Summary of work activities
Dafni Katerina Paspaliari
The ECDC Fellowship Programme
Public Health Microbiology path (EUPHEM), 2020 cohort

Background

The ECDC Fellowship Programme is a two-year competency-based training with two paths: the field epidemiology path (EPIET) and the public health microbiology path (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 provide training and practical experience using the 'learning by doing' approach in acknowledged training sites across European Union (EU) and European Economic Area (EEA) Member States.

According to Articles 5 and 9 of ECDC's founding regulation (EC No 851/2004) 'the Centre shall, encourage cooperation between expert and reference laboratories, foster the development of sufficient capacity within the community for the diagnosis, detection, identification and characterisation of infectious agents which may threaten public health' and 'as appropriate, support and coordinate training programmes in order to assist Member States and the Commission to have sufficient numbers of trained specialists, in particular in epidemiological surveillance and field investigations, and to have a capability to define health measures to control disease outbreaks'.

Moreover, Article 47 of the Lisbon Treaty states that 'Member States shall, within the framework of a joint programme, encourage the exchange of young workers. 'Therefore, ECDC initiated the two-year EUPHEM training programme in 2008. EUPHEM is closely linked to the European Programme for Intervention Epidemiology Training (EPIET). Both EUPHEM and EPIET are considered 'specialist pathways' of the two-year ECDC fellowship programme for applied disease prevention and control.

This report summarises the work activities undertaken by Dafni Katerina Paspaliari, cohort 2020 of the European Public Health Microbiology Training Programme (EUPHEM) at the Finnish Institute for Health and Welfare (THL).

Pre-fellowship short biography

Dafni Katerina Paspaliari holds two MSc degrees, one in chemical engineering and one in microbial biotechnology, as well as a PhD in microbiology. After her PhD studies, she worked as a postdoctoral researcher at the University of Copenhagen, a researcher in the private sector, as well as a consultant. She is passionate about public health microbiology and epidemiology, and pursued the EUPHEM fellowship in order to gain further experience in the field.

Methods

This report accompanies a portfolio that demonstrates the competencies acquired during the EUPHEM fellowship by working on various projects, activities and theoretical training modules.

Projects included epidemiological investigations (outbreaks and surveillance); applied public health research; applied public health microbiology and laboratory investigation; biorisk management; quality management; teaching and public health microbiology management; summarising and communicating scientific evidence and activities with a specific microbiological focus.

The outcomes include publications, presentations, posters, reports and teaching materials prepared by the fellow. The portfolio presents a summary of all work activities conducted by the fellow, unless prohibited due to confidentiality regulations.

Results

The objectives of these core competency domains were achieved partly through project or activity work and partly through participation in the training modules. Results are presented in accordance with the EUPHEM core competencies, as set out in the ECDC Fellowship Manual [1].

1. Epidemiological investigations

1.1 Outbreak investigations

1.1.a *Salmonella* Typhimurium outbreak associated with frozen tomato cubes at a restaurant in western Finland, January–February 2021
Supervisor: Ruska Rimhanen-Finne

In late January 2021, several individuals reported gastrointestinal symptoms following meals consumed at a restaurant in western Finland. We conducted a retrospective cohort study and invited exposed individuals to participate in the study via press releases. We defined a case as a person who ate lunch at the restaurant between 27–29 January 2021 and experienced stomach ache, vomiting or diarrhoea, and/or had a laboratory-confirmed *Salmonella* Typhimurium infection within two weeks post exposure. In parallel, we collected faecal and food samples for microbiological analysis. *Salmonella* isolates were characterised in detail using whole-genome sequencing (WGS) and cluster analysis by core genome multilocus sequence typing (cgMLST).

Altogether, 393 meals were sold at the restaurant in question between 27–29 January 2021. Among the individuals who ate at the restaurant during this time period, 101 individuals (who consumed 142 meals) participated in the cohort study. Among them, there were 49 cases, 23 of which were laboratory-confirmed infections with *S.* Typhimurium. cgMLST comparison revealed that *S.* Typhimurium isolates from cases and from frozen tomato cubes, which had been used uncooked in salads at the restaurant, were closely related and clustered together. The salads had been consumed by 76% of the cases, and based on the cgMLST clustering, the frozen tomato cubes were the suggested vehicle of the outbreak. The outbreak strain was found to be resistant to multiple antibiotics, including ciprofloxacin.

This outbreak investigation highlighted the need to cook frozen products thoroughly before consumption. As a result of this outbreak investigation, the manufacturer of the frozen tomato product associated with the outbreak changed the product labelling to indicate that it should only be used cooked.

Role: The fellow participated in all stages of the outbreak investigation, including case definition, data collection and analysis and laboratory investigation. She co-authored the outbreak report, a scientific article on the outbreak investigation [8.2], and an ESCAIDE (European Scientific Conference on Applied Infectious Disease Epidemiology) abstract, as the third author.

1.1.b Outbreak of enterohaemorrhagic *Escherichia coli*, July–August 2021, Finland
Supervisors: Saara Salmenlinna, Timothee Dub

Between July and mid-August 2021, the Finnish Institute for Health and Welfare (THL) received an unusually high number of notifications of suspected enterohaemorrhagic *Escherichia coli* (EHEC) outbreaks. In addition, the national reference laboratory received an unexpectedly elevated number of EHEC isolates. This raised suspicions of an ongoing EHEC outbreak, and triggered a preliminary outbreak investigation to determine whether an outbreak was ongoing and evaluate its extent.

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[1] European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/ecdc-fellowship-programme-manual-cohort-2021

EHEC is a notifiable disease in Finland. Notifications to the National Infectious Diseases Register (NIDR) are filed by physicians as well as the microbiological laboratories for all laboratory-confirmed cases. We analysed data through three resources: NIDR notifications of EHEC cases, laboratory data on received isolates from the national reference laboratory of THL, as well as a standardised questionnaire, which had been used to interview several of the cases. The latter included questions on possible exposures, symptoms, symptom severity, as well as the occupation of the patients.

Our investigation demonstrated a clear increase in the number of EHEC cases during the last week of July and early August 2021. Despite some serotyping data still pending at the time, we found the outbreak strain to likely be of serogroup O103, carrying *stx1*. The outbreak appeared to be nationwide, as cases were not concentrated in any specific geographic area, and stemmed from 12 out of the 20 hospital districts. Based on the questionnaire and the demographic information available from the notifications, we could not identify any association with the age and sex of the cases, nor any possible common exposure. The severity of the clinical manifestations, including two cases of haemolytic uremic syndrome (HUS), was higher than what is expected for *stx1*-carrying strains.

Based on our investigation, THL issued a news bulletin to alert about the ongoing outbreak and to provide advice to the public. Follow-up investigations identified pre-cut fresh salad as a likely food vehicle for the outbreak.

Role: Together with the EPIET fellow Sohvi Kääriäinen, the fellow carried out the preliminary investigation, helped draft the THL news bulletin and wrote the investigation report.

Training modules related to the assignment/projects
EPIET/EUPHEM Introductory Course: Through the EPIET/EUPHEM Introductory Course, the fellow was introduced to outbreaks and the ten steps of outbreak investigations. The concepts and methods were introduced during lectures and practised through case studies and group work.

Outbreak Investigation Module: In this module the fellow delved deeper into outbreak investigations and practised all the ten steps in detail, including epidemiologic analyses in Excel, R and STATA and analysis of microbiological results from outbreak investigations. The practical aspect of the training was largely achieved through dedicated case studies, specially designed to simulate real-life investigations.

Multivariable Analysis Module: This module provided advanced skills in analytical epidemiology, including the use of multivariable analysis in outbreak investigations, with focus on linear, logistic, Poisson and Cox regression models.

Educational outcome
Through her participation in the outbreak investigations, the fellow had the opportunity to be involved in all analytical and laboratory elements of outbreak investigations. Her involvement in the early investigation of the EHEC outbreak allowed her to gain insights into the very first steps of outbreak investigations, with focus on establishing the existence of an outbreak. In addition, the investigation of the *S.* Typhimurium outbreak included a retrospective cohort study, univariate/multivariate analysis, whole-genome sequencing, phylogenetic comparisons and antibiotic susceptibility testing. Finally, the fellow practised dissemination skills by co-authoring the outbreak investigation reports, as well as a scientific article.

1.2 Surveillance

1.2.a Incidence of secondary COVID-19 cases following exposure to SARS-CoV-2 at comprehensive schools and early childhood education and care facilities, August 2020 – March 2021, Finland
Supervisors: Emmi Sarvikivi, Timothee Dub, Lotta Siira

Closure of schools is a controversial public health measure to curb SARS-CoV-2 transmission. To assess the risks related to keeping schools open during the pandemic, we calculated and compared COVID-19 secondary attack rates among children and adults exposed to SARS-CoV-2 at early childhood education and care (ECEC) facilities (0–6 years), primary (7–12 years) or lower secondary schools (13–15 years) in Finland between August 2020 and March 2021.

During this period, a total of 70 244 individuals were exposed to SARS-CoV-2 at educational institutions. Of those, 1 343 (1.9%) acquired a laboratory-confirmed infection (268 adults; 1 054 children; 21 unspecified). The secondary attack rates for children were: 2.5% when exposed at ECEC, 1.4% at primary schools and 1.7% at lower secondary schools. For adults, the respective rates were 5.0%, 1.7% and 1.3%. The risk was significantly higher for adults compared to children for ECEC settings, but not for the higher educational levels. The secondary cases associated with school/childcare exposures accounted for only 6.9% of the total COVID-19 cases among 0–15-year-olds during the study period. In conclusion, we found the risk of transmission within childcare and school settings to be low during the period under study.

Role: The fellow was involved in all stages of the project, including planning, reviewing literature, as well as cleaning and analysing the data. The fellow presented the results at the ESCAIDE 2021 conference and wrote an internal report.

1.2.b Expansion of wastewater-based surveillance in Finland: Informed selection of priority targets
Supervisors: Tarja Pitkänen, Outi Lyytikäinen, Jaana Vuopio

Wastewater-based epidemiology (WBE) has emerged as a powerful epidemiologic tool to surveil the circulation of infectious agents and their genomic properties in local communities. For WBE purposes, influents of wastewater treatment plants (WWTP) can be used to estimate the burden of communicable disease agents excreted by the serviced population. In Finland, there are efforts under way to set up a nationwide wastewater-based sentinel surveillance system for multiple infectious agents and antimicrobial resistance.

The aim of this project was to evaluate the relevance of wastewater-based surveillance for a number of proposed infectious disease targets, and to prioritise them in terms of added-value for communicable disease surveillance. The evaluation was based on a set of criteria specifically applied in the context of the Finnish surveillance system. The criteria included prevalence, current knowledge of reservoirs and routes of transmission, adequacy of current surveillance and pandemic potential.

Based on the set criteria, we proposed the following pathogens as high-priority targets for wastewater-based surveillance: SARS-CoV-2, influenza, *Cryptosporidium*, enterohaemorrhagic *Escherichia coli* (EHEC), vancomycin-resistant enterococci (VRE), ESBL-producing *Enterobacteriaceae* and carbapenemase-producing *Enterobacteriaceae* (CPE). Sapovirus and *Giardia* were proposed as targets of medium priority; human metapneumovirus (HMPV) and *Candida auris* were acknowledged as targets of potential interest.

Role: This project was carried out by the fellow, based on literature review, description of the current surveillance for each target in Finland, and discussions with public health officials in charge of surveillance. The panel of targets for evaluation was proposed by the WastPan consortium. The fellow presented the results in the form of an internal report.

1.2.c Wastewater-based surveillance of extended-spectrum beta-lactamase (ESBL)-producing *Enterobacteriaceae* in Finland: Informed selection of sites for sampling
Supervisors: Tarja Pitkänen, Outi Lyytikäinen, Jaana Vuopio

Wastewater surveillance can complement clinical surveillance by providing information on circulating infectious agents and antimicrobial resistance at a community level. Sampling should be optimised, so that it remains representative, while costs from sample collection and transportation are minimised. We examined different sampling scenarios to optimise a pilot scheme for wastewater-based surveillance of extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* and *Klebsiella pneumoniae* in Finland.

To this end, we plotted the monthly ESBL incidence between 01.2018–09.2021 based on notifications from the National Infectious Diseases Register (NIDR). We compared the nationwide incidence to that in: a) the national network comprising 28 wastewater-treatment plants (WWTPs); b) a smaller-scale representative network of 10 WWTPs; c) the WWTP serving the capital region. The monthly trends in incidence of both the 28 and 10 WWTP networks fully followed and represented national trends. Conversely, the trends in incidence of only the WWTP in the capital region showed some deviation from the national trends.

In conclusion, informed selection of WWTPs for wastewater surveillance can increase cost-efficiency. To pilot ESBL wastewater-based surveillance, we proposed sampling from only 10 WWTPs, which appeared to sufficiently represent national trends. Their representativeness should be confirmed by correlation with relative gene copy counts from wastewater samples.

Role: The fellow was responsible for the project. Her work included planning, reviewing literature, collating, cleaning and analysing the data, as well as writing an internal report. The fellow will present this work at the 2022 ESCAIDE conference.

1.2.d COVID-19 reinfections in Finland, January 2020–May 2021
Supervisors: Outi Lyytikäinen, Timothee Dub, Lotta Siira

Following the onset of the COVID-19 pandemic, cases of prolonged SARS-CoV-2 viral shedding were described, as well as cases of true COVID-19 reinfections. However, the confirmation of true reinfections remained challenging. An additional challenge was how to define cases for surveillance purposes, so that true cases would be distinguished from cases of prolonged viral shedding. As a result of these challenges, during the early pandemic period, surveillance of COVID-19 reinfections was only carried out in few countries in a limited fashion, and the true scale of COVID-19 reinfections remained unclear.

To facilitate the development of a reinfection variable for surveillance purposes and to evaluate the scale of COVID-19 reinfections in Finland before the advent of the Delta variant, we collected all suspected cases of reinfection between January 2020 and May 2021 from the National Infectious Diseases Register of Finland. The definition of a suspected case was based on the ECDC case definition, i.e., a case with a positive PCR or rapid antigen test (RAT) sample ≥60 days following a previous positive PCR, a previous positive RAT or a previous positive serology (anti-spike IgG Ab).

To retrieve the cases, we developed a retrieval algorithm and validated it manually. This was challenging, as in the NIDR for each individual, all notifications of COVID-19 received within one year were routinely combined into a single notified case, without information on the actual number of notifications that were associated with the case.

The retrieval algorithm was refined and validated with manual comparison for each case. The final optimised algorithm was found to identify almost all cases of reinfection in the register. It was, thus, added as a routine search algorithm in the system, associated with a new surveillance variable for reinfections, which was integrated into the routine surveillance of COVID-19 in Finland. This variable became especially important during the surveillance of the Omicron variant in Finland, for which a considerable proportion of cases constituted cases of reinfection.

Role: The fellow was the main investigator in this project. She helped select the case definition for reinfections, manually checked all suspected cases of reinfections, validated the algorithm, cleaned and analysed the data and gave a presentation on COVID-19 reinfections in Finland between January 2020 and May 2021.

1.2.e Evaluation of COVID-19 surveillance in Finland in 2020
Supervisors: Outi Lyytikäinen, Timothee Dub, Lotta Siira

SARS-CoV-2 was first described in the city of Wuhan in China at the end of 2019. The outbreak spread from China and was declared a Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) on 30 January 2020 and a pandemic on 11 March 2020.

The first COVID-19 case in Finland was identified on 28 January 2020 in the Lapland Hospital District. The first peak phase in the COVID-19 epidemic in Finland occurred between March and April 2020.

As a result of the different phases of the pandemic, the surveillance of COVID-19 in Finland underwent many changes in 2020. The aim of this project was to describe and evaluate the surveillance of COVID-19 in Finland during that year.

We described the multi-component surveillance system for COVID-19 cases and pertaining epidemiological indicators, including: a) the National Infectious Diseases Register (NIDR), to which COVID-19 was added in early March 2020. COVID-19 cases were reported to NIDR through laboratory-based and physician-based surveillance and was the main method for collecting data on the number of cases and their demographics; b) surveys completed by laboratories, used to collect data on the daily number of tests; c) data collected by hospital districts on the regional number of hospitalisations and COVID-19 deaths, notified to THL through electronic surveys. These surveys allowed the collection of data in real-time; d) Data on hospitalisations collected continuously through the Finnish Hospital Discharge Register (HILMO) that covers the data for all hospitalised patients in primary, secondary and tertiary healthcare; e) data on out-patient care and on patients contacting primary healthcare centres collected through the part of the HILMO register that covers out-patient care (AvoHILMO); f) data on deaths from Statistics Finland; g) contact-tracing data collected through separate surveys developed by THL. Several recommendations on how to improve the system were put together, including suggestions for changes in the case definition and in the way that several variables are encoded in the NIDR.

Role: Together with EPIET fellows Dorothée Obach and Sohvi Kääriäinen, the fellow carried out the description of the surveillance system and presented identified weaknesses and recommendations for improvement. Additionally, the fellow evaluated the system with regards to the surveillance of COVID-19 reinfections.

1.2.f COVID-19 breakthrough infections in Finland
Supervisors: Outi Lyytikäinen, Timothee Dub

Finland began vaccinations against SARS-CoV-2 on 27 December 2020 with Comirnaty, followed in the next months by Spikevax and Vaxzevria; however, Vaxzevria was gradually dropped after spring 2021, in favour of the two RNA-based vaccines. The Janssen COVID-19 vaccine was never used in Finland.

Despite the large vaccination coverage and high initial vaccine effectiveness, infections among fully vaccinated persons (breakthrough infections) soon emerged both worldwide as well as in Finland, including severe and fatal cases. Therefore, a need arose to describe the incidence of COVID-19 breakthrough infections in Finland, and to identify factors that may increase the risk for a breakthrough infection, in order to guide public health policies and inform decisions on the administration of vaccine booster doses and allocation of resources.

Role: The fellow wrote the research protocol for the collection and analysis of COVID-19 breakthrough infection data from the National Infectious Diseases Register. She additionally completed and submitted the data request form. Due to the late retrieval of the data, it was not possible to carry out the analysis within the timeframe of the fellowship.

1.2.g Transmitted HIV drug resistance in Finland, 2019–2020
Supervisor: Kirsi Liitsola

Transmitted HIV drug resistance (HIVDR) can occur when previously uninfected individuals are infected with an HIV virus that carries drug-resistance mutations. HIVDR can lead to treatment failure and therefore, it is under surveillance in Finland as well as in Europe. The aim of this activity was to collect data on transmitted HIV drug resistance among newly diagnosed HIV cases in Finland between 2019–2020 for surveillance purposes and to report it to ECDC.

Overall, in 2019–2020, out of the 144 individuals tested for HIVDR, 14 (10%) were found to carry sequences associated with reduced drug sensitivity. The proportion of resistance sequences was at same level in both 2019 and 2020, at approximately 10%. For seven of the 14 cases, the same single mutation was identified, expected to confer intermediate-level resistance to rilpivirine. For the rest of the cases, multidrug resistance was predicted.

All cases with resistance were to the non-nucleoside reverse transcriptase inhibitors (NNRT) class and associated with five drugs, namely doravirine, efavirenz, etravirine, nevirapine and rilpivirine. The most prevalent mutation was 138A, carried by nine of the total 14 cases. The maximum number of drugs to which a case was predicted to be resistant was three. There were no cases of resistance to the nucleoside reverse transcriptase inhibitors (NRTI), protease inhibitors (PI) or integrase inhibitors (INI) classes and no multiclass resistance was recorded. Ten out of the 14 cases had contracted HIV in a country other than Finland. The most common transmission mode was heterosexual, in eight out of the 14 cases.

In conclusion, the level of HIVDR in Finland has remained low over 2019–2020. For all the individuals tested there were still several treatment regimens available. However, it is important to test for resistance before starting treatment to avoid treatment failures.

Role: The fellow used sequencing data to predict resistance, analysed the drug resistance data, compiled them in an aggregated form for submission to ECDC, and wrote an internal report.

Training modules related to the assignment/projects
EPIET/EUPHEM introductory course: This three-week course introduced concepts around the surveillance of infectious diseases, including different study designs, with focus on cohort and case-control studies, types of surveillance, as well as examples of surveillance systems and means of evaluating them. Importantly, the training included the analysis of surveillance data through case studies and exercises.

Rapid Assessment and Survey Methods module: This module familiarised fellows with rapid assessments, surveys, and sampling methods. Part of the course was dedicated to complex emergency situations, and how to apply surveillance and control measures to optimally respond to the particular needs arising in this context.

Multivariable Analysis Module: This module provided analytical skills in multivariable analysis, including the development, validation, and use of linear, logistic, Poisson and Cox regression models for surveillance purposes.

Educational outcome
The fellow had the opportunity to engage in multiple surveillance projects. She practised the evaluation of surveillance systems through the project on the evaluation of COVID-19 surveillance in Finland. She wrote a protocol on how to analyse surveillance data on breakthrough infections and helped improve the surveillance of COVID-19 reinfections, by analysing the respective surveillance data and contributing to the development of a new targeted surveillance variable. In addition, she participated in the activities around the expansion of wastewater-based surveillance in Finland and evaluated targets and sampling schemes. In terms of implementation, she analysed surveillance data on COVID-19 transmission in educational environments, which supported decisions pertaining to school closures. Finally, she aided in the collection and analysis of HIV drug resistance data, which confirmed that HIV drug resistance remains low in Finland.

2. Applied public health research

2.1 Invasive beta-haemolytic streptococcal infections in Finland, 2006–2020
Supervisors: Jaana Vuopio, Emmi Sarvikivi

Beta-haemolytic streptococci are a major cause of morbidity and mortality, especially in conjunction with invasive infections. The main human pathogens belong to three Lancefield groups: A (GAS), B (GBS) and C/G (GCGS). Despite their significance, invasive streptococcal infections are notifiable only in a few countries. We studied the incidence of invasive beta-haemolytic streptococcal infections in Finland in the period from 2006–2020, focusing on GCGS, which particularly lack surveillance. Case notifications were retrieved from the National Infectious Diseases Register, where all invasive cases are mandatorily notified. Cases were defined as isolations from blood and/or cerebrospinal fluid.

Between 2006–2020, 3 352 GAS, 4 190 GBS and 8 239 GCGS invasive infections were reported in Finland. The average annual incidence was 4.1 (range: 2.1–6.7), 5.2 (4.0–6.3) and 10.1 (5.4–17.6) per 100 000 population, respectively, peaking in 2018–2019. The incidence has displayed an increasing trend over the study period, in particular, for GCGS (8% annual relative increase). The median age of cases was 56 years for GAS, 66 years for GBS and 73 years for GCGS. Male sex was overall a risk factor for GCGS (adjIRR=1.6, 95% CI=1.5–1.8) and GAS (adjIRR=1.2, 95% CI=1.1–1.4); for GBS, the association was age-group-dependent. In adults, GCGS incidence increased significantly with age, especially for age>55 years.

In conclusion, we found that the incidence of invasive beta-haemolytic streptococcal infections in Finland has been rising over the past 15 years, especially for GCGS. It is important that surveillance of GCGS be enhanced, including the study of disease burden and risk factors, as well as the systematic collection and typing of isolates, to guide infection prevention strategies.

Role: The fellow was the principal investigator in this study. The fellow reviewed literature, wrote the protocol, extracted, cleaned and analysed the surveillance data, wrote the manuscript and submitted it to a peer-reviewed journal [8.1]. The fellow will present the results at the 2022 ESCAIDE conference.

Training modules related to the assignment/projects

EPIET/EUPHEM Introductory Course: The introduction course incorporated a module on applied research and research protocols. For practice, the fellow wrote a short research proposal. The course also provided theoretical and practical training on study designs and epidemiological analyses, which helped the fellow select the appropriate design and type of analysis for her research study.

Multivariable Analysis Module: This module provided analytical skills in multivariable analysis and logistic, Poisson and Cox regression models, which the fellow used for data analysis in her research project.

Time Series Analysis module: This module provided training in the basic definitions and concepts of different types and models of time series used in public health surveillance and research. The lectures were combined with extensive practical sessions, including the assessment of performance of different types of time-series analyses and the interpretation of the results.

Management, Leadership and Communication in Public Health Module: This module introduced tools pertaining to project management, which the fellow applied for the successful completion of the project.

Educational outcome

Through this work, the fellow conducted all stages of a research project, including the identification of a public health problem, literature review, planning and writing of the study protocol, collection and analysis of data, as well as writing and submission of a scientific article as the first author. In terms of analytical skills, the fellow practised skills in descriptive and analytical epidemiology, including logistic, Poisson and negative binomial regression, as well as time-series analysis.

3. Applied public health microbiology and laboratory investigations

3.1 Set-up and validation of multilocus sequence typing (MLST) for pneumococcal isolates, based on whole-genome sequencing (WGS)

Supervisors: Lotta Siira, Outi Nyholm and Maija Toropainen

Streptococcus pneumoniae is a common aetiologic agent of otitis media, sinusitis, conjunctivitis, as well as community-acquired pneumonia. In severe cases, pneumococcal infections can develop to invasive pneumococcal disease (IPD), presenting mainly as meningitis, osteomyelitis and sepsis. In Finland, IPD is a communicable disease with mandatory notification to THL. All pneumococci isolated from blood or cerebrospinal fluid are sent to the Expert Microbiology Unit of THL for characterisation and typing. Typing is important for surveillance, as different serotypes are associated with distinct epidemiological characteristics. It is also important for monitoring the effectiveness of the national pneumococcal vaccination program.

Pneumococcal isolates at THL are routinely subjected to WGS. There is, therefore, the possibility to use WGS in tandem with specialised software for high-throughput typing. The aim of this project was to compare and validate available tools for routine WGS-based MLST typing at THL. Three tools were evaluated: MOST, stringMLST and SRST2.

Based on the evaluation and validation, we found stringMLST and SRST2 to fulfil the requirements for usage as typing tools for pneumococcal isolates at THL. Overall, we proposed stringMLST as the optimal typing tool for THL, as it outperformed SRST2 in several validation criteria, including the sensitivity and specificity. However, we also identified some limitations of stringMLST, namely low quality control, lack of a quality parameter output, and failure to assign new variants. Importantly, we noted a discrepancy with regards to allele *gdh* between stringMLST and SRST2. We, therefore, suggested the interim usage of both stringMLST and SRST2 at THL, until this discrepancy is clarified and resolved.

Role: The fellow was involved in all stages of the project, including literature review, SRA database search, selection and collection of sequences for the validation, design of the validation and data analysis. The fellow wrote the validation plan and validation report.

3.2 Validation of ResFinder for WGS-based prediction of antimicrobial resistance (AMR) of *Salmonella*

Supervisor: Saara Salmenlinna

Antimicrobial resistance (AMR) is associated with high morbidity and mortality and is recognised as a major public health threat by WHO. Surveillance of AMR is crucial for monitoring the level of circulating resistant strains and emerging antimicrobial resistance genes. In Finland, the national reference laboratory of THL collects all domestic *Salmonella* isolates and/or isolates from invasive infections for surveillance purposes, including AMR surveillance. To that end, isolates undergo antibiotic susceptibility testing (AST) with regards to ampicillin, chloramphenicol, streptomycin, sulfonamides, tetracycline, pefloxacin, nalidixic acid, trimethoprim, gentamicin, cefotaxime, mecillinam and meropenem.

At the moment, due to limited resources, only the two major *Salmonella* serotypes *S*. Enteritidis and *S*. Typhimurium undergo routine AST at THL. However, a considerable share of infections are caused by other serotypes. The integration of WGS-based AMR predictions into the analysis pipeline would allow the expansion of AMR surveillance to include all received isolates, more antibiotics and the collection of additional information regarding the genotype associated with resistance.

ResFinder is a well-known and widely used AMR prediction tool. To test whether ResFinder could be put into routine use for AMR prediction at THL, we carried out a validation project, to evaluate the sensitivity of ResFinder predictions and their level of concordance with phenotypic AST results. The validation dataset comprised 117 *Salmonella* isolates received between October 2021 and March 2022 by the bacteriology laboratory of THL, as well as 16 *Salmonella* strains of different serotypes, which were previously received by THL as part of External Quality Assurance (EQA) schemes.

For the panel of isolates tested, the sensitivity of ResFinder predictions was 100% for all antibiotics, except for pefloxacin and mecillinam that were not included in ResFinder. Regarding concordance, we found that for all antibiotics included in ResFinder the predictions exceeded the threshold of 95%, which we had set as minimum for acceptance.

In conclusion, the method fulfils the set criteria for being put into routine use at THL for ampicillin, chloramphenicol, streptomycin, sulfonamides, tetracycline, nalidixic acid, trimethoprim, gentamicin, cefotaxime, and meropenem. Still, our panel was limited in terms of some serotypes and resistance phenotypes. In addition, for nalidixic acid we identified some discordance with phenotypic AST. Therefore, it would be desirable to include a transitional period, where both methods, phenotypic and genotypic, are applied in parallel, in order to further validate the results. Finally, it should be kept in mind that WGS-based AMR prediction is suitable only for AMR surveillance, and not for clinical guidance, as phenotypes of intermediate resistance (defined by EUCAST as 'susceptible, increased exposure'), which may require adjusted treatment regimens, cannot be inferred from WGS data.

Role: The fellow was the main investigator carrying out the project. Together with Saara Salmenlinna she designed the validation and thereafter ran the ResFinder predictions, collected and cleaned all the data and analysed them. Finally, she wrote the validation plan and validation report.

Training modules related to the assignment/projects

Biorisk and Quality Management Module: This module provided training on biorisk and quality control management. This training and especially the part on quality was taken into use for both projects.

Educational outcome

Through her two projects, the fellow gained hands-on experience with writing protocols and performing validations, while adhering to quality assurance standards. In addition, she furthered her skills around MLST, AST and AMR predictions, and had the opportunity to work with WGS data.

4. Biorisk management

4.1 Theoretical and practical training in biosafety level 3 (BSL-3), THL, Finland

THL harbours a BSL-3 facility, comprising one lab for viral and one for bacterial samples. The fellow received theoretical and practical training in the procedures and laboratory practices around working in the BSL-3 laboratory facility.

The theoretical part of the training involved lectures on the concepts of biorisk, biosafety, and BSL classification. Further, the fellow was introduced to the BSL-3 lab of THL, together with the pertinent laboratory procedures and good practices, including airflow cleaning procedures, decontamination and general cleaning procedures, handling of waste, procedures for handling accidents, as well as types of personal protective equipment (PPE) available for the laboratory staff. This part of the training was provided by Susanna Sissonen and Pamela Österlund.

The fellow was also familiarised with the surveillance of tuberculosis in Finland, and the procedures around working with mycobacterial samples in the BSL-3 lab of THL, through a lecture by Silja Mentula.

The practical part of the BSL-3 training concerned the processing and analysis of mycobacterial samples in the BSL-3 lab for diagnostic and surveillance purposes. During the demonstration, the fellow had the opportunity to try different types of PPE, visit the BSL-3 facility and become familiar with how mycobacterial samples are handled. In addition, she became acquainted with how to work safely in the biosafety cabinet, how to dispose of waste, how to clean up and decontaminate, and what quality control procedures are put in place to ensure the safe and proper functioning of the lab.

4.2 Simulation exercise in biosafety risk assessment and management

The fellow participated in a simulation exercise involving the biosafety risk assessment of a laboratory research project on a fictional viral pathogen. Taking into account, among others, the characteristics of the pathogen, transmission properties/virulence (routes of infection, morbidity, mortality, transmissibility, incubation period), epidemiology, treatment options as well as the laboratory procedures around testing, containment and decontamination, the exercise produced an assessment of the likelihood of infection of animal and human hosts, the consequences of infection of animal and human hosts, the likelihood of exposure for an individual performing *in vitro* work, as well as the likelihood of exposing the community outside of the laboratory to the virus. In the end, the overall biosafety risk was assessed as a combined function of the likelihood of infection and respective consequences.

Training modules related to the assignment/projects
Biorisk and Quality Management Module: This module provided in-depth training in the concepts of biosafety and biorisk, as well as in biosafety risk assessment. Procedures for risk mitigation were also discussed.

Educational outcome
Through these activities, the fellow became acquainted with the concepts of biosafety and biorisk, as well as their assessment and mitigation. She was also trained in BSL-3 lab work and personal protection in the field.

5. Quality management

5.1 External quality assessment (EQA) of the bacteriology lab of THL on antibiotic susceptibility testing (AST) of *Salmonella*
Supervisor: Saara Salmenlinna

The Expert Microbiology Unit of THL participated in the seventh external quality assessment (EQA) scheme on antimicrobial susceptibility testing (AST) of *Salmonella* (EQA7-AST), as well as in AMR capacity-building activities, commissioned by ECDC. The fellow assisted in these activities and reported the results.

Initially, the fellow received training in antibiotic susceptibility testing (AST) at the bacteriology laboratory of THL, with the method of disc diffusion. For the EQA, 12 antibiotics were tested: ampicillin (AMP), chloramphenicol (CHL), streptomycin (STR), sulfonamide (SUL), tetracycline (TET), trimethoprim (TMP), pefloxacin (PEF), gentamicin (GEN), nalidixic acid (NAL), cefotaxime (FTX), mecillinam (MEC) and meropenem (MEM). Breakpoints were based on the EUCAST guidelines. In parallel, the EQA strains were whole-genome sequenced with Illumina MiSeq and the sequences were used for AMR prediction, using ResFinder and SRST2. All results were reported to the EQA organisers.

Based on the results, the laboratory scored well at the EQA and the results were overall in concordance with the answers provided. Only few deviations were observed, limited to specific measurement readings, with most of them pertaining to the testing of susceptibility to gentamicin. These have been noted and taken into consideration for future improvements.

Role: The fellow completed and submitted a survey, aimed at identifying the needs for capacity building, within the framework of the FWD AMR-RefLabCap. For the EQA, the fellow participated in all the meetings, helped with WGS-based AMR predications, collated, reviewed, and reported the results to the EQA organisers. Finally, the fellow reviewed the results and presented them in an internal report. As part of the activity, the fellow additionally participated in workshops regarding EQA, AMR testing, genome-based AMR prediction and capacity across the laboratory network.

5.2 Audit of the bacteriology laboratory of THL, Finland
Supervisor: Lotta Siira

This was a training activity, where the fellow participated as an observer in the official audit of the bacteriology lab of THL by FINAS, the Finnish Accreditation Service (ISO 17025) in September 2021. The audit aimed at renewing accreditations received previously, as well as at expanding the accreditation around mycobacteria to include sensitivity rapid tests for tuberculosis. The assessment was done in accordance with the requirements of ISO/IEC 17025:2017, ILAC P10:07/2020 and EA-2/15:2019.

Very few deviations were noted, none of which were classified as serious, and which only pertained to minor documentation issues. It was agreed upon that these would be addressed rapidly.

Role: The fellow was engaged in this activity as an observer and wrote a reflective note on the mode of the audit, its results, as well as her observations.

5.3 Quality audit of the virology laboratory of THL, Finland

As part of a training activity, the fellow carried out an internal audit of the virology laboratory of THL, assessing the quality protocols, process management, documentation and workflows in the laboratory. Based on the audit, the laboratory achieved a score of 99% in process management and quality control, and 91% in documentation, yielding an overall general indicator score of 95%. The overall quality was high, with no deviation, except for incomplete documentation regarding some minor procedural aspects. Those were noted down and presented to the staff.

Training modules related to the assignment/projects
Biorisk and Quality Management Module: The module provided training in quality management in biomedical and public health laboratories according to the ISO 15189 norm. Many aspects of quality assurance were introduced, including quality standards, audits, internal quality controls and external quality assurance.

Educational outcome
The fellow carried out a series of activities around the assurance of quality in public health laboratories and became familiar with quality audits and audit reports. She also had the opportunity to participate in an EQA round and get engaged in the network of laboratories and experts carrying out surveillance of *Salmonella* AMR.

6. Teaching and pedagogy

6.1 Essentials of Infectious Disease Epidemiology course, Tampere University, Finland

As part of the teaching team, the fellow co-taught the one-week course, 'Essentials of Infectious Disease Epidemiology', offered to students attending MSc and PhD programmes in Public Health or Epidemiology, at Tampere University in Finland. The fellow was involved in all aspects of the course, including planning, designing the curriculum, developing training materials and teaching. In terms of teaching, she developed and delivered a lecture on COVID-19 surveillance in Europe and facilitated four case studies on scenarios around outbreaks and surveillance of infectious diseases. Further, she facilitated a simulation exercise on communication in public health. Finally, together with the teaching team, she helped shape the evaluation questionnaire. The course as well as the lecture offered by the fellow received excellent evaluation scores from the participants.

Training modules related to the assignment/projects
EPIET/EUPHEM Introductory Course: The introductory course included a sub-module on teaching, including learning styles, teaching methods and how to communicate messages efficiently. It also provided tools on how to build up lectures and educational activities and stressed the importance of interaction between teacher and learner, which the fellow applied to her teaching.

Educational outcome
The fellow gained invaluable hands-on practice in teaching, by developing and delivering a lecture and facilitating case studies and group exercises. She included interactive elements and opportunities for learner involvement in her teaching and appreciated the importance of this type of teaching mode. Finally, she gained experience in planning courses, through her contribution to the planning of the course, 'Essentials of Infectious Disease Epidemiology'.

7. Public health microbiology management

The fellow was responsible for the management of all her projects and activities, including time management, follow ups with collaborators, as well as the organisation of project meetings. Through her projects, she also had the opportunity to engage with external stakeholders, such as universities, clinical diagnostic laboratories in Finland, European national public health laboratories and ECDC.

Additionally, the fellow's projects had clear components of management. As an example, during the outbreak investigations the fellow successfully took part in and collaborated within interdisciplinary teams, comprising experts from different public health agencies. Moreover, these investigations included elements of communication to the public and the different stakeholders. As another example, the fellow's validation projects and audits were directly related to quality management of a public health laboratory.

7.1 Editing and English translation of a news bulletin on the THL website

The fellow helped to edit and translate into English, in a scientifically accurate manner, a news bulletin on travel recommendations related to COVID-19 for the website of THL.

Training modules related to the assignment/projects

Management, Leadership and Communication in Public Health Module: This module provided training in effective management, which was essential for public health microbiology management. It also provided theoretical knowledge and simulation exercises pertaining to team dynamics and strategies for successful team outcomes; this was particularly useful for collaboration in multi-disciplinary teams. Finally, it included exercises in communication with authorities and the public.

Introduction course: The introduction course included a module on how to communicate messages effectively, using communication tailored to the target audience. This was useful for all communication activities, such as delivering presentations to peers and compiling information material for the public THL webpage.

Educational outcome

Working on the *S.* Typhimurium outbreak together with investigators from both the food authority and THL, provided the fellow training in management and communication skills, which were additionally developed at the management, communication and leadership module. In addition, the validation and EQA projects, endowed the fellow with an overview of laboratory management procedures, and engagement with EU and national laboratory networks. Her involvement in the translation of a news bulletin for the THL website emphasised the importance of effective communication for infectious disease control.

8. Communication

Publications related to the EUPHEM fellowship

8.1 **Paspaliari DK**, Sarvikivi E, Ollgren J and Vuopio J. Invasive beta-haemolytic streptococcal infections in Finland, 2006–2020: The rise of Lancefield group C/G infections. Submitted manuscript.

8.2 Kääriäinen S, Obach D, **Paspaliari DK**, Tofferi M, Nieminen A, Pihlajasaari A, Kuronen H, Vainio A, Rimhanen-Finne R. *Salmonella* Typhimurium outbreak associated with frozen tomato cubes at a restaurant in western Finland, January to February 2021. Euro Surveill. 2022;27(41):pii=2200316.

Reports

8.3 Kääriäinen S, Obach D, **Paspaliari DK**, Tofferi M, Nieminen A, Pihlajasaari A, Kuronen H, Vainio A, Rimhanen-Finne R. *Salmonella* Typhimurium outbreak associated with frozen tomato cubes at a lunch restaurant in Western Finland, January–February 2021. Outbreak report, 2021.

8.4. Outbreak of enterohaemorrhagic *Escherichia coli* in July–August 2021, Finland. Outbreak report, co-authored with Sohvi Kääriäinen, 2021.

8.5 External quality assessment (EQA) of the bacteriology lab of THL on antibiotic susceptibility testing (AST) of *Salmonella*. Internal report, 2021.

8.6 Sentinel wastewater-based surveillance of communicable diseases and antimicrobial resistance in Finland, Part I: Informed selection of priority targets. Internal THL report, 2021.

8.7 Sentinel wastewater-based surveillance of communicable diseases and antimicrobial resistance in Finland, Part II: Informed selection of frequency and sites for sampling for wastewater-based surveillance of ESBLs. Internal THL report, 2022.

8.8 Incidence of secondary COVID-19 cases following exposure to SARS-CoV-2 at comprehensive schools and early childhood education and care facilities in Finland, August 2020–March 2021. Internal THL report, 2022.

8.9 Transmitted HIV drug resistance in Finland, 2019–2020. Internal THL report, 2022.

8.10 Validation of MOST, stringMLST and SRST2 for WGS-based MLST typing of *Streptococcus pneumoniae*. Validation report, 2022.

8.11 Validation of ResFinder for WGS-based AMR prediction of *Salmonella* strains. Validation report, 2022.

Conference presentations

8.12 **Paspaliari DK**, Dub T, Siira L., Helve O and Sarvikivi E. Low occurrence of secondary COVID-19 cases following exposure to SARS-CoV-2 at comprehensive schools and early childhood education and care facilities between August 2020 and March 2021 in Finland. Poster presentation at ESCAIDE 2021.

8.13 Kääriäinen S, Obach D, **Paspaliari DK**, Tofferi M, Nieminen A, Pihlajasaari A et al. *Salmonella* Typhimurium outbreak associated with frozen tomato cubes at a lunch restaurant in Western Finland, January–February 2021. Oral presentation at ESCAIDE 2021, delivered by Sohvi Kääriäinen.

8.13 Sarekoski A., Hokajärvi A-M, **Paspaliari DK**, Räisänen K, Oikarinen S, Heikinheimo A and Pitkänen T. Wastewater-based surveillance reveals temporal and spatial trends in prevalence of antimicrobial resistance and multiple communicable disease agents. Poster at One Health European Joint Programme Scientific Meeting 2022, presented by Anniina Sarekoski.

8.14 **Paspaliari DK**, Sarekoski A, Lyytikäinen O, Räisänen K, Lipponen A, Oikarinen S, Lehto K-M, Heikinheimo A and Pitkänen T. Wastewater-based surveillance of extended-spectrum beta-lactamase (ESBL)-producing *Enterobacteriaceae* in Finland: Informed selection of sites for sampling. Abstract accepted for poster presentation at ESCAIDE 2022.

8.15 **Paspaliari DK**, Sarvikivi E, Ollgren J and Vuopio J. Invasive beta-hemolytic streptococcal infections in Finland, 2006–2020: The rise of Lancefield group C/G infections. Abstract accepted for oral presentation at ESCAIDE 2022.

Other presentations

8.16 Investigation to confirm a suspected EHEC outbreak, Finland, August 2021. Presentation together with Sohvi Kääriäinen at internal meeting at THL, 04.11.21.

8.17 Wastewater-based surveillance of antimicrobial resistance in Finland, presentation at the Nordic Mini Module, February 2021.

8.181 Wastewater-based surveillance of antimicrobial resistance in Finland, presentation at internal THL meeting, 14.04.21.

8.192 COVID-19 reinfection cases in Finland, presentation at internal THL meeting, 06.03.2021.

8.20 Surveillance of COVID 19 in Finland in 2020. Presentation together with Dorothée Obach and Sohvi Kääriäinen at internal THL meeting, 19.11.2020.

8.21 Set-up and validation of WGS-based MLST-typing of pneumococcal isolates, presentation at internal THL meeting, 11.02.2021.

8.22 Low occurrence of secondary COVID-19 cases following exposure to SARS-CoV-2 at comprehensive schools and early childhood education and care facilities between August 2020 and March 2021 in Finland. Presentation at the Project Review Module, August 2021.

8.23 Invasive beta-hemolytic streptococcal infections in Finland, 2006–2020. Presentation at Nordic Mini Project Review Module, Oslo, February 2022.

9. Other activities

1. COVID-19 Think Tank session series hosted by ECDC, 2020–2022

10. EPIET/EUPHEM modules attended

1. Fellowship Introductory Course, 28.9. – 16.10.2020, online

2. Inject days on Operational Research, 9.11. – 10.11.2020, online

3. Outbreak Investigation Module, 7.12. – 11.12.2020, online

4. Multivariable Analysis Module, 15.2. – 19.2.2021, online

5. Multivariable Analysis - Cox regression inject day, 18.03.2021, online

6. Introduction Course part III, 26.4. – 30.4.2021; 4.5.2021 and 7.5.2021, online

7. Rapid Assessment and Survey Methods module, 5.5. – 6.5.2021, online

8. Project Review Module, 23.8. – 26.8.2021, online

9. Biorisk and Quality Management, 17.1. – 18.1.2022, online

10. Vaccinology Module, 14.2. – 18.2.2022, online

11. Time Series Analysis Module, 3.4. – 8.4.2022, Rome, Italy

12. Management, Leadership and Communication in Public Health, 13.6. – 17.6.2022, Stockholm, Sweden

13. Project Review Module, 29.8 – 2.9.2022, Lisbon, Portugal

10. Other training

1. Nordic Mini Project Review Module, 23.3. – 24.3.2021, online

2. BSAFE, United Nations security awareness training, May 2021, online

3. Training on QGIS, 27.05.21 and 09.06.21, Helsinki, Finland

4. AMR workshop for FWD-Net, 19.04. – 20.04.2021, online

5. FWD AMR-RefLabCap Network meeting, 30.11. – 01.12.2021, online

6. Biosafety, biosecurity and BSL-3 training, THL course, Helsinki, Finland, February 2022

7. Nordic Mini Project Review Module, 7.3. – 8.3.2022, Oslo, Norway

8. Microbiology lecture series, 2022

Discussion

Coordinator's conclusions

One of the main goals of the EUPHEM programme is to expose fellows to diverse and multidisciplinary public health experiences and activities, thus enabling them to work across different disciplines. This report summarises all the activities and projects conducted by Dafni Katerina Paspaliari during her two-year EUPHEM fellowship (cohort 2020) as an EU-track fellow at the Finnish Institute for Health and Welfare (THL). During the two years of the fellowship, Dafni has shown a high level of competency, this portfolio being the reflection of her dedication and hard work. The laboratory and epidemiologically based projects covered a diverse range of disease programmes involving multidisciplinary work and teamwork on all levels such as with physicians, laboratory technicians, epidemiologists, statisticians, government officials and public health officers, showing the strength of the fellow and the ability to work within such a diverse environment(s). During the two years, she has not only achieved her primary objectives but contributed to the response to the COVID-19 pandemic in Finland in different areas such as investigating the incidence of secondary COVID-19 cases at comprehensive schools, early childhood educational and care facilities, improving the surveillance of COVID-19 reinfections in Finland or initiating the evaluation of the COVID-19 surveillance system and COVID-19 breakthrough infections. In addition to the COVID-19 response, she has taken an important role in the investigation of two national outbreaks and the expansion of wastewater-based surveillance, both activities with an important component of management and leadership. Moreover, Dafni has expanded her research knowledge and analytical skills participating in a research project on invasive beta-haemolytic streptococcal infections. She also contributed in enhancing the capacities of the national laboratories by setting up an MLST scheme based on WGS for pneumococcal isolates and validating ResFinder as a tool to predict antimicrobial resistance of *Salmonella* from genomic data. All these activities were in line with the 'learning by doing' approach of the EUPHEM programme and fulfilled the core competency domains described for professionals in their mid-career and above. The activities were complemented by training modules providing theoretical and practical knowledge and skills. Finally, I would like to comment on Dafni' personal attitude towards the fellowship. She is a hard worker who can work independently, eager to learn and cascade her knowledge and apply new competences to her projects.

The EUPHEM Coordinator Team concludes that the fellow has succeeded in performing all her tasks to a very high standard and with a professional attitude. We wish the fellow every success in her future career and congratulate the training site for the successful training of the fellow.

Supervisor's conclusions

Dafni started her EUPHEM fellowship with the ambition to broaden her scope into public health microbiology and epidemiology. Her background in engineering, microbial biotechnology, medical microbiology and the private sector had already made her an excellent communicator with a keen eye for details. From the start, she showed that she was a committed and organised fellow. Over the course of the fellowship, she has developed her skills as a public health professional by contributing to two outbreak investigations, looking at how to expand wastewater-based surveillance in Finland and participating in the COVID-19 response by analysing the surveillance system, infection incidence in schools, and reinfections. She has validated methods for further use of WGS to multi-locus sequence type pneumococci and to predict the antimicrobial resistance of *Salmonella*, and has studied invasive beta-haemolytic streptococcal infections. Her projects have added to public health knowledge and activities that are at the core of THL's mission. She always kept a positive and constructive outlook, even when she encountered challenges related to the COVID-19 pandemic and response. Through her cooperative style, Dafni has not only contributed to furthering collaboration across the different disciplines and groups at THL, but she also has the ability to work and write independently. As her supervisory team, we have enjoyed working with Dafni, and based on her personal and professional qualities, we are in no doubt that she will contribute to the public health field also in the future.

Personal conclusions of fellow

I entered the fellowship with the wish to delve into public health and, upon finishing it, I can confidently say that this goal was achieved to the fullest. I have amassed knowledge and experience in field epidemiology and public health to the level that I can now consider myself a professional in these fields. While working at THL and with ECDC, I had the opportunity to gain an insider's point of view of routine surveillance, response to unusual events and outbreak investigations. I could contribute to interesting projects, including the surveillance of beta-haemolytic streptococci, wastewater-based surveillance, AMR, validation projects and the surveillance of COVID-19, to name a few. I also had the chance to teach infectious disease epidemiology at the Tampere University, which was a formative experience. Importantly, being a fellow during the COVID-19 pandemic allowed me to experience the difficulties of navigating the fine balance between public opinion, politics, and evidence-based decision-making. Over these two years I have grown professionally, as well as personally, and I have been endowed with friendships and professional networks that I am certain I will treasure in the years to come.

Acknowledgements of fellow

My fellowship was shaped by the people who escorted me throughout this journey. I was extremely lucky to have not only one, but two amazing main supervisors, Lotta Siira and Jaana Vuopio, who ensured that my fellowship was on course, and always gave me valuable feedback. I was similarly lucky to have Silvia Herrera Leon as my coordinator, who followed my progress closely but discreetly, and always made insightful comments. Carita Savolainen-Kopra was available whenever needed. I am extremely grateful to all my supervisors for both our professional and personal relationships.

I would also like to thank my epidemiology supervisors, Outi Lyytikäinen, Tim Dub and Emmi Sarvikivi for stimulating projects and sharing their expertise in epidemiology and surveillance, as well as Jukka Ollgren for discussions around statistics. And many thanks to all my project supervisors, including Saara Salmenlinna and Tarja Pitkänen, for allowing me to take part in their exciting projects.

Last, but not least, I would like to thank my cohort-mates for wonderful professional and social exchanges, relentless hours of group work, as well as online support. A special mention goes to my 'Finnish' fellow-mates Dorothée Obach and Sohvi Kääriäinen, as well as Charlotte Hammer and Eveline Otte im Kampe, without whom the fellowship would have never been the wonderful experience that it was.