections carried out?

Study Objectives

The present study aims to analyse the temporal evolution of food alert notifications recorded within the Rapid Alert System for Food and Feed (RASFF), with particular reference to data from Italy and the European Union over the period 2019–2024. At the time of writing, the most recent annual RASFF report available covered the year 2024.

The study is based on the hypothesis that the number of food alert notifications has shown a steady increase over recent years.

Accordingly, the study seeks to evaluate both the quantitative and qualitative trends in RASFF notifications in order to identify any significant changes over time.

Specifically, the objectives are to:

- Monitor the quantitative trend of notifications: Assess changes in the number of food alerts and determine whether these are associated with an increase in the number of official inspections and food samples analysed.
- Identify the main risk categories: Determine which food products are most frequently involved in notifications and identify the predominant hazards, including microbiological, chemical (e.g., pesticide residues), and physical hazards (e.g., foreign bodies).
- Investigate major critical events: Examine specific incidents or events that may have significantly influenced notification trends during the study period.

Overall, the study aims to provide a comprehensive overview of whether the increase in food alert notifications observed in recent years reflects



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the enhanced performance of an increasingly comprehensive and technologically advanced food safety surveillance system, capable of detecting emerging risks before they reach the final consumer.

MATERIALS AND METHODS

The methodology adopted for this study consisted of three main phases: (i) multi-source document collection, (ii) extraction and categorisation of quantitative and qualitative data, and (iii) correlation analysis performed using Microsoft Excel.

The study used official documents published by the Italian Ministry of Health – Directorate General for Hygiene, Food Safety and Nutrition (DGISAN) as its primary data sources.

- RASFF data: Annual reports of the Rapid Alert System for Food and Feed (RASFF) covering the period 2021–2024 were reviewed, with particular emphasis on the analysis of original notifications submitted within the European network.
- National Official Controls: Official control activities were analysed using the annual reports of the Multi-Annual National Control Plan (MANCP) for the period 2021–2024, focusing on inspection and sampling activities carried out by the competent authorities.

The extracted data were organised according to predefined variables to facilitate the analysis of temporal trends and the evolution of the observed phenomena.

The analysis of the Rapid Alert System for Food and Feed (RASFF) annual reports shows a progressive increase in food alert notifications over the study period. The total number of notifications increased from 3,783 in 2020 to 5,268 in 2024, representing the highest value recorded since the establishment of the system. Following the decline associated with the COVID-19 pandemic, the RASFF recorded a steady increase in notifications, as illustrated in the table below.

Year	Number of food alert notifications
2021	4.588
2022	4.339
2023	4.683
2024	5.268

In 2021, the number of RASFF notifications increased markedly compared with 2020, when 3,783 notifications had been recorded, representing an increase of 21.3%. The most frequently reported hazards were pesticide residues and Salmonella contamination.

In 2022, a slight decrease in the total number of notifications was observed; however, significant outbreaks involving monophasic Salmonella Typhimurium and Listeria monocytogenes were reported.

During 2023 and 2024, pathogenic microorganisms became the leading cause of food alert notifications, particularly Salmonella spp., Listeria monocytogenes, and Escherichia coli, while pesticide residues remained the second most frequently reported hazard.

Among the notifying countries, Germany, the Netherlands, and Italy consistently ranked among the most active reporters. The principal countries of origin of non-compliant products were Turkey, China, and India.

The food categories most frequently involved in notifications were fruits and vegetables, nuts and seeds, meat and poultry products, food supplements, and, in recent years, ready-to-eat foods and food contact materials (FCMs).

The main food safety hazards identified were:

- Microbiological hazards, primarily Salmonella spp. and Listeria monocytogenes;
 - Chemical hazards, particularly pesticide residues, mycotoxins, and heavy metals.
- With regard to official sampling activities, data relating to food samples were extracted and analysed, with particular emphasis on samples tested for microbiological criteria and pesticide residues. This methodological approach was adopted because microbiological hazards and chemical hazards—



particularly pesticide residues—represented the most frequently reported risk categories within the RASFF during the study period.

Microbiological analyses

- 2021: 24,772 samples analysed for microbiological criteria, of which 580 were non-compliant.
- 2022: 33,036 samples analysed, of which 938 were non-compliant.
- 2023: 33,342 samples analysed, of which 868 were non-compliant.
- 2024: 34,684 samples analysed, of which 1,149 were non-compliant.

Pesticide residue analyses

- A similar trend was observed for pesticide residue monitoring:
- 2021: 10,543 samples analysed, of which 69 were non-compliant.
 - 2022: 9,120 samples analysed, of which 40 were non-compliant.
 - 2023: 10,655 samples analysed, of which 130 were non-compliant.
 - 2024: 11,330 samples analysed, of which 139 were non-compliant.

Anno / Year	Numero Campioni Ricerche Microbiologiche / Number of Samples for Microbiological Analysis
2021	24.772
2022	33.036
2023	33.342
2024	34.684

Anno / Year	Numero Campioni per Ricerca Pesticidi/Samples for Pesticide Analysis
2021	10.543
2022	9.120
2023	10.655
2024	11.330

RESULTS

The data collected and analysed during the study enabled a quantitative assessment of the trends in RASFF notifications and official sampling activities carried out in Italy during the four-year period 2021–2024.

In order to address the research questions concerning the actual sensitivity of the food control system, the statistical association between territorial analytical activities (distinguished into microbiological and chemical–pesticide investigations) and the overall evolution of recorded food alerts was evaluated.

The linear correlation analysis (Pearson correlation coefficient) revealed markedly different patterns depending on the target hazard considered (biological vs. chemical–pesticide hazards).

The quantitative analysis showed a progressive increase in the number of samples analysed for microbiological criteria, rising from 24,772 samples in 2021 to 34,684 samples in 2024 (+39.9%). In parallel, the rate of microbiological non-compliances showed an increasing trend, rising from 580 non-compliant samples in 2021 to 1,149 in 2024, representing an almost two-fold increase in positive findings.

However, the application of the correlation test between the number of microbiological samples analysed and the total number of RASFF alerts recorded during the same period resulted in a weak-to-moderate correlation coefficient ($r = 0.371$).

It should be specified that the parameter “Number of alerts” used in the statistical analysis refers to the total number of original notifications recorded within the RASFF system, and not exclusively to notifications resulting from microbiological non-compliances.

A summary of the analysed data is provided in the table below.



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Year	Number of Samples for Microbiological Testing	Number of Alerts (RASFF)	Non-Compliant Samples
2021	24,772	4,588	580
2022	33,036	4,339	938
2023	33,342	4,683	868
2024	34,684	5,268	1,149
CORRELATION	–	0.371514152	–

This value suggests that the overall increase in food alerts cannot be explained solely by a simple increase in the volume of microbiological controls carried out at the national level. Other factors, such as the occurrence of unexpected multinational outbreaks (e.g., *Salmonella* or *Listeria*), appear to exert a predominant influence on biological hazard notifications.

A completely different pattern emerged from the analysis of chemical contaminants, specifically pesticide residues. The number of samples analysed for this class of substances showed a slight decrease in 2022 (9,120 samples), followed by a steady increase, reaching 11,330 samples in 2024. Associated non-compliances increased from 69 in 2021 to 139 in 2024 (+101.4%).

In this case, the linear correlation analysis between the number of samples analysed for pesticide residues and the overall volume of RASFF notifications showed an extremely strong and positive correlation coefficient ($r = 0.884$).

DISCUSSION

The findings obtained from the statistical analysis provide important insights into the intrinsic nature of official controls and the actual epidemiological significance of RASFF notifications during the four-year period 2021–2024. The most relevant aspect is the marked divergence observed between the dynamics of chemical risks (pesticides) and those of biological risks (microbiological hazards). This demonstrates that the trend in food alerts is not driven by a single determining factor, but is influenced by fundamentally different sampling strategies and hazard dissemination mechanisms.

The strong positive correlation observed between the number of samples analysed for pesticide residues and the total number of alerts suggests that chemical risk can be defined as a “screening-driven risk.”

In the field of pesticide residues, there is an almost mathematical relationship between analytical effort and the detection of non-compliances. The

Year	Number of Samples Tested for Pesticide Residues	Number of Alerts (RASFF)	Non-Compliant Samples
2021	10,543	4,588	69
2022	9,120	4,339	40
2023	10,655	4,683	130
2024	11,330	5,268	139
CORRELATION	–	0.884016942	–

This statistical result indicates a very strong linear relationship: the annual fluctuations in the overall number of food alerts closely mirror the intensity and coverage of the analytical screening programmes implemented for pesticide residues.

more Competent Authorities invest in sampling programmes, using increasingly sensitive and broad-spectrum multi-residue analytical methods, the greater the probability of detecting unauthorised active substances or concentrations exceeding the Maximum Residue Levels (MRLs).

Furthermore, pesticide contamination is generally associated with non-compliant agricultural practices at the production origin (often in third countries), which tend to be distributed relatively uniformly within batches of raw materials (e.g., fruit, vegetables, seeds). Consequently, the detection of such violations is directly proportional to the coverage of the monitoring network and the frequency of border and national controls. In other words, the increase in alerts within this sector does not necessarily indicate a deterioration in global agricultural practices, but rather reflects the excellent ability of the control system to detect hazards in those areas where analytical resources are concentrated.

Conversely, the weak-to-moderate correlation observed in the microbiological sector highlights that the presence of pathogens does not follow a linear proportional relationship with the volume of routine controls carried out at the territorial level.

The reasons underlying this statistical asymmetry are multiple and structural:

For microbiological hazards, the causal relationship between sampling activity and food alerts is disrupted by the occurrence of large-scale outbreak events. A single non-compliance originating from a large industrial facility may generate hundreds of follow-up notifications and related alerts across the European Union. Such peaks in notifications occur independently of the volume of standard local sampling activities.

Unlike pesticide residues, whose presence in food is the result of a deliberate application (although non-compliant), microbiological contamination is often an accidental event influenced by biological, hygienic, and environmental variables that are difficult to predict.

Microbiological controls are strongly affected by seasonal dynamics and by targeted interventions following investigations of foodborne diseases (FBDs). Consequently, many microbiological samples are collected following suspicion or during emergency situations, which may distort the linearity of historical trends compared with a standardised annual monitoring plan.

CONCLUSIONS

This study analysed the evolution of food alert notifications within the RASFF system during the post-pandemic period (2021–2024), investigating the relationship between the historical increase in notifications and the actual effort devoted to official controls (sampling activities) at the national level in Italy.

The results obtained allow the initial research questions to be addressed.

Is the higher number of alerts due to a higher number of samples?

The answer is dichotomous and depends strictly on the nature of the hazard:

- Yes, for chemical risks (pesticides): A linear relationship exists, demonstrating that the increase in alerts is the direct consequence of more extensive and targeted sampling campaigns.
- No, for biological risks: No direct correlation was observed. The increase in alerts related to microbiological hazards is driven by stochastic epidemiological dynamics, in which individual contamination events can generate cascading notifications independently of the volume of routine sampling activities.

The analysis conducted suggests that effective public health protection relies on a dual-track strategy, which Competent Authorities will need to further refine in the coming years.

Since pesticide and chemical contaminant risks follow a screening-based pattern, control effectiveness can be maximised by allocating financial and analytical resources towards historically critical food matrices and countries of origin (e.g., fruit and vegetables imported from third countries), while optimising multi-residue testing approaches.

Since microbiological emergencies cannot be managed through linear planning, maintaining a very high capacity for rapid response is essential. Tools such as traceability systems, product withdrawal and recall procedures, and genomic sequencing



technologies—which allow rapid comparison between bacterial strains isolated from patients and those detected in food products—represent indispensable pillars for containing outbreaks at an early stage.

In conclusion, the RASFF system and the network of national contact points represent essential pillars

of European public health protection. This study demonstrates that the integration of multi-source data flows represents the most effective approach for correctly interpreting surveillance statistics, transforming raw data into meaningful indicators of the effectiveness of food control systems aimed at protecting consumers.

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