NATIONAL PUBLIC
HEALTH ORGANIZATION

EPIDEMIOLOGICAL DATA FOR FOODBORNE/WATERBORNE CLUSTERS/OUTBREAKS IN GREECE 2004-2024

MANDATORY NOTIFICATION SYSTEM

Key points

- For the period 2004-2024:
  - In total, 712 foodborne/waterborne clusters/outbreaks were reported
  - Most of the reported clusters/outbreaks were caused by bacteria, with *Salmonella* spp. being the most frequently reported causative agent
  - There is a seasonal pattern, with an increase in summer months, a peak in August and a subsequent decrease
  - More than half of the reported clusters/outbreaks regarded only one household (domestic)
  - The decrease in the number of reported clusters/outbreaks, in 2021, is probably associated with the COVID-19 pandemic.
  - In 2024, the notification rate increased by 20.1% compared to 2023.

The term foodborne/waterborne cluster refers to two or more cases with similar symptoms, usually gastrointestinal (diarrhoea and/or vomiting), which can be attributed to the consumption of the same food item or water of the same origin. The term foodborne/waterborne outbreak refers to a situation where the observed number of cases of a foodborne/waterborne disease exceeds the expected number in a specific population and in a specific area[1].

In Greece, the surveillance of foodborne/waterborne clusters/outbreaks was introduced to the mandatory notification system in 2004.

Time trend

During 2004-2024, 712 foodborne/waterborne clusters/outbreaks were notified. The total number of reported clusters/outbreaks per year is presented in **Table 1**. The median annual number of reported clusters/outbreaks was 34 (min: 6, max: 72). In the years 2024 and 2023, the notification rate increased by 20.1% and 77.3% respectively compared to the previous years, 2023 and 2022. The foodborne/waterborne clusters/outbreaks notification rate for the period of interest is depicted in **Graph 1**.

Seasonality

The number of reported clusters/outbreaks, for the period 2004-2024, increased during summer reaching a peak in August, and decreased in the following months. The mean monthly notification rate of clusters/outbreaks per 1,000,000 population is depicted in **Graph 2**.

Geographical distribution

The highest mean annual notification rate for the period 2004-2024 was recorded for the region of Peloponnese (5.23 clusters/outbreaks per 1,000,000 population) and the lowest for Western Greece (2.04 clusters/outbreaks per 1,000,000 population). The mean annual notification rate of reported clusters/outbreaks by region is depicted in **Figure 1**.

Causative agents

The causative agent was known for 553 (77.7%) of the clusters/outbreaks. The majority (n=521, 94.2%) were caused by bacteria, and *Salmonella* spp. was the most frequently identified pathogen. *Salmonella* Enteritidis was responsible for 109 (24.0%) of the 455 (87.3%) reported salmonellosis clusters/outbreaks. In 2023, the reported number of salmonellosis clusters/outbreaks increased by 85.7% compared to 2022. Hepatitis A virus, norovirus and rotavirus were the most identified viruses.

Table 2 presents the distribution of reported clusters/outbreaks by year and causative agent for the years 2004-2024.

Type and size of the clusters/outbreaks

During 2004-2024, the median number of cases per cluster/outbreak was 4 (min: 2, max: 702). The median number of cases for the 620 (87.1%) of them that referred to closed populations was 3 (min: 2, max: 213). Out of these 620 clusters/outbreaks, 399 (64.4%) were

domestic (affecting only members of the same household). Eighty-nine (12.6%) clusters/outbreaks, in open populations, were reported. In those, the median number of cases was 20 (min: 2, max: 702).

Cluster/Outbreak investigation

Descriptive epidemiology: Descriptive data (number of cases, symptoms, date of disease onset, etc.) were collected for all reported clusters/outbreaks through telephone communications with physicians and/or patients.

Analytical epidemiology: An analytical epidemiological study was conducted in 46 (6.5%) clusters/outbreaks [2-13]. In specific, in 25 (54.3%) a cohort study and in 19 (41.3%) a case-control study was conducted, while in one (2.2%) cluster/outbreak both study designs were performed. Finally, on one (2.2%) occasion a case-control and a case-crossover study were conducted. **Table 3** summarises the characteristics of the clusters/outbreaks for which the analytical study resulted in a possible vehicle of transmission.

Laboratory investigation: Laboratory investigation of clinical samples (stool/blood culture or other test) was conducted in 589 (84.4%) of the reported clusters/outbreaks.

Environmental investigation: The competent bodies conducted an environmental investigation by visiting the place of preparation or consumption of the suspected foodstuff/meal in 63 (75.0%) clusters/outbreaks in open populations and 172 (32.8%) involving closed populations. The Regional Public Health Directorates investigated 180 (76.3%) clusters/outbreaks, the National Food Agency nine (3.8%), whereas teams from both bodies participated in the environmental investigation of 25 (10.6%).

Results of cluster/outbreak investigation

Fourteen (2.0%) clusters/outbreaks were travel related. In 653 (93.6%) of the remaining clusters/outbreaks the results of the epidemiological investigation indicated foodborne transmission, while 45 (6.4%) were attributed to water consumption.

Household was the place of consumption of the suspected foodstuff in 274 (47.5%) clusters/outbreaks, a restaurant/fast food in 169 (29.3%), and a hotel in 38 (6.6%).

Poultry (141 clusters/outbreaks), eggs (107 clusters/outbreaks) and dairy products (39 clusters/outbreaks) were the most frequently incriminated foodstuffs. In most cases, information was derived from descriptive epidemiological data without laboratory confirmation or analytical epidemiological studies.

Conclusion

A significant number of food-borne/water-borne clusters/outbreaks are reported and investigated every year in Greece. The fact that *Salmonella* spp. is the prevailing causative agent is consistent with data from other European countries (1,115 of 5,691 (19.6%) foodborne clusters/outbreaks were caused by *Salmonella* spp. in EU in 2023) [14]. This finding could also explain the similar seasonal distribution of the number of clusters/outbreaks and of salmonellosis sporadic cases. Epidemiological, laboratory and environmental investigation provide valuable information regarding the most common vehicles of transmission, causative agents and contributing factors for the occurrence of foodborne/waterborne clusters/outbreaks in our country.

The decrease in the number of reported clusters/outbreaks, in 2021, is probably associated with the COVID-19 pandemic. This is a finding compatible with those of other European countries [14].

The increase in the notification rate of foodborne/waterborne clusters/outbreaks in 2023, and in the number of reported salmonellosis clusters/outbreaks are consistent with that observed in the reported incidence of the disease [15]. A smaller-scale increase was also observed in 2024.

The observed increase in the notification rate of foodborne/waterborne diseases clusters/outbreaks after the COVID-19 pandemic in Greece is a concern for other European countries as well [14], and it is likely attributed to multiple factors, such as the more frequent use of multiplex PCR technology, the rising temperatures within the context of climate change, food safety issues, and the enhancement of event based surveillance systems for the early detection of outbreaks, that require further investigation.

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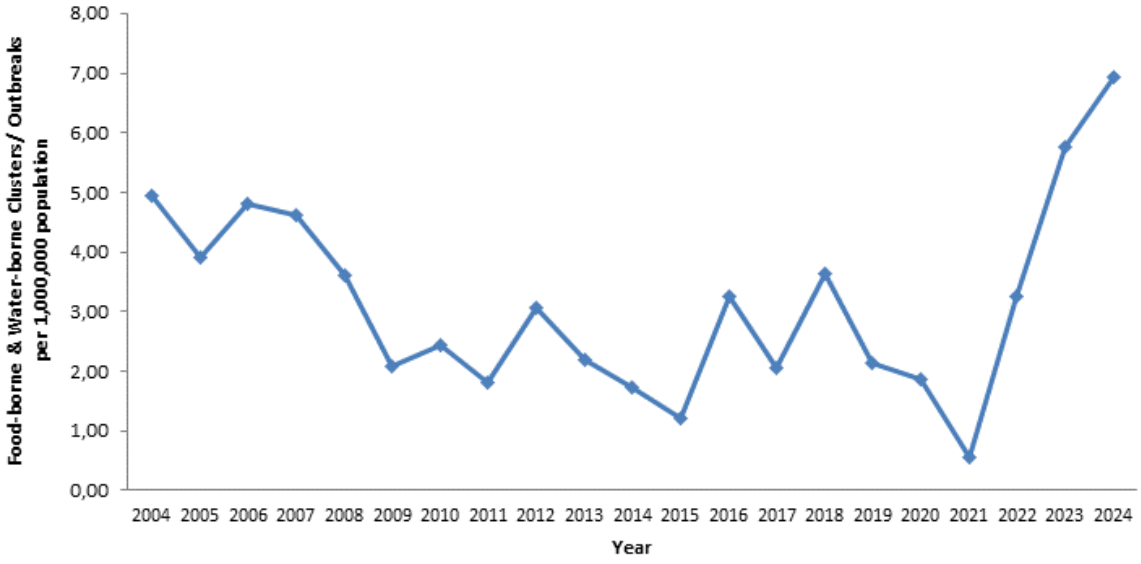
Table 1. Distribution of the reported clusters/outbreaks by year, Greece, Mandatory Notification System, 2004-2024*.

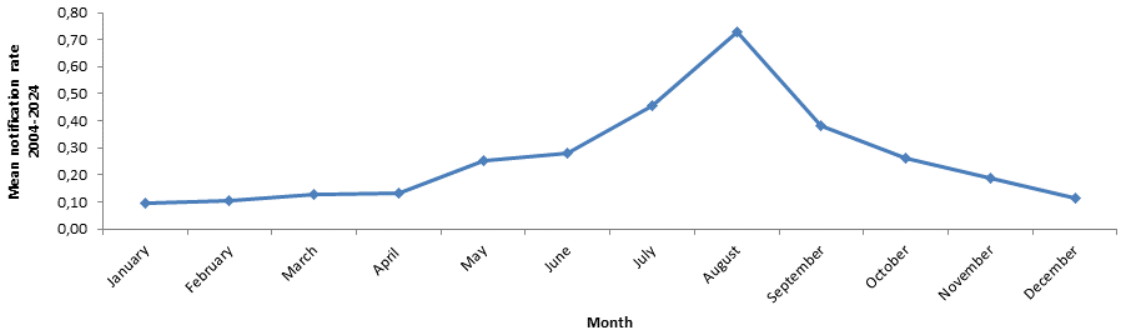
Year	Foodborne clusters/outbreaks	Waterborne clusters/outbreaks	Total
2004	48	5	53
2005	41	2	43
2006	50	2	52
2007	49	0	49
2008	40	0	40
2009	21	2	23
2010	26	1	27
2011	18	1	19
2012	29	4	33
2013	18	5	23
2014	17	2	19
2015	10	3	13
2016	31	3	34
2017	21	1	22

2018	37	1	38
2019	17	5	22
2020	19	1	20
2021	5	1	6
2022	31	3	34
2023	57	1	58
2024	68	2	70

*Fourteen travel related clusters/outbreaks were excluded



Graph 1. Mean annual notification rate of clusters/outbreaks (number of reported clusters/outbreaks per 1,000,000 population), Mandatory Notification System, Greece, 2004-2024



Graph 2. Mean notification rate of foodborne/waterborne clusters/outbreaks (number of clusters/outbreaks per 1,000,000 population) by month, Mandatory Notification System, Greece, 2004-2024.

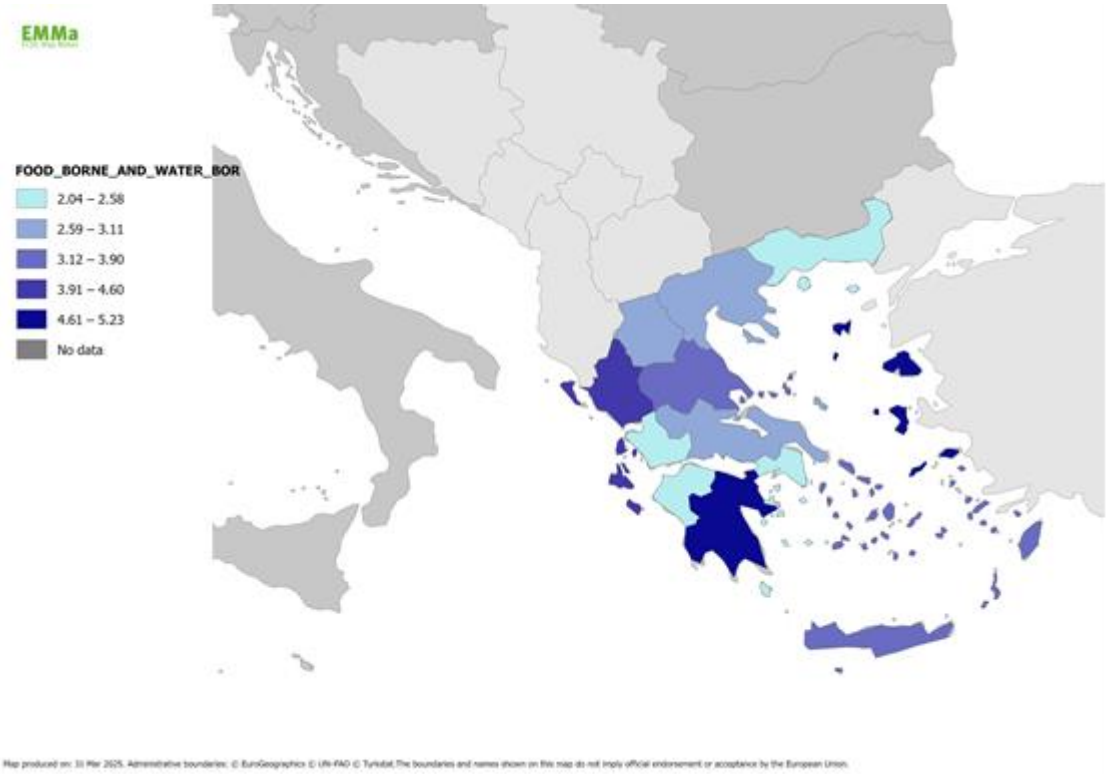


Figure 1. Mean annual notification rate (clusters/outbreaks per 1,000,000 population) of reported clusters/outbreaks by region, Mandatory Notification System, Greece, 2004-2024.

Table 2. Distribution of the reported clusters/outbreaks by year and causative agent, Greece, Mandatory Notification System, 2004-2024.

	***Salmonella* spp.**	**Other bacteria**	**Viruses**	**Parasites**	**Unknown**	**Total**
2004	36	1	0	0	17	54

2005	33	0	2	0	8	43
2006	40	1	1	0	11	53
2007	29	4	6	0	12	51
2008	34	1	0	0	5	40
2009	18	4	0	0	1	23
2010	12	4	1	1	9	27
2011	16	1	1	0	2	20
2012	20	5	5	0	4	34
2013	10	3	1	0	10	24
2014	6	2	0	0	11	19
2015	4	2	4	0	3	13
2016	22	1	1	0	11	35
2017	16	2	0	0	4	22
2018	29	2	2	0	6	39
2019	13	2	2	0	6	23
2020	13	3	0	0	4	20
2021	4	1	0	0	1	6
2022	21	5	0	0	8	34
2023	39	10	1	1	9	60
2024	42	10	2	1	17	72

Table 3. Main characteristics of foodborne/waterborne clusters/outbreaks for which an analytical epidemiological study was conducted, Greece, 2004-2024.

Pathogen – Year*	Number of cases†	Number of lab-confirmed cases‡	Region	Type of study	Implicated foodstuff
Salmonella spp. - 2004	17	4	Attica	Cohort	Cheese pie
Unknown - 2004	73	0	Crete	Cohort	Veal
S. Typhimurium - 2004	37	35	Crete	Case - Control	Water
Unknown – 2005	39	0	Thessaly	Cohort	Egg
Salmonella spp. - 2005	38	2	Central Greece	Cohort	Lamp

Pathogen – Year*	Number of cases†	Number of lab-confirmed cases‡	Region	Type of study	Implicated foodstuff
Salmonella spp. - 2005	30	12	Attica	Cohort	Desert
S. Enteritidis - 2005	67	11	Attica	Cohort	Egg
S. Enteritidis - 2005	133	70	Crete	Case - Control	Cheese
S. arizonae - 2006	31	6	Peloponnese	Cohort	Side dish
Brucella melitensis - 2008	131	104	Eastern Macedonia - Thrace	Case - Control	Raw cheese
Campylobacter jejuni - 2009	54	54	Crete	Case – Control & Case-crossover	Water
Unknown - 2010	16	0	Central Macedonia	Cohort	Carbonara sause
Unknown - 2010	62	0	Northern Aegean	Cohort	Seafood
Norovirus/ Adenovirus - 2011	36	2	Attica	Case-Control	Salad
Norovirus/ Adenovirus-2012	80	4	Central Macedonia	Cohort	Tap water
Rotavirus-2012	986	29	Thessaly	Case-Control	Tap water
Unknown-2012	19	0	Attica	Cohort	Pork
Unknown-2013	8	0	Attica	Cohort	Desert
Unknown-2013	42	0	Attica	Cohort	Pork
Unknown-2014	13	0	Ionian Islands	Cohort	Spaghetti bolognese
Norovirus-2015	256	7	Central Macedonia	Case-Control	Tap water
S. Enteritidis - 2016	23	6	Western Greece	Case-Control	Spaghetti
S. Enteritidis - 2016	83	22	Central Greece	Case-Control	Mac and cheese
Salmonella Typhimurium 1,4 [5],12:i:- -2017	40	40	Thessaly and Central Macedonia	Case-Control	Pork
Salmonella Typhimurium 1,4 [5],12:i:- -2017	42	42	Attica and Central Macedonia	Case-Control	Milk
S. Enteritidis - 2018	15	7	Central Macedonia	Cohort	Desert/Cake
Unknown-2018	24	0	Central Greece	Cohort	Tap water
Mixed aetiology: Norovirus, *Campylobacter*	638	10	Western Macedonia	Case-Control & Cohort	Tap water

Pathogen – Year*	Number of cases†	Number of lab-confirmed cases‡	Region	Type of study	Implicated foodstuff
jejuni, EHEC, EPEC-2019					
Clostridium perfringens-2019	58	0	Central Macedonia	Cohort	Spaghetti bolognese
VTEC O157, *Salmonella spp*., EPEC, *E.coli* O157-2020	58	7	Peloponnese	Case-Control	Tap water
Clostridium perfringens-2021	30	2	Northern Aegean	Cohort	Spaghetti bolognese
Salmonella Bovismorbificans *-2022*	40	8	Peloponnese	Case-Control	Tap water
Salmonella Enteritidis-2023	69	5	Epirus	Cohort	Chicken
S. Bovismorbificans -2024	144	20	Thessaly	Case-Control	Tap water
Staphylococcus aureus, (SEB)-2024	38	4	Attica	Cohort	Meat product

*In some clusters/outbreaks the identification of the causative agent was not possible, either because the notification of the cluster/outbreak was delayed or because the laboratory capacity of local health care services was limited

†Total number of cases (possible and laboratory confirmed cases)

‡ Number of laboratory- confirmed cases

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