FELLOWSHIP REPORT

Summary of work activities
Myrsini Tzani
Intervention Epidemiology path (EPIET)
Cohort 2018

Background

The ECDC Fellowship Training Programme includes two distinct curricular pathways: Intervention Epidemiology Training (EPIET) and Public Health Microbiology Training (EUPHEM). After the two-year training EPIET and EUPHEM graduates are considered experts in applying epidemiological or microbiological methods to provide evidence to guide public health interventions for communicable disease prevention and control.

Both curriculum paths are part of the ECDC fellowship programme that provides competency based training and practical experience using the 'learning by doing' approach in acknowledged training sites across the European Union (EU) and European Economic Area (EEA) Member States.

Intervention Epidemiology path (EPIET)

Field epidemiology aims to apply epidemiologic methods in day to day public health field conditions in order to generate new knowledge and scientific evidence for public health decision making. The context is often complex and difficult to control, which challenges study design and interpretation of study results. However, often in Public Health we lack the opportunity to perform controlled trials and we are faced with the need to design observational studies as best as we can. Field epidemiologists use epidemiology as a tool to design, evaluate or improve interventions to protect the health of a population.

The European Programme for Intervention Epidemiology Training (EPIET) was created in 1995. Its purpose is to create a network of highly trained field epidemiologists in the European Union, thereby strengthening the public health epidemiology workforce at Member State and EU/EEA level. Current EPIET alumni are providing expertise in response activities and strengthening capacity for communicable disease surveillance and control inside and beyond the EU. In 2006 EPIET was integrated into the core activities of ECDC.

The objectives of the ECDC Fellowship - EPIET path are:

- To strengthen the surveillance of infectious diseases and other public health issues in Member States and at EU level;

- To develop response capacity for effective field investigation and control at national and community level to meet public health threats;
- To develop a European network of public health epidemiologists who use standard methods and share common objectives;
- To contribute to the development of the community network for the surveillance and control of communicable diseases.

Fellows develop core competencies in field epidemiology mainly through project or activity work, but also partly through participation in training modules. Outputs are presented in accordance with the EPIET competency domains, as set out in the ECDC Fellowship Programme Manual.

Pre-fellowship short biography

Myrsini Tzani holds a Bachelor of Science in Veterinary Medicine from the Veterinary School of the Aristotle's University in Thessaloniki, Greece and a Master of Science from the National School of Public Health of the University of West Attika in Athens, Greece. From 1996 to March 2002 she worked as a private veterinarian in her own veterinary clinic and as from 22 of March 2002 she was appointed in the Department of Zoonoses of the Animal Health Directorate of the General Veterinary Directorate of the Hellenic Ministry of Rural Development and Food in Athens, Greece. Since January 2012 until September 2018 she was the head of the Department of Zoonoses. Myrsini was designated as the Greek national expert for salmonella and until now she is a member of the EFSA's scientific network on zoonoses. In September 2018 she started her EPIET-fellowship as an MS-track fellow as this was a great opportunity for her to gain experience in different public health aspects and grow both as a public health professional and person.

Fellowship assignment: Intervention Epidemiology path (EPIET)

On 11/09/2018, Myrsini Tzani started her EPIET fellowship at the Hellenic National Public Health Organisation (former Hellenic Centre for Disease Control and Prevention) in Athens, Greece, under the supervision of Dr. Kassiani Mellou. Her frontline coordinator was initially Dr Biagio Pendalino, followed by Dr Marion Muehlen, Dr Alicia Barrasa, and Dr Frantiska Hruba. This report summarizes the work performed during this fellowship.

Fellowship portfolio

This portfolio presents a summary of all work activities (unless restricted due to confidentiality regulations) conducted by the fellow during the ECDC Fellowship, EPIET path. These activities include various projects, and theoretical training modules.

Projects included epidemiological contributions to public health event detection and investigation (surveillance and outbreaks); applied epidemiology field research; teaching epidemiology; summarising and communicating scientific evidence and activities with a specific epidemiology focus. The outcomes include publications, presentations, posters, reports and teaching materials prepared by the fellow.

This portfolio also includes a reflection from the fellow on the field epidemiology competencies developed during the 2-year training, a reflection from the supervisor on the added value of engaging in the training of the fellow, as well as a reflection by the programme coordinator on the development of the fellow's competencies.

Fellowship projects

1. Surveillance

1.1 Leishmaniasis in humans in Greece 2004-2018. Summary of the epidemiological data and evaluation of the surveillance system

1.a Leishmaniasis in humans in Greece, 2004-2018. Evaluation of the surveillance system.

Leishmaniasis is a mandatory notifiable disease in Greece and each case should be notified to the National Public Health Organisation (EODY) within one week after diagnosis. The aim of the project was to evaluate the existing surveillance system in order to identify the gaps and provide recommendations for improving surveillance of the disease. This was the first time such an evaluation was conducted.

We evaluated timeliness, completeness and validity of the surveillance system. We evaluated timeliness of the disease's notification and calculated the median completeness and validity of the recording information, both for all the variables under assessment and per category of variables; demographic data, possible exposures, clinical manifestations, and laboratory data.
Between 2004 to 2018, in total 940 leishmaniasis cases were recorded. The median time of notification could not be calculated due to the absence of a specific variable for the date of diagnosis.

The median completeness for all 42 variables that were evaluated was 83.1% (range: 2.8-100). Clinical manifestations presented the highest completeness (87.6%, range: 58% -98%), while laboratory data the lowest (42.13%, range: 9.6% -88%).
Median validity was 97.1% (range: 3.3% -100%). Demographics presented the highest validity (99.6%, range: 51.2% -100%), while laboratory data the lowest (78.9%, range: 8.3% -96.5%).

With the exception of the variables related to the laboratory data, where significant deficiencies were identified, the overall completeness and validity of information recording in the system was satisfactory. However, it was impossible to evaluate timeliness of notification. We recommended improvement of the notification form, the inclusion of a variable for the time of diagnosis and the training of both clinical and laboratory doctors as well as of the staff responsible for the receipt of the notification forms and data entry.

1.1.b Leishmaniasis in humans in Greece, 2004-2018. Analysis of the available surveillance data.

Human leishmaniasis is listed by WHO as a neglected tropical disease and is not under surveillance at European level.
We summarised the surveillance data for visceral (VL) and cutaneous (CL) leishmaniasis for 2004-2018 in Greece in order to better understand the epidemiology of leishmaniasis in the country, assess the disease's public health importance, raise awareness of decision makers and develop a sustainable action plan for its management and control.

We extracted data from the mandatory notification system. A case was defined as an individual with clinical manifestations compatible with VL or CL and laboratory confirmation. We analysed separately VL and CL, imported and domestic cases.

Overall, 881 VL (862 domestic and 19 imported) and 58 CL cases (24 domestic and 34 imported) were recorded in 2004-2018.
The mean annual notification rate of domestic VL was 0.5/100,000 (range: 0.12-1.43/100,000) with a statistically significant increasing trend (p =0.013). Cases were reported by all regions. The highest notification rate was recorded in the 0-4 years age-group (1.3/100,000). Among cases 24% (164/680) were immunosuppressed.
The mean annual notification rate of domestic CL was 0.05/100,000 (range:0.01-0.19/100,000) with highest rate in the age-group 5-14 years (0.03/100,000). Cases were recorded in six of the 13 regions and 3% (1/31) were immunosuppressed.
Among imported CL cases, 85% were foreigners, mainly refugees/migrants originating from Syrian Arab Republic (8/23) and Afganistan (7/23).

VL is endemic in Greece, with an increasing trend and a considerable burden as it causes severe disease with young children being the most affected. CL is a sporadic disease in the country. A sustainable action plan is needed for reducing the burden of VL and preventing local transmission of CL.

Role and outputs: Myrsini was the principal investigator. Initially she evaluated the database and informed the respective authority for the results. This was the first time this database was evaluated, and this procedure resulted in the cleaning of the database. Afterwards she conducted data analyses and created a report (14). She also prepared two abstracts (6,9); one for a poster presentation at ESCAIDE 2019. Finally she was the first author in the manuscript which was submitted to Eurosurveillance (1).

Supervisor(s): Dr Danai Pervanidou (Hellenic Public Health Organisation (EODY)), Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:
Myrsini developed competencies to evaluate surveillance systems and provide epidemiological advice on improvement of surveillance systems, to analyse and interpret the time component of surveillance data, to perform data analyses in STATA, to analyse and interpret the surveillance data to generate information for action and to effectively communicate the results of her work in the form of a structured surveillance report and poster and oral presentations.

1.2 Evaluation of the laboratory capacity for the diagnosis of leishmaniasis in Greece in 2018

Leishmaniasis is a public health problem in many parts of the world. Visceral (VL) and cutaneous (CL) leishmaniasis are the most common forms of the disease. Greece is endemic for zoonotic VL. Reported cases of anthroponotic CL are sporadic. The mean annual notification rate of domestic VL and CL cases was 0.49/100,000 and 0.05/100,000, respectively for the period 2004-2018. For the first time, we evaluated the laboratory capacity of Greek hospitals to diagnose leishmaniasis, in order to explore areas for improvement.

A structured questionnaire was dispatched to the microbiological laboratories of all country's public hospitals. Diagnostic methods used, typing capacity and collaboration with other laboratories for diagnosis of leishmaniasis were recorded. Data were analysed as a whole, by region and by method of testing, i.e. parasitological testing, which is the reference diagnostic method used for the disease, serological and molecular testing.

Feedback was provided by 56 of the 110 hospitals (response rate 51%); of these, 25 (45%) reported a capacity to diagnose the disease. Capacity varied among different regions of the country with hospitals in Attica (area of the capital of the country) reporting the highest (52%) capacity overall.
Serology was performed by 16/56 (64%) hospitals, followed by parasitology (52%). PCR capacity was low (1 hospital). Three (12%) hospitals could type leishmania species, all located in Attica region; two of them reported capacity for typing *L. donovani* complex, one *L. donovani donovani* and one *L. donovani infantum*. No hospital could type *L. tropica* or other species.

There is suboptimal capacity to diagnose leishmaniasis in Greece with significant geographical variation. Future efforts should focus on enhancing diagnostic capacity preferably through the development of a network of specialised laboratories coordinated by a national reference lab, including the development of typing methods for the timely detection of new species that may emerge in Greece.

Role and outputs: Myrsini was the principal investigator. In collaboration with her supervisors she created the questionnaire form and adapted instructions for data collection. Myrsini also conducted data analyses and prepared a report (15) and an abstract for a poster presentation at ESCMID 2020 (7).

Supervisor(s): Dr Danai Pervanidou (Hellenic Public Health Organisation (EODY)), Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:
Myrsini developed competencies to make questionnaires and guidelines adapted to the target authorities, to perform data analyses in STATA, to analyse and interpret the surveillance data to generate information for action and to effectively communicate the results of her work in the form of a structured surveillance report and poster presentation.

1.3 Surveillance of waterborne outbreaks due to drinking water consumption in Greece, 2004-2019.

Waterborne outbreaks (WBOs) remain a public health concern as large numbers of people can be infected within a short time. We summarize Greek data on WBOs from January 2004 to June 2019 and the conducted investigations and identify points for improvement.

WBOs are mandatorily notified in Greece. Data on outbreak characteristics (type, size, duration, demographics, hospitalization, outcome) and conducted investigations (epidemiological, laboratory, environmental) were analyzed.

Overall, 33 WBOs were recorded (mean 2.1 outbreaks per year). Analytical epidemiological studies were conducted in seven (21%) and suggested tap water consumption as the probable vehicle of infection. Environmental investigation was performed in 23 (70%). Clinical specimens were tested in 24 (73%) and water samples in 14 outbreaks (42%).
The median number of cases per WBO was 54 (range: 2-1,640); eight had more than 200 recorded cases each with a total number of 4,892 cases (81% of total recorded cases); 56% of cases were women. Most WBOs (72%) affected more than one household and affected people from all age-groups. Clinical manifestations were compatible with gastrointestinal illness and 194 cases were hospitalized (7%). No deaths were recorded. Outbreaks' duration ranged from 1 to 44 days.
Clinical samples were positive in 79.2% (19/24) of the outbreaks; Salmonella spp., Norovirus, Shigella spp., Campylobacter spp., and Rotavirus were isolated in 6 (31.6%), 6 (31.6%), 3 (15.8%), 2 (10.5%) and 2 (10.5%) outbreaks respectively and in one multiple pathogens (Norovirus, Campylobacter jejuni, and Enterohemorrhagic

Escherichia coli, EHEC) were detected. Water samples tested positive in 35.7% (4/14) of the outbreaks investigated. In two outbreaks samples were collected after chlorination and consequently results were negative. Environmental investigation identified factors that led to water contamination, such as failures in water treatment and disinfection, in 17/33 (52%) WBOs.

WBOs, although rare in Greece, pose a significant public health burden due to their usually large size. Environmental investigation often fails to identify the contributing factors. An integrated plan is needed to ensure water safety based on WHO recommendations, water sample collection before water treatment and testing of samples for a wide spectrum of pathogens.

Role and outputs: Myrsini was the principal investigator. She reviewed and analysed data and created an abstract for an oral presentation at ESCMID 2020 (8). Myrsini is also one of the co-authors of a manuscript which was submitted to Journal of Water and Health (4).

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:
Myrsini developed competencies to perform data analyses in STATA v12, to analyse and interpret the surveillance data to generate information for action and to effectively communicate the results of her work in the form of a manuscript and oral presentation.

1.4 Review and analysis of the European surveillance data on waterborne outbreaks for the period 2005-2018 (source: Joint EFSA/ECDC report on zoonoses, zoonotic agents and foodborne outbreaks).

In Europe, a number of waterborne outbreaks is reported every year by EU and EU non-Member States according to the requirements of the EU Directive 2003/99. Waterborne outbreaks are potentially large, especially if public drinking water is contaminated. Hospitals and institutions hosting small kids or elderly citizens are most vulnerable for infections. The aim of this study was to summarise the data on the total number of waterborne outbreaks, of the total number of cases and the number of cases per detected pathogen for the period under study as these summarized data were not available in order to describe the epidemiological situation of waterborne outbreaks at EU level and compare it with the national situation.

Data on waterborne outbreaks were extracted from the joint EFSA/ECDC annual summary reports on zoonoses, zoonotic agents and food-borne outbreaks between 2005 to 2018. Since 2012 a distinction was made between strong and weak evidence waterborne outbreaks and since 2014 weak evidence waterborne outbreaks were also reported.
A database was constructed in MICROSOFT EXCEL to host these data. Data analysis was conducted using MICROSOFT EXCEL and STATA v12.0 (Stata Corporation, Texas, USA).

Overall, 286 waterborne outbreaks (both string and weak evidence) were reported by EU Member States and reporting EU non-Member States affecting more than 54,609 people* (median number of outbreaks 16 per year (range: 9-50). Pathogens most frequently detected were Calicivirus (including Norovirus and Sapovirus) (10.131 cases, (19%*), *Campylobacter* spp (4.969 cases, 9%), parasites (Cryptosporidium, Cryptosporidium parvum, other parasites,) (32.800 cases, 60%), E. coli (1764 cases, 3%), Rotavirus (552 cases, 1%).

Waterborne outbreaks, although rare in Europe, pose a significant public health burden due to their usually large size.

*Only the number of cases in strong evidence WBOs was taken into consideration for the analysis.

Role and outputs: Myrsini was the principal investigator. She reviewed EFSA reports and created a database in EXCEL to host the data on waterborne outbreaks and conducted data analysis. Part of the results were included in a manuscript (2).

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:
Myrsini developed competencies to review relevant information, to construct a database with the necessary information, to perform data analyses in STATA v.12 and to effectively communicate the results of her work in the form of a manuscript.

1.5 National surveillance data on zoonoses, zoonotic agents and antimicrobial resistance in Greece, 2018 and 2019. Submission of the annual reports to EFSA.

The EU system for monitoring and collection of information on zoonoses is based on the Zoonoses Directive 2003/99/EC, which obliges European Union (EU) Member States (MS) to collect relevant and, when applicable, comparable data on zoonoses, zoonotic agents, antimicrobial resistance and food-borne outbreaks (FBO). In addition, MS shall assess trends and sources of these agents, as well as outbreaks in their territory, submitting an annual report each year by the end of May to the European Commission (EC) covering the data collected. EC subsequently forwards these reports to the European Food Safety Authority (EFSA). EFSA is assigned the tasks of examining these data and publishing the EU Annual Summary Reports. In 2004, an electronic reporting system and database for monitoring of zoonoses were set up (EFSA Mandate No. 2004-01782). Since 2005, both EFSA and ECDC prepare each year a joint annual report presenting the results of zoonoses monitoring activities in humans, animals, food and feed.

For 2018 and 2019, data were submitted for 15 zoonotic agents under surveillance.

Role and outputs: Myrsini was the reporting officer (assigned by the Ministry of Rural Development and Food) and therefore she coordinated, collected, collated, validated and analysed the national surveillance data on zoonoses, zoonotic agents, food borne outbreaks and antimicrobial resistance and in collaboration with the Ministry's IT service she prepared and submitted the annual report (text and surveillance data) to EFSA using EFSA's online reporting system (16, 17).

Supervisor(s): None

Competencies developed:
Myrsini further exercised her competencies to collect, validate and analyse surveillance data and to effectively communicate the results of her work in the form of a report.

1.6 Epidemiological situation regarding salmonellosis in humans in Greece, 2004-2019.

Salmonella spp. is one of the etiological agents of foodborne infections and the main bacterial cause of foodborne outbreaks in Europe and globally. We aimed to summarise the Greek salmonellosis data between 2004-2019, in order to better understand the disease's epidemiology, raise awareness of decision makers and set public health priorities in the context of One Health.

We extracted surveillance data from the mandatory notification system (MNS). An non-typhoidal salmonellosis case is defined an individual with clinical presentation compatible with salmonellosis and isolation of *Salmonella* (non-typhi, non-paratyphi) from a clinical specimen (EU case definition). We assessed disease's trend adjusted for seasonality using a negative binomial regression model on the monthly number of reported cases and calculated incidence rates by reporting year and month, region of residence (incidence maps), sex and age-group and proportions of hospitalisation, exposures to risk factors like link to another case and different serovars.

In total 10,321 cases were reported, and disease's trend was statistically significantly decreasing (IRR=0.99, CI:0.996-0.998, P<0.001). Mean annual notification rate was 5.9 cases/100,000 population and increased during summer reaching a peak in August suggesting a seasonal pattern. Northern Aegean islands presented the highest mean annual notification rate (9/100,000 population) while Southern Aegean islands the lowest (3/100,000 population). Notification rate between males and females was 6.3 and 8.7 cases per 100,000 population respectively and age-group 0-4 years old was the most affected (47/100,000 population). Of the cases, 88%(8,902/10,088) were hospitalised and 14% (1555/9489) reported one or more persons with similar symptoms among their contacts. *S.* Enteritidis (61%-2,362/3,872), *S.* Typhimurium (14%-545/3,872) and monophasic *S.* Typhimurium (4.6%-177/3,872) were the most frequently reported serovars.

Despite the decreasing trend, the disease remains of public health importance as it affects mainly young children and poses a considerable burden on health care services. Therefore, it is necessary to strengthen the disease's control in food-producing animals and to continue raising public awareness about the importance of hygiene rules and proper cooking practices.

Role and outputs: Myrsini was the principal investigator. She conducted data analyses and prepared the annual report for salmonellosis epidemiological data in humans in Greece (18).

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:

Myrsini further developed competencies to analyse and interpret the time component of surveillance data, to describe patterns of disease dynamics by modelling a time series, to perform data analyses in STATA, to analyse and interpret the surveillance data to generate information for action and to effectively communicate the results of her work in the form of a structured surveillance report.

2. Outbreak investigations

2.1 Evidence for waterborne origin of an extended mixed gastroenteritis outbreak in a town of Northern Greece, 2019.

On 26/01/2019, health care services in Northern Greece, informed the National Public Health Organization (EODY) on the occurrence of a high number of gastroenteritis cases. The size of the outbreak captured wide media and public attention. An investigation was initiated to identify the possible source and mode of transmission and to implement control measures.

People that visited the local health care services with diarrhea and/or vomiting from 24/01/2019 to 04/02/2019 were recorded and descriptive analysis was performed. A 1:1 case-control study was conducted randomly selecting participants >16 years of age, residents of town-X, who visited the health care center between 25 and 28/01/2019. Moreover, a retrospective cohort study was conducted at the town's four elementary schools. OR, RR and 95% CI were calculated. Clinical samples were tested with multiplexed PCR or/and standard culture methods for a broad spectrum of bacteria, viruses and parasites. The water supply system was inspected, and water samples were collected.

 In total 638 cases; 53% women, median age 44 years (range 0-93) were recorded. The main symptoms were diarrhea (88.7%) and vomiting (86.2%). Temporal distribution of cases was compatible with a point source outbreak. Most cases (79%) were residents of Town-X. Forty-eight cases and 52 controls participated in the case-control study and 236 students participated in the cohort study. Both case-control and cohort study showed tap water as the most likely source (OR=10, 95% CI, 2.09-93.4, explaining 95.7% of cases, RR= 2.22, 95% CI, 1.42-3.46, respectively). More than one pathogens were detected from stool samples of 6 of 11 patients tested (Norovirus*, Campylobacter jejuni,* EHEC and EPEC). Water samples, collected after ad hoc chlorination, tested negative. Technical failures of the water tanks' status were identified.

Our results suggested a waterborne outbreak. Regular monitoring of the water supply system and immediate repair of technical failures was recommended.

Role and outputs: Myrsini was the primary investigator. She participated in the outbreak investigation team, in the design of the two analytical epidemiological studies and in the press release. She also participated in the design of the questionnaires, in the phone interviews, in the communication with the competent Public Health services, in the drafting of the questionnaires and in the collection of information. She also created the two databases in EpiDATA and she participated in the data entry. Additionally, she analysed the data, prepared the intermediate and final reports in both Greek and English (19,20) and prepared an abstract which was presented at ESCAIDE 2019 as an oral presentation (5) and a manuscript (2) which was submitted to Public Health Journal on the 20th of March 2020 and to Epidemiology and Infection journal on the 30th of July 2020.

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:

Myrsini further developed her competencies in the investigation of outbreaks and became confident to lead an outbreak investigation. More specifically, she developed competencies to effectively collaborate and communicate with all the stakeholders involved (she interviewed cases and controls, staff of the Public Health Directorates, staff working at the laboratories etc.), to develop questionnaires adapted to the nature of the outbreak, to develop the data entry mask, to perform data entry using EpiData Manager, to analyse data using STATA, to calculate and interpret point of estimates and of confidence intervals, to apply univariate and multivariate analysis and significant tests, to develop a structured report and to effectively communicate the results of her work in the form of two structured reports, oral presentation at ESCAIDE and publication.

2.2 Investigation of an increased number of reported salmonellosis cases in komotini, Eastern Macedonia and Trace, August- September 2019.

We investigated an increased number of reported salmonellosis cases in Komotini area in Eastern Macedonia and Thrace region during August-September 2019. The median annual number of salmonellosis cases in the area between 2004-2018 was 2 cases (min: 0, max: 4).

Information was collected on demographics and telephone interviews were conducted using a trawling questionnaire to investigate any potential association of the cases with a common source. For the case found to be part of a possible outbreak related to a wedding, information was requested on the wedding's menu, the catering company, and the number of cases and list of quests. An analytical epidemiological study was not possible due to the groom's refusal to cooperate for the investigation of the incident. *Salmonella* isolates reported by the local hospital were sent to the National Reference Center for Salmonella-Shigella (EKASS) for confirmation and serotyping.

On-site environmental inspection was conducted at the wedding-restaurant and the catering premises and information about monitoring of *Salmonella* in animals and food was requested.

In total, 18 cases were reported between 01/01/2019 to 20/09/2019; 10 (55.6%) were women. Age-groups" 0-4" (33%) and "5-14" (33%) years old were the most affected. Thirteen out of the 18 cases (72.2%) were recorded during August (9) and September (4). Telephone communication was possible for nine of the 13 cases (69%).

The cases were sporadic, apart from one who was part of a possible outbreak associated with the consumption of a common meal during a wedding.

For the sporadic cases, no common food consumption or participation in a common event was identified and serotyping performed by EKASS showed that, except from one case, the remaining cases were incorrectly reported as salmonellosis.

Regarding the possible outbreak, about 1,000 guests attended the wedding and 13 were hospitalised with gastroenteritis symptoms. Three of them were interviewed and indicated chicken as the suspect food as they had all eaten chicken, while their relatives who did not, did not show any symptoms. *S.*Enteritidis was isolated in one of the fecal specimens collected.

Environmental inspection revealed non-conformities with good hygiene requirements, while no *Salmonella* spp. detection was reported from animals and food.

The investigation did not lead to a hypothesis regarding a common source of infection. This was in line with the results of EKASS as diagnosis was not confirmed.

The association of gastroenteritis cases with the wedding meal was confirmed (epidemiological link), however the responsible food was not confirmed as further investigation was not conducted. Public Health Authorities recommended to the Food Business Operators to comply with minimum legal hygiene requirements.

Role and outputs: Myrsini was the primary investigator. She participated in the design of the questionnaires, in the phone interviews, in the communication with the competent Public Health services, in the development of the questionnaires and in the collection of information. Additionally, she analysed the data and prepared the final report in both Greek and English (21).

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)).

Competencies developed:

Myrsini further developed her competencies in the investigation of outbreaks. More specifically, she developed competencies to effectively collaborate and communicate with all the stakeholders involved (she interviewed cases, staff of the Public Health Directorates, staff of the veterinary authorities, staff working at the laboratories etc.), to develop questionnaires adapted to the nature of the outbreak, to analyse data using STATA and to develop a structured report and effectively communicate the results of her work in the form of this structured report.

3. Applied epidemiology research

3.1 Title: Evaluation of the impact of the control measures targeted *Salmonella* Enteritidis, and *Salmonella* Typhimurium (including monophasic *Salmonella* Typhimurium) in poultry breedings on human salmonellosis in Greece.

S. Enteritidis (SE), *S.* Typhimurium (ST) and *Salmonella* monophasic Typhimurium (SMT) are the most frequently reported serotypes in humans in Greece. Since 2008, National Salmonella Control Programmes (NSCPs) have been implemented targeting these serotypes in poultry. We aimed to assess impact of NSCPs on trend and total number of human SE and ST cases.

Using monthly serotype data from the National Reference Laboratory for 2006-2017 as proxy for the number of salmonellosis cases, we defined three intervention (all targeted serotypes, SE, ST) and one control series comprising of serotypes not associated with poultry or eggs. For SE, analysis was also performed for 2006-2015 due to a large SE multicounty outbreak in 2016. Analysis was not performed for SMT, as data were available only after NSCPs' introduction. We performed interrupted time series analysis. We used a negative binominal regression model with trend and sine components to adjust for secular and cyclical trends, one lag to count for autocorrelation, an indicator variable to define the intervention, and an interaction term for assessing changes in trend after the intervention's introduction. We calculated IRR values and respective CIs as measures of association.

Before NSCPs there was no significant trend for the targeted, SE, ST and control serotypes (p>0.05). The same applied for the targeted, SE and ST serotypes (p>0.05) after NSCP's introduction, while the trend was increasing (IRR: 1.0045, %95CI:1.0010-1.0080) for controls. For 2006-2015, SE presented a decreasing trend after the NSCPs' introduction (IRR: 0.99, %95CI:0.98-0.99). NSCPs had a statistically significant impact on total targeted and SE cases which were reduced on average by 44% and 49% (IRR: 0.56, 95% CI: 0.42-0.75 and IRR:0.51, 95%CI:0.35-0.74) respectively for 2006-2017 and SE cases by 47% ((IRR:0.52, 95%CI:0.38-0.72) 2006-2015. No impact was shown on the total ST and control cases (p>0.05).

Significantly decreased number of human SE cases justifies added value of NSCPs. For ST however, further measures should be considered.

Role and outputs: Myrsini was the primary investigator. She drafted the project proposal and conducted the data collection and data analysis. She also prepared a report (22), an abstract (10) for ESCAIDE 2020 and a manuscript (3). The abstract was accepted as a poster presentation and the manuscript is still under preparation.

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)), Mrs Joana Gomes Dias (ECDC).

Competencies developed:
Myrsini further developed her competencies to conduct an applied epidemiological research project from planning to writing of the scientific paper, to use Time Series Analysis (TSA) in general and in particular Interrupted TSA , to use TSA in STATA v16.0 (Stata Corporation, Texas, USA), to interpret the results of the TSA, to develop a structured report and to effectively communicate the results of her work in the forms of a structured report, an abstract and a manuscript.

3.2 Title: Prediction of future trend of human salmonellosis for 2020, in Greece.

Salmonella remains the most frequently detected etiological agent from foodborne outbreaks at EU and national level. We aim to forecast future values of notification rates of salmonellosis in humans for 2020 in the country, based on the historical data up to and including 2019, in order to inform the decision makers so as to better organise the available resources and the country's policy for the control of the disease.

Role and outputs: Myrsini was the primary investigator. She wrote the project proposal and conducted the data collection. Project proposal is still under review.

Supervisor(s): Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)), Mrs Joana Gomes Dias (ECDC).

Competencies developed:

Myrsini further developed her competencies to draft an applied epidemiological research project proposal.

4. Communication

Publications in peer reviewed journals

Manuscripts submitted to peer reviewed journals (in review process)

1. Tzani M, Barrasa A, Vakali A, Georgakopoulou T, Mellou K, Pervanidou D. Surveillance data for human leishmaniasis in Greece for the period 2004-2018 indicate the need for a sustainable action plan for its management and control. The manuscript was submitted to Eurosurveillance and is currently under publication.
2. TZani M, Mellou K, Kyritsi M, Kolokythopoulou F, Vontas A, Sideroglou T, Chrysostomou A, Mandilara GD, Tryfinopoulou K, Georgakopoulou T, Hadjichristodoulou C. Evidence for waterborne origin of an extended mixed gastroenteritis outbreak in a town of Northern Greece, 2019. The manuscript was submitted to Public Health Journal on 20th of March 2020 and to Epidemiology and Infection Journal on 30th July 2020 and is currently under the second review.

3. Tzani M, Dias JG, Mellou K. Salmonella control programmes in poultry in Greece. Impact on human salmonellosis.(Under preparation)

4. Mellou K, Sideroglou T, Tzani M, Chrysostomou A, Maltezou E. Deficiencies in the investigation of waterborne outbreaks in the last 16years in Greece support the need for changes". The manuscript was submitted to Journal of Water and Health on 20th of September 2020 but was rejected.

Conference presentations

5. Tzani M, Mellou K, Kyristsi M, Sideroglou T, Chrisostomou A, Tryfinopoulou K, Mandilara G, Georgakopoulou T, Hadjichristodoulou C. "Large waterborne gastroenteritis outbreak of mixed origin in Western Macedonia, Greece, January – February 2019". European Scientific Conference on Applied Infectious Disease Epidemiology, 2019 November 27-29, Stockholm, Sweden (accepted as oral presentation, abstract ID: 122).

6. Tzani M, Mellou K, Sideroglou T, Chrisostomou A, Georgakopoulou T, Pervanidou D. "Epidemiological situation of visceral leishmaniasis in humans, Greece, 2004-2018 - Future challenges". European Scientific Conference on Applied Infectious Disease Epidemiology, 2019 November 27-29, Stockholm, Sweden (accepted as poster presentation, abstract ID: 121).

7. Tzani M, Mellou K, Sideroglou T, Chrysostomou A, Vakali A, Georgakopoulou T, Pervanidou D, Tsiodras S. "Laboratory capacity for the diagnosis of leishmaniasis in Greece, 2018: a national surveillance study". ECCMID 2020, 2020 April 18-21, Paris, France (accepted as a poster presentation, abstract ID: 6582. However, due to Covid-19 pandemic the conference was cancelled, and the abstract was included in the conference's abstract book that was published online (as PDF) and is freely accessible on the website: https://www.escmid.org/fileadmin/src/media/PDFs/Abstractbook2020_05.05.2020_Part1.pdf

8. Mellou K, Tzani M, Sideroglou T, Chrysostomou A, Georgakopoulou T, Tsiodras S. "Investigation of waterborne outbreaks due to drinking water consumption in Greece, 2004-2019 (1st semester): time to learn our lessons". ECCMID 2020, 2020 April 18-21, Paris, France (accepted as an oral presentation, published in the conference's abstract book: https://www.escmid.org/fileadmin/src/media/PDFs/Abstractbook2020_05.05.2020_Part1.pdf

9. Tzani M, Mellou K, Vakali A, Georgakopoulou T, Pervanidou D. "Αξιολόγηση του εθνικού συστήματος επιτήρησης της λεϊσμανίασης στην Ελλάδα, 2004-2018" (Evaluation of the national surveillance system for

leishmaniasis in Greece, 2004-2018). 13th National Public Health Conference, 16-18/03/2020, Athens, Greece (accepted as an oral presentation, abstract ID: EA 036).

10. Tzani M, Mellou K, Dias JG, Sideroglou T, Chrysostomou A, Maltezou E. "Did the implementation oft he National Salmonella Control Programmes in poultry have an impact on human salmonellosis in Greece?". European Scientific Conference on Applied Infectious Disease Epidemiology, 2020 November 24-27, online (accepted as poster presentation, abstract ID: 39).

Other presentations

11. Tzani M. "Epidemiological situation with regard to brucellosis in small ruminants and bovine population in Greece". Oral presentation for the Hellenic Public Health Organisation (EODY) weekly scientific meetings, January 2019, Athens, Greece.
12. Tzani M. "Can we take our companion animals with us at the beach and the sea? What does legislation foresee?" Oral presentation during the educational daily seminar titled "Sea and Health" organized by the Hellenic Scientific Committee for One Health, June 2019, Athens, Greece.
13. Tzani M. "Use of TSA in the Hellenic Public Health Organisation (EODY)". Oral presentation during the TSA module, November 2019, Bilthoven, NL.

Reports

During her fellowship Myrsini wrote nine reports in total: five surveillance reports (14-18), three outbreak reports (19-21) and one research report (22).

14. Tzani M, Mellou K, Pervanidou D. Leishmaniasis in humans in Greece 2004-2018. Summary of the available epidemiological data and evaluation of the surveillance system. Internal report for National Public Health Organisation. Athens, Greece, September 2019. (Report available in English).

15. Tzani M, Mellou K, Pervanidou D. Evaluation of the laboratory capacity for the diagnosis of leishmaniasis in Greece in 2018. Internal report for National Public Health Organisation. Athens, Greece, September 2019. (Report available in English).

16. Tzani M, Alexandraki M. National surveillance report on zoonoses, zoonotic agents, food borne outbreaks and antimicrobial resistance for the year 2018 submitted to the European Food Safety Authority (EFSA) in accordance to EU directive 2003/99. Athens, Greece, May 2019. Available at: http://www.efsa.europa.eu/en/biological-hazards-data/reports

17. Tzani M, Alexandraki M. National surveillance report on zoonoses, zoonotic agents, food borne outbreaks and antimicrobial resistance for the year 2019 submitted to the European Food Safety Authority (EFSA) in accordance to EU directive 2003/99. Athens, Greece, May 2020. Available at: (has not been published yet).

18. Greek National Public Health Organisation. Annual report on the epidemiological situation of salmonellosis in humans in Greece, 2004-2019. Athens, Greece, March 2010. Available at: https://eody.gov.gr/wp-content/uploads/2020/04/Epidemiological-data-for-Salmonellosis_2004-2019.pdf

19. Tzani M, Mellou K, Chrysostomou A, Sideroglou T. Investigation of a gastroenteritis outbreak in a town of Western Macedonia in Greece, in January-February 2019. Internal intermediate report for National Public Health Organisation. Athens, Greece, February 2019. (Report also available in English).

20. Tzani M, Mellou K, Chrysostomou A, Sideroglou T. Investigation of a gastroenteritis outbreak in a town of Western Macedonia in Greece, in January-February 2019. Internal final report for National Public Health Organisation. Athens, Greece, February 2019. (Report also available in English).

21. Tzani M, Mellou K. Investigation of an increased number of reported salmonellosis cases in the area of Komotini, East Macedonia and Thrace, Greece, August-September 2019. Internal report for National Public Health Organisation. Athens, Greece, September 2019. (Report also available in English).

22. Tzani M, Mellou K. The impact of the national salmonella control programmes in poultry on human salmonellosis in Greece. Internal report for National Public Health Organisation. Athens, Greece, June 2020. (Report available in English).

5. Teaching activities

5.1 Multisectoral approach to Salmonella control, Athens, February 2019.

This 2.5-hour training activity was organised as part of the "Public Health" postgraduate module at the National School of Public Health (NSPH) for the period January-September 2019 (second semester).
Target audience was consisted of the 24 postgraduate students with different public health background and took place at the premises of the NSPH in Athens on 28/02/2019.

The overall goal was to gain experience in public health and to understand the importance of multisectoral collaboration in case of foodborne outbreaks investigation. At the end of the practical training the participants were expected to be able to understand the basic principles of the National Salmonella Control Programmes (NSCPs) and the link between their implementation and public health protection, to describe the steps of an outbreak and to describe the outbreak by time, place and person, to interpret the results of the univariate analysis (cohort study) and to describe the veterinary investigation and measures that should be applied.

The teaching methods used were lectures (PowerPoint), case-study and exercises (close-ended questions).

The evaluation of the trainee's knowledge was performed using exercises and written tests (part of the final written examinations) and the audience's reaction was assessed (Kirkpatrick level of evaluation) using a short-structured questionnaire comprised of eight questions (six close-ended and two open-ended for suggestions) that enabled Myrsini to measure the trainees' level of engagement and satisfaction.

Role: Myrsini organised the training and the case- study session, prepared the training material, delivered the lectures/case study, evaluated the activity and wrote the training activity report.

Reflection
The training was evaluated with very positive feedback from all participants. This activity provided the opportunity to learn and combine new methods for evaluation. In the future it would be more beneficial to allocate more time for practical activities, including exercises using statistical programmes for epidemiological investigations.

Supervisor(s): 1. Dr Kassiani Mellou (Hellenic Public Health Organisation (EODY)) 2. Dr G. Mandilara (Assistant Professor at the Dept. of Public Health Policy of the School of Public Health (University of West Attica)).

5.2 Training of state veterinarians on topics related to the "fight against zoonoses".

This is an accredited training programme carried out in cooperation with the National Institution for the training of civil servants (INEP) and the Department of Zoonoses of the Ministry of Rural Development and Food. It takes place three times a year in different Greek cities and its duration is 21 hours per time. Target audience consists mainly of state veterinarians involved in the implementation of animal control and eradication programmes, however, other state health professionals working in public health sector can also participate.

The overall goal is to upgrade the knowledge and skills of a target group of employees on the implementation of the national surveillance, control and eradication programmes for zoonoses and to illustrate the importance of multisectoral collaboration for the effective management of zoonoses. At the end of the practical training the participants are expected to be able to understand the relevant legislation on food safety and control and eradication of specific zoonoses, to correctly handle suspect and positive cases and implement the necessary control measures for each zoonoses under study, to understand basic epidemiological indicators so as to evaluate

the programmes' results and to cooperate effectively with other public health professionals in case of investigation of outbreaks related to zoonoses.

Teaching methods include lectures (PowerPoint), case-studies, exercises (open and close-ended questions) and audiovisual material.

The evaluation of the participants' Knowledge is based on a written test at the end of each seminar (open and close-ended questions). A general evaluation of the training programme (room, instructors, training material etc) and the evaluation of the seminar's usefulness are conducted within a week and two months after its completion respectively, using online questionnaires available at INEP's website.
Trainers who succeed in the final evaluation and completed the general evaluation acquire a certification of attendance by INEP.

Role: Myrsini drafted and submitted the training file to INEP in 2013. Moreover, she is one of the seminar's instructors as she is included in the INEP's official registry for instructors. She teaches mainly topics related to food-safety legislation, zoonotic *Salmonella* and Rabies. In total, between September 2018 to April 2020, she has participated in four seminar cycles teaching for 39 hours. Myrsini has organised the training for the above-mentioned topics, the case study sessions and has prepared the training material and delivery of the lectures/case studies. Finally, Myrsini has been appointed in some occasions by INEP to evaluate the tests for the knowledge assessment.

Reflection

In general, the training has been evaluated with very positive feedback from all participants. This activity is providing the opportunity to apply different teaching approaches depending on the composition of the audience (purely veterinarians, or other health professionals as well). Moreover, due to the continuation of the seminars, it is possible to continuously improve the training material in order to better meet the needs of the trainees. In the future it would be more beneficial to allocate more time to the seminar in order to include training material for more zoonoses, include exercises using statistical programmes for epidemiological investigations and if possible include a practical part for the implementation of the programmes on the field.

Supervisor(s): The scientific coordinator who is appointed each time by INEP.

Educational outcome:

Engagement in the above-mentioned teaching activities enabled Myrsini to further develop the competencies to identify training needs in a particular target group, to plan and organise training events, to design and develop training materials (including case studies based on previous experience), to moderate case studies, to give lectures applying didactic/pedagogical techniques and to plan and conduct evaluation of training.

6. Other activities

A. During her fellowship, except from the mandatory EPIET modules, Myrsini has also attended the following additional online seminars and e-learning courses:

1. ECDC E-learning course on Introduction to Outbreak Investigation-Certificate obtained.

2. Online videos on EpiData manager and EpiData client

3. IHR Simulation Exercise JADE 2018. The scope of this exercise was to focus on participants' understanding and use of IHR principles and assessment of public health events. The exercise aimed to strengthen the capacity of NFPs in order to facilitate communication and collaboration during a potential or actual emergency event.

4. Stata Tutorials-Stata training on data cleaning, management and manipulation-Prezzi on typing of outbreak strains.

5. WEBINAR on "Randomized control trials" given by one of Myrsini's fellows.

6. WEBINAR on "R for Epidemiologists - Episode 1: Getting started with R" given by one of Myrsini's fellows.

7. WEBINAR: "Bayesian tools for the harmonization of disease prevalence estimates".

8. The seminar was organized by the Hotline Project, a consortium of European organizations benefiting from the EFSA Partnering Grant.

9. United Nations Security in the field short courses -Certificate obtained.

10. EAN webinar on "Ebola response in DRC: experiences from the field".

11. GOARN emodules.

12. WEBINAR on "Brief introduction to behavioural science" given by one of Myrsini's fellows.

13. ECDC's e-Learning course titled "Rapid Risk Assessment"- Certificate obtained.

14. Assessing and grading evidence in public health e-learning course (PRECEPT)-Certificate obtained.

15. ECDC webinar "Essentials of Writing and Reviewing Scientific Abstracts: a field epidemiology focus"-Certificate obtained.

16. EAN webinar "Revising operational research in humanitarian health emergencies and epidemics: showcasing an example from the Rohingya refugee response in Cox's Bazar, Bangladesh".

17. Briefing & Exchanges on China's COVID-19 Experiences with Leading Experts -webinar organized by JuniperMD, HHRDC, CPAA, CPHCF, & IHL .

B. During her fellowship Myrsini has been involved in several additional tasks:

1. She participated in the development of the final technical and financial report for the implementation of the National Salmonella Control Programmes (NSCPs) in poultry populations for the year 2018. (April 2019)

2. She participated in the audit conducted by the European Commission in order to assess the implementation of the NSCPs in poultry populations (September 2019).

3. She participated in the annual meetings of the EFSA's scientific network on zoonoses and AMR (October 2018 and October 2019).

4. She participated in the construction of a manual describing the necessary procedures and flow of information for the investigation of foodborne outbreaks.

7. EPIET/EUPHEM modules attended

1. Introductory Course, 24/09/2018-12/10/2017, Spetses, Greece

2. Outbreak Investigation Module, 03/12/2018-07/12/2018, Berlin, Germany

3. Multivariable Analysis Module, 25/03/2019-29/03/2019, Madrid, Spain

4. Rapid Risk Assessment Module, 13/05/2019-18/05/2019, Zagreb, Croatia

5. Project Review Module, 26/08/2019-30/08/2019, Prague, Czech Republic

6. Time Series Analysis Module, 4/11/2019- 8/11/2019, Bilthoven, Netherlands

7. Management, Leadership and Communication in Public Health, 10/02/2020-14/02/2020, online (web participant)

8. Vaccinology Module, May and June 2020, online

9. Project Review Module, 24/08/2020-28/08/2020, online

Supervisor's conclusions

Myrsini is a veterinarian with a long career at the Greek Ministry of Rural Development and Food. She was the first EPIET MS-track fellow hosted at the National Public Health Organization (NPHO) without already being an employee of the Organization and this alone was a success for the program in the country. Her willingness and commitment to attend the program surely helped in surpassing the administrative obstacles for hosting her at the Department of the Epidemiological Surveillance and Intervention of NHPO. As a result, now the way is open for public health professionals of other agencies to apply for the fellowship.

Those two years of training turned out to be very successful for the fellow as she was involved in a great variety of public health activities, as described in her portfolio. Her work was an added value for the Organization as she worked on leishmaniasis, a neglected disease in Greece, showing that surveillance and response needs strengthening in the country. Her research work on salmonellosis led us to consider proposing further action in regards of public health measures in the concept of One Health (animal and human sector). Also, she enhanced the annual statistical analysis of salmonellosis mandatory notification data.

During her fellowship Myrsini gained experience on field epidemiology, statistics and teaching, as well as on scientific writing.

Overall, Myrsini was a hardworking fellow, highly motivated, keen to gain knowledge and experience and we were lucky to have her these two years working with us. She was remarkably responsible, accomplished all assigned tasks in a highly competent and professional manner. I have no doubt that she will continue her excellent work at the Ministry of Rural Development and Food and it was a pleasure working with her. Myrsini never complained for the increased workload and worked harmoniously with the colleagues at the Organization.

Finally, I believe that this fellowship will be the basis for further collaboration between the Ministry of Health and the Ministry of Rural Development and Food in the future.

Coordinator's conclusions

Myrsini started her fellowship with strong one health background, and was working in the veterinary field at national and international level. She maximised use of the two fellowship years, being involved in nine field assignments in the surveillance and research area, along with two outbreak investigations. Through her knowledge and experience from veterinary service, enthusiasm and a high commitment, she has completed all of these, achieving all EPIET objectives and producing large amount of public health outputs of high quality.

She is very experienced and organised, able to work independently and effectively. Supported by excellent supervision and project availability at the site, her fellowship has been highly successful. She improved her competencies working with many public health topics, also using novel methods like time series analysis to study impact of interventions. I believe that Myrsini has professional and interpersonal skills needed for excellent collaboration between public health and veterinary services in Greece and internationally.

Personal conclusions of fellow

During my EPIET Fellowship as an MS-track fellow I had the opportunity to grow both as a public health professional and as a person. One of my main goals during this fellowship was to gain experience in different public health aspects and to implement part of my learning in my routine work and I managed to fulfil that. The diverse variety of projects gave me the opportunity to understand the role of a field epidemiologist and strengthen my competencies. Being an EPIET fellowship enabled me to apply an holistic approach in the context of One Health in managing public health situations related to zoonoses. However, at the same time I gained valuable knowledge and experience in the surveillance and control of human diseases. During my fellowship I had the opportunity to refresh my knowledge in basic statistics and to practice and develop new skills in data analyses by using new statistical methods. Moreover, the programme offered me invaluable knowledge and skills to achieve effective communication with public health professionals of different expertise, to negotiate, to manage my time, to write project protocols and to approach public health problems in a more systematic way. Finally, my fellowship was the base for the development of two important networks which will allow future collaboration and communication both at national and European level. As a person I am very thankful for meeting and networking with all my co-fellows and all the modules' facilitators who are a great group of talented and motivated public health professionals. In the future I look forward in using all this experience from the fellowship working as a trainer regarding field epidemiology in programmes for public health professionals.

Acknowledgements