



EPIDEMIOLOGICAL DATA FOR FOODBORNE / WATERBORNE OUTBREAKS IN GREECE 2004-2022

MANDATORY NOTIFICATION SYSTEM

Key points

- For the period 2004-2022:
 - In total, 580 outbreaks were reported
 - The majority of the reported 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 outbreaks regarded only one household (domestic outbreaks)
- The decrease in the number of the reported foodborne/waterborne outbreaks, in 2021, is probably associated with the COVID-19 pandemic.

The term foodborne / waterborne outbreak 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 [1]. In Greece, the surveillance of foodborne / waterborne outbreaks was introduced to the mandatory notification system in 2004.

Time trend

During 2004-2022, 580 foodborne / waterborne outbreaks were notified. The total number of reported outbreaks per year is presented in **Table 1**. The median annual number of reported outbreaks was 27 (min: 6, max: 54). The foodborne / waterborne outbreaks notification rate for the years 2004-2022 is depicted in **Graph 1**.

Seasonality

The number of reported outbreaks, for the period 2004-2022, increased during summer reaching a peak in August, and decreased in the following months. The mean monthly notification rate of outbreaks per 1,000,000 population is depicted in **Graph 2**.

Geographical distribution

The highest mean annual notification rate for the period 2004-2022 was recorded for the region of Ionian Islands (4.8 outbreaks/1,000,000 population) and the lowest for Western Greece (2.0 outbreaks/1,000,000 population). The mean annual notification rate of reported outbreaks by region for the period 2004-2022 is depicted in **Figure 1**.

Causative agents

The causative agent was known for 447 (77.1%) of the outbreaks. Most of the reported outbreaks (n=420, 94.0%) were caused by bacteria, and *Salmonella* spp. was the most frequently identified pathogen. *Salmonella* Enteritidis was responsible for 94 (25.1%) of the 374 (89.0%) reported salmonellosis outbreaks. Hepatitis A virus, norovirus and rotavirus were the most commonly identified viruses.

Table 2 presents the distribution of the reported outbreaks by year and causative agent for the years 2004-2022.

Type and size of the outbreaks

During 2004-2022, the median number of cases per outbreak was 4 (min: 2, max: 986). The median number of cases for the 499 (86.5%) of them that referred to closed populations was 3 (min: 2, max: 213). Out of these 499 outbreaks, 311 (62.3%) were domestic (affecting only members of the same household). Seventy-eight (13.5%) outbreaks, in open populations, were reported. In these outbreaks, the median number of cases was 21 (min: 2, max: 986).

Outbreak investigation

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

Analytical epidemiology: An analytical epidemiological study was conducted in 41 (7.2%) outbreaks [2-13]. In specific, in 23 (56.1%) outbreaks a cohort study and in 16 (39.0%) a case-control study was conducted, while in one (2.4%) outbreak both study designs were

performed. Finally, in one (2.4%) study a case-control and a case-crossover study were conducted. **Table 3** summarises the characteristics of the outbreaks for which the analytical study resulted at a possible vehicle of transmission.

Laboratory investigation: Laboratory investigation of clinical samples (stool/blood culture or other test) was conducted in 494 (86.0%) of the reported outbreaks.

Environmental investigation: The competent bodies conducted an environmental investigation by visiting the place of preparation or consumption of the suspected foodstuff/meal in 56 (72.0%) outbreaks in open populations and 146 (29.2%) outbreaks involving closed populations. The Regional Public Health Directorates investigated 155 (75.9%) outbreaks, the National Food Agency nine (4.4%), whereas teams from both bodies participated in the environmental investigation of 18 (8.8%) outbreaks.

Results of outbreak investigation

Ten (1.8%) outbreaks were travel-related. In 528 (92.6%) of the remaining outbreaks the results of the epidemiological investigation indicated foodborne transmission, while 42 (7.4%) were attributed to water consumption.

Household was the place of consumption of the suspected foodstuff in 212 (46.0%) outbreaks, a restaurant/fast food in 129 (28.0%), and a hotel in 34 (7.4%).

Eggs (93 outbreaks), poultry (94 outbreaks) and dairy products (36 outbreaks) were the most frequently incriminated foodstuffs. In most cases, information derived from descriptive epidemiological data without laboratory confirmation.

Conclusion

A significant number of food-borne/water-borne 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 (773 of 4,005 (19.3%) foodborne outbreaks were caused by *Salmonella* spp. in EU in 2021) [14]. This finding could also explain the similar seasonal distribution of the number of 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 outbreaks in our country.

The decrease in the number of the reported foodborne/waterborne outbreaks, in 2021, is probably associated with the COVID-19 pandemic. Reduction of visits in healthcare services due to the fear of people of contracting COVID-19, prolonged lockdowns, mitigation

measures related to social events and the closure of restaurants, and other hygiene and safety measures may have reduced population exposure to contaminated food. In addition, the COVID-19 pandemic may have led to a higher under-reporting of outbreaks. This is a finding compatible with those of other European countries [14].

References

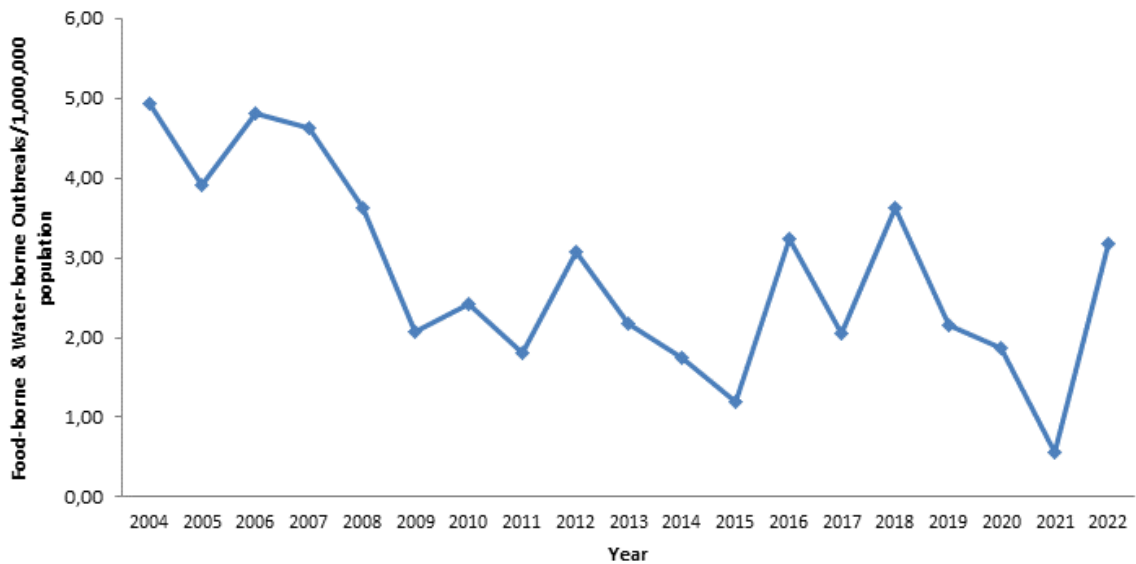
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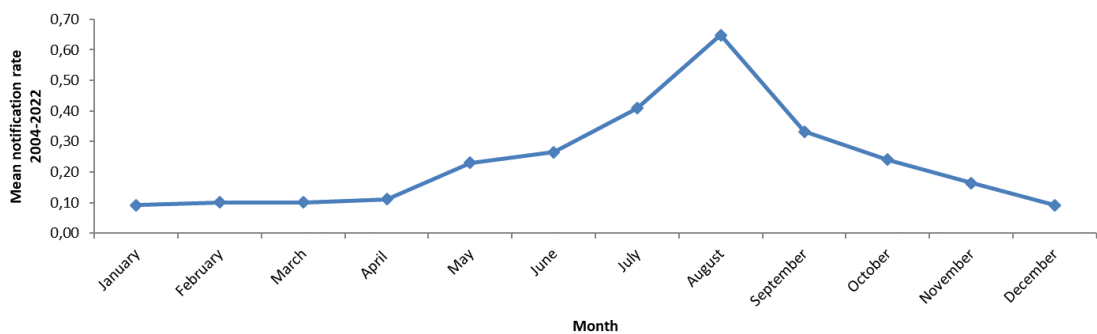
Table 1. Distribution of the reported outbreaks by year, Greece, Mandatory Notification System, 2004-2022*.

Year	Foodborne outbreaks	Waterborne 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

*Ten travel related outbreaks were excluded



Graph 1. Mean annual notification rate of outbreaks (number of reported outbreaks per 1,000,000 population), Mandatory Notification System, Greece, 2004-2022.



Graph 2. Mean notification rate of foodborne / waterborne outbreaks (number of outbreaks/1,000,000 population) by month, Mandatory Notification System, Greece, 2004-2022.

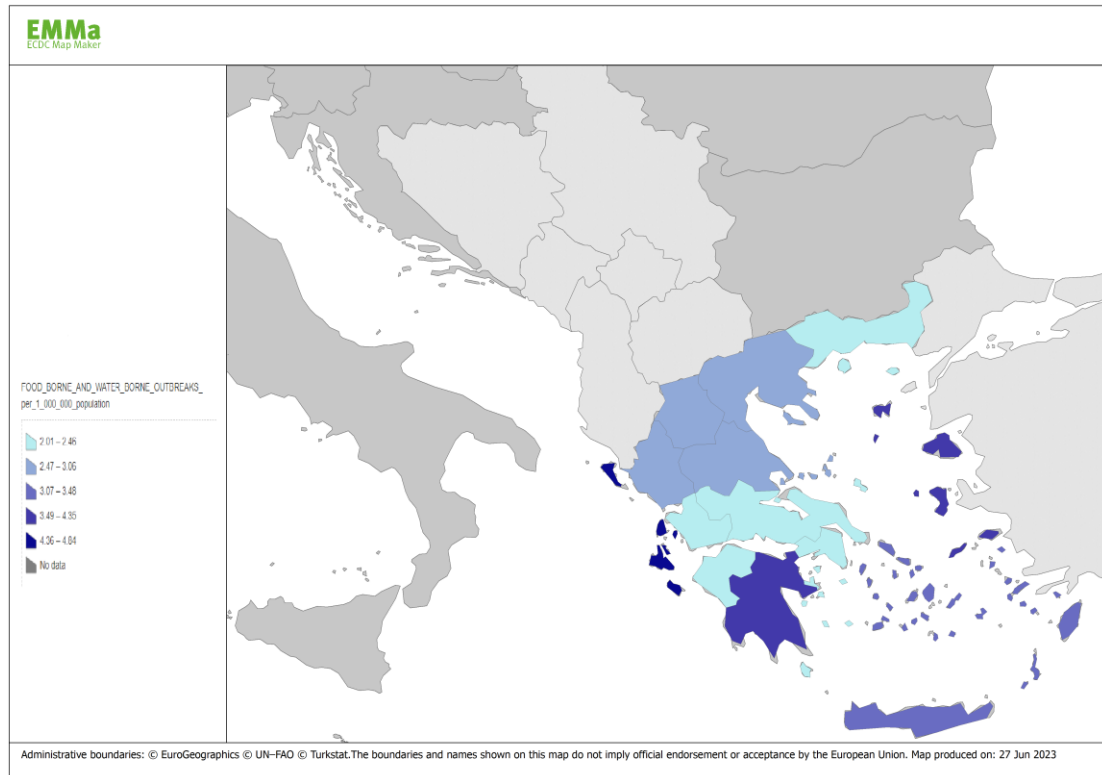


Figure 1. Mean annual notification rate (outbreaks/1,000,000 population) of reported outbreaks by region, Mandatory Notification System, Greece, 2004-2022.

Table 2. Distribution of the reported outbreaks by year and causative agent, Greece, Mandatory Notification System, 2004-2022.

	<i>Salmonella</i> 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

Table 3. Main characteristics of foodborne / waterborne outbreaks for which an analytical epidemiological study was conducted, Greece, 2004-2022.

Pathogen – Year*	Number of cases[†]	Number of lab-confirmed cases	Region	Type of study	Implicated foodstuff
<i>Salmonella</i> spp. - 2004	17	4	Attica	Cohort	Cheese pie
Unknown - 2004	73	0	Crete	Cohort	Veal
<i>S. Typhimurium</i> - 2004	37	35	Crete	Case - Control	Water
Unknown – 2005	39	0	Thessaly	Cohort	Egg
<i>Salmonella</i> spp. - 2005	38	2	Central Greece	Cohort	Lamp
<i>Salmonella</i> spp. - 2005	30	12	Attica	Cohort	Desert
<i>S. Enteritidis</i> - 2005	67	11	Attica	Cohort	Egg
<i>S. Enteritidis</i> - 2005	133	70	Crete	Case - Control	Cheese
<i>S.arizonae</i> - 2006	31	6	Peloponnese	Cohort	Side dish
<i>Brucella melitensis</i> - 2008	131	104	Eastern Macedonia - Thrace	Case - Control	Raw cheese
<i>Campylobacter jejuni</i> - 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

Pathogen – Year*	Number of cases [†]	Number of lab-confirmed cases	Region	Type of study	Implicated foodstuff
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
<i>Salmonella</i> Typhimurium 1,4 [5],12:i:- -2017	40	40	Thessaly and Central Macedonia	Case-Control	Pork
<i>Salmonella</i> 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, <i>Campylobacter jejuni</i> , EHEC, EPEC-2019	638	10	Western Macedonia	Case-Control & Cohort	Tap water
<i>Clostridium perfringens</i> -2019	58	0	Central Macedonia	Cohort	Spaghetti bolognese
VTEC O157, <i>Salmonella spp.</i> , EPEC, <i>E.coli</i> O157-2020	58	7	Peloponnese	Case-Control	Tap water
<i>Clostridium perfringens</i> -2021	30	2	Northern Aegean	Cohort	Spaghetti bolognese
<i>Salmonella</i> Bovismorbificans -2022	40	8	Peloponnese	Case-Control	Tap water

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

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

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