FELLOWSHIP REPORT

Summary of work activities

Diederik Brandwagt
Intervention Epidemiology path (EPIET)
Cohort 2016

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 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;

This portfolio does not represent a diploma. Fellows receive a certificate listing the theoretical modules attended and the 23-month training. Additionally, if all training objectives have been met, they receive a diploma.

Stockholm, September 2018

- 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.

Pre-fellowship short biography

Diederik Brandwagt graduated as medical doctor at Nijmegen University in 2012. From 2012 to 2015, he was trained in communicable disease control at the Public Health Service (GGD) Utrecht region in Zeist, the Netherlands.

Fellowship assignment: Intervention Epidemiology path (EPIET)

On the 14th of september 2016, Diederik Brandwagt started his member state (MS) EPIET fellowship at the National Institute for Public Health and the Environment (RIVM) in Bilthoven, the Netherlands. His RIVM-supervisor during the fellowship was Mirjam Knol, local supervisor at the GGD was Ewout Fanoy. His EPIET frontline coordinator was Louise Coole. This report summarizes the work performed during this fellowship.

Methods

This portfolio demonstrates the competencies acquired during the ECDC Fellowship, EPIET path, by working on various projects, activities 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. 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 EPIET core competencies, as set out in the EPIET scientific guide[1].

Fellowship projects

1. Surveillance

Title: *Evaluating the completeness and timeliness of the surveillance system for invasive meningococcal disease (IMD) in the Netherlands, 2004-2016.*

Supervisors: Mirjam Knol (RIVM)

Enhanced surveillance for confirmed cases of invasive meningococcal disease (IMD) was introduced in the Netherlands in 2003, in which reference laboratory data (NRLBM) is linked with notification data (OSIRIS). With an increasing incidence of IMD in the Netherlands since 2015 and implementation of a new vaccination schedule in 2018, the quality of surveillance information is important for public health decision making. Our objective was to describe the system and evaluate it for data completeness and timeliness.
Cases reported in the surveillance system from 2004 to 2016 were included. We corrected the database for missing links and described the proportion of cases in each database. For the OSIRIS data, we used information on mortality, vaccination status, country of infection and serogroup as indicators for record completeness. Notification times to regional and national level were calculated using the reported dates available in the OSIRIS database.
A total of 2,123 cases were reported in the years 2004-2016, of which 1,968 (93%) were reported by the NRLBM and 1,995 (94%) in OSIRIS. Information on mortality, vaccination status and country of infection was available in

[1] European Centre for Disease Prevention and Control. European public health training programme. Stockholm: ECDC; 2013. Available from: http://ecdc.europa.eu/en/publications/Publications/.pdf

99%, 88% and 97% of all cases, respectively. The serogroup was known in 85% of cases overall, and was significantly higher (92%) in the years 2012-2016. Regional notification of cases occurred within one working day for 86% of cases and 98% were notified nationally within three working days.
A well performing IMD surveillance system was demonstrated, although there is some room for improvements. The manual linking of the data can be replaced by automated linking using a common identifier. Underlining the need for reporting to both the clinical and laboratory surveillance system remains important to further improve the overall performance in supporting public health response and vaccination policy.

Role: The fellow was the main investigator, performed data analysis and drafted and submitted an abstract that was accepted for a poster presentation at ESCAIDE 2018 (1). The fellow is main author of a manuscript that is under preparation for submission to a peer-reviewed journal (2).

Title: *Setting up a regional infectious disease surveillance system for the Utrecht region*

Supervisor: Ewout Fanoy (GGD Utrecht region)

Since December 2014, the GGD Utrecht region has been using HP Zone as a case management system (CMS). Data transfer from the previous CMS (Orion) was not possible, so no historical disease data is available in HP Zone. Historical data is useful in interpretation of actual case numers, as many disease have a seasonal or cyclic pattern. The aim of this project was to combine the data from Orion and HP Zone in one database to create a time series of all individual cases in the Utrecht region since 2004. The second aim was to build a tool based on the database, that could provide insight into historical disease patterns within the region.
Data from Orion and HP Zone were uniformized and cleaned from double entries. Data were merged to create a time series with all cases from 2004-2017. For diseases of interest, the time series were reshaped in table format with the number of cases per month per year. Using the Stroup-method, 5-years moving averages were calculated for every month. Per month also the upper prediction limit was calculated, to be used as an alarm threshold for action.
The total time series included 17500 disease episodes. The most commonly reported disease was pertussis with 9000 cases. The tool was used to illustrate increases in the number of invasive meningococcal cases in 2016 and 2018, scabies cases in 2017 and pertussis cases in 2018.
The tool proved to be useful when numbers were discussed in the weekly team meetings. For legionnaires' disease and invasive meningococcal disease, the numbers have exceeded the alarm threshold in 2018, but further investigation made clear there where no clusters or outbreaks.

Role: The fellow was the main investigator, created the database, built the tool and wrote the project report.

2. Outbreak investigations

Title: *Outbreak of Salmonella Bovismorbificans associated with raw ham products in the Netherlands, 2016-2017*

Supervisors: Kees van den Wijngaard, Eelco Franz (RIVM)

In January 2017, an increase was observed in reported *Salmonella* Bovismorbificans cases in the Netherlands since October 2016. A similar increase was observed concurrently in Belgium. An outbreak investigation was initiated to identify the source.
Cases were defined as persons with laboratory-confirmed *S.* Bovismorbificans infections reported after October 2016, in the Netherlands. Human isolates were sequenced using whole-genome sequencing (WGS). We interviewed cases to identify exposures and then implemented a case-control study, including all cases from December 2016. Age, gender and municipality matched controls were randomly selected from population registers. Adjusted odds ratios were calculated using logistic regression analysis. We traced back the distribution chain of suspected foods, and sampled them for microbiological analysis.
From October 2016 to March 2017, 53 cases of *S.* Bovismorbificans were identified (typically 3-14 cases/year reported). Cases were 5 to 90 years old (median 65) and 56% were female. Sequencing indicated all, including Belgian cases, had identical strains (<5 alleles difference). Twenty-four cases and 37 controls participated in the study. Cases were more likely to have consumed ham products than controls (aOR 13, 95% CI 2.0-77) and to have shopped at a supermarket chain (aOR 7, 95% CI 1.3-38). Trace-back investigations led to a Belgian meat producer: one ham sample from this producer tested positive for *S.* Bovismorbificans and matched the outbreak strain by WGS.
Trace-back investigations guided by the case-control study identified ham products from a specific producer as the source of this outbreak. The product was withdrawn from the market to prevent further cases. Pork meat is a

known risk factor for salmonellosis, but not for serovar Bovismorbificans. Therefore the use of a broad questionnaire including rare causes can be useful in outbreak investigations. This investigation further illustrates the importance of laboratory surveillance for all *Salmonella* serotypes, including rare serotypes. Intensive collaboration among epidemiologists, microbiologists and food safety specialists, and the use of WGS were key factors in this investigation.

Role: The fellow was the main investigator, performed data analysis, drafted and submitted an abstract for ESCAIDE 2017 that was accepted for oral presentation (3). The fellow was first author of a manuscript that was published in a peer-reviewed journal (4).

Title: *Outbreak of hepatitis A caused by the consumption of frozen fruit in the Netherlands, 2017.*

Supervisors: Margreet te Wierik, Ingrid Friesema (RIVM)

In april 2017, within one week three cases of acute hepatitis A were reported to the public health service Utrecht region. All patients lived in the same neighboorhood, and source tracing led to a local supermarket, although the food item involved in the outbreak could not be identified. Within a few weeks 11 additional cases of hepatitis A with unknown source were reported in other regions of the Netherlands. Genotyping of the patient samples indicated the hepatitis A strains (genotype IB) were highly similar among the 14 cases. The origin of strains could be narrowed to Bulgaria based on information from EPIS-FWD.
As an association with consumption of soft fruit was suspected, a case-control study was initiated using a questionnaire and a document with pictures of soft fruit available at the supermarket chain involved.
Twelve out of 13 cases consumed a specific frozen raspberry/blueberry product shown on the list (OR 46.0,95%CI 5.0–27). In multivariable regression analysis this product was the only risk factor (aOR 26.6, 95%CI 2.0–263).
Laboratory analyses could not demonstrate HAV-RNA in batches that had been on the market in the incubation periods of patients. Trace back of frozen fruit showed that raspberries had been traded by a producer in Bulgaria.
After withdrawal of the product from the supermarket no new cases were reported.
Use of advertisement pictures of consumed food was helpful in this investigation as it helped the patients to remember what sort of product they had consumed, furthermore it guided the trace back investigation. Suspicion of the source was strengthened by data from molecular typing and food trace back activities, underlining the importance of good (inter)national cooperation between public health and food safety organizations.

Role: As medical doctor working at the GGD Utrecht region the fellow was involved as main investigator of the local outbreak in the Utrecht region. In the national outbreak investigation the fellow was involved as co-investigater and co-author of a manuscript that was published in a peer-reviewed journal (5).

3. Applied epidemiology research

Title: *Prospective study on gastro-intestinal illness associated with swimming event in urban canals*

Supervisor: Ewout Fanoy (GGD Utrecht region / RIVM)

In 2017 the Utrecht SingelSwim took place for the third successive year in the city canals of Utrecht. As similar events in non-official swimming water in the past has led to cases of gastro-intestinal illness, a prospective study was performed among participants and family controls, to investigate the risk of gastro-intestinal disease associated with competing in such a swimming event.
Online questionnaires were sent to all 227 swimmers. Participants were requested to forward the questionnaire to three friends or relatives to complete the questionnaire as unexposed non-swimmers. The questionnaire included questions on outcome of disease (gastro-intestinal and other health complaints) after the events and exposures before and during the event. To calculate the risk for participating in the swim, we calculated adjusted odds ratio (aOR) including the friends and relatives in the analysis. Within the cohort of swimmers, we calculated adjusted relative risks (aRR) for developing disease for several risk factors, using binomial regression.
Ninety-four swimmers and 19 non-swimmers participated in the study. Swimming was associated with a higher risk for health complaints, but this was not statistically significant (aOR 6.0; 95% CI 0.7 – 50). Swimmers that had trained in open water before the event had a lower frequency of health complaints compared with the untrained swimmers (aRR 0.6; 95% CI 0.3 – 1.1) and for gastro-intestinal complaints the risk was significantly lower (aRR 0.17; 95% CI 0.03 – 0.8). Other swim-related factors e.g. the use of protective equipment and biological factors were not associated with a lower risk on health complaints.
Our study found similar results as to the two preceding editions of the SingelSwim. Based on our findings and previous studies, the risk of a swimming event in good weather conditions and with the right hygiene measures is

low, but not completely absent. Therefore information about the risk of swimming in non-official swimming water should be given to all participants. Results of this study and previous studies on similar events, will be used as input for a national guideline for public health services. With increasing popularity of these events in the Netherlands and other countries, this guidance is helpful for future events.

Role: The fellow was the main investigator, designed the questionnaire, analyzed the results and wrote the research report and summary with key findings for participants in the study and organization of the event. The fellow contributed to a review in the Dutch Infectious Disease Bulletin (6) and a national guideline on events in non-official recreational water (7).

Title: *Human exposure to H5N8 highly pathogenic avian influenza virus in the Netherlands, 2016 – 2017.*

Supervisors: Wim van der Hoek, Marit de Lange, Michiel van Boven (RIVM)

Since 2010, H5N8 highly pathogenic avian influenza (HPAI) virus has been detected in wild birds and on poultry farms in the Eurasian and North American region. So far, no transmission of H5N8 to humans has been detected in symptomatic patients after poultry contact. We initiated a prospective cohort study to investigate the zoonotic potential of H5N8.
We conducted our study among persons working or living on a H5N8-infected poultry farm in the Netherlands from November 2016 through March 2017. Within two days after confirmation of poultry infection, we collected a finger-prick dried blood-spot sample (fpDBS) and collected data on socio-demographics, bird exposure, influenza-related symptoms and use of personal protective equipment (PPE) from study participants, in collaboration with the local public health services. Further fpDBSs and symptom data were collected four weeks later (T4). We used a protein microarray to test fpDBSs for IgG antibodies against the hemagglutinin subunit HA1 of seasonal and avian influenza viruses. We calculated relative risks (RR) for association between exposures and symptoms.
Twenty-two persons from 10 different farm outbreaks participated. Direct contact with infected birds (14 persons, RR 0.9; 0.2-4.1) and not using PPE (13 persons, RR 0.5; 0.1-2.2) were not associated with influenza-related symptoms at T4. One person showed a >4-fold titer increase against subtype H5, but also a >4-fold titer increase against multiple other subtypes. None of eight other participants with a >4-fold titer increase against one or more other subtypes did so for H5.
For the first time a prospective study was performed to investigate the risk for humans to be exposed to H5N8 HPAI. We found no evidence that direct contact with H5N8-infected birds is associated with influenza-related symptoms. One participant showed a generalized immunological response to multiple influenza virus subtypes, including H5. From seven participants of the study, additional blood samples are taken for further testing, to determine whether this response could represent a specific response against H5N8.

Role: The fellow was one of the main investigators on the epidemiological site, adapted and updated the existing protocol, was on call for new outbreaks in order to organize logistics for questionnaires and blood samples. The fellow was main investigator in analysis of questionnaire data and analytical study including the microbiological results and drafted and submitted an abstract for ESCAIDE 2018 that was accepted for a poster presentation (8).

Title: *Study protocol: Exposure to roads and the risk for Legionnaires' disease (LD).*

Supervisor: Petra Brandsema (RIVM)

For the majority of domestic (non travel-related) LD cases, the source of infection remains unknown. In the summer months of 2006 and 2010, a large increase was seen in the number of LD cases. As the summers were extremely warm and had periods with excessive rainfall, a link with the weather conditions was assumed. When the incidence of LD cases for 2006 and 2010 was plotted on a map of the Netherlands, the pattern resembled the main road network in the Netherlands, leading to the hypothesis that cases could have been exposed via roads. In an pilot analytical study a higher relative risk was seen for persons living close to motorways or other primary roads, but no multivariable analysis could be performed due to the small number of cases.

With the number of LD cases increasing again since 2014, the aim of the study is to investigate the hypothesis that LD cases are living relatively closer to main roads than non-LD cases. We will perform a retrospective cohort study, using existing notification data from the years 2006, 2010, 2014, 2015, 2016 and 2017, as these were the years with the highest numbers of cases, and for most of these cases the PC6 area (the smallest administrative region in the Netherlands) is availabe, to calculate distances to the different road types for all cases.

In the analysis, PC6 areas that have one or more LD cases will be defined as case-PC6, and PC6 areas without LD cases as non-case-PC6. Based on the distance to the different road types (motorway, primary roads and secondary roads) PC6-areas will be stratified in strums of 50 meter. We will use the stratum with PC6-areas further than 1000 meter from a road as reference, to calculate the relative risks for having case-PC6 areas for each strutum. This relative risk for having case-PC6 is used as a proxy for the risk of developing LD. For each PC6 area, demographic information is known (age and gender distribution, social economic status, urbanization) and information on the number of smokers and number of persons with underlying chronic illnesses is known. This additional information will be included in a multivariable model to calculate adjusted relative risks, for each stratum of PC6-areas.

Analysis will be done seperately for domestic and imported (travel-related) LD cases. Furthermore we will do additional analysis including weather data, to define PC6-areas in having cases after a wet period and during warm periods.

Role: The fellow developed the study protocol and is the main investigator of the study.

4. Communication

Publications

- One manuscript has been published as first author (4) and one as co-author (5)
- One review has been published as co-author in the Dutch Infectious Disease bulletin (6)
- A manuscript on the IMD surveillance project is under preparation to be submitted to a peer-reviewed journal.

Reports

- Summary report on the Utrecht SingelSwim 2017

Conference presentations

- One oral presentation at ESCAIDE, November 2017, Stockholm, Sweden (3)
- Two poster presentations at ESCAIDE, November 2018, Saint Julian's, Malta (1, 8)

Other presentations

- Oral presentation at the Netherlands School of Public & Occupational Health, February 2017
- Oral presentation on tick projects at the TickTactics symposium, December 2016
- Oral presentation on the first case of autochthonous TBEV at a regional zoonosis symposium, June 2017

Other work

- Delegate of the Public Health Service Utrecht region in outbreak meeting and environmental investigations of the first autochthonous case of TBEV in the Netherland in 2017
- Co-investigator of the regional tick projects at the Public Health Service Utrecht region in 2016, 2017 and 2018
- Co-organizer of the "Transmissiedag", annual symposium for professionals in infectious disease controls in the Netherlands, March 2017
- Five manuscripts of PHS projects started before EPIET have been published as co-author in peer reviewed journals (9, 10, 11, 12, 13)
- One manuscript has been published as first author in the Dutch Epidemiological bulletin (14)

5. Teaching and pedagogy

Lecture on study design (cohort vs case-control)
Developed and delivered a lecture on 7 March 2017 on the design of outbreak investigations. Netherlands School of Public & Occupational Health for a group of approximately 15 residents in infectious disease control.
Case study trichinosis in Paris
Facilitated case study on 7 March 2017 at the Netherlands School of Public & Occupational Health for a group of approximately 15 residents in infectious disease control.
Introduction in infectious disease control
Introductory lecture for medical interns at the Utrecht University on 9 January 2017, just before their internships in Public Health.
Case study giardiasis in Bergen
Facilitated case study on 22 June 2017 at the Utrecht University for Phd students and Ms students in Epidemiology.
Introduction in infectious disease control
Introductory lecture for medical interns at the Utrecht University on 7 August 2017, just before their internships in Public Health.
Case study trichinosis in Paris
Facilitated case study on 4 December 2017 at the Radboud University in Nijmegen for a group of medical students. Introduction in infectious disease control during the end of their BSc.

Reflection

I came in the fellowship with experience in teaching and have been able to further develop my teaching compentencies through teaching activities during my fellowship. Furthermore the fellowship provided opportunities to teach other groups than I was used to. Teaching others in epidemiology was a good opportunity to boost my own knowledge of epidemiology, as I think you can only understand theories, if you can explain them to others. The teaching activities at the NSPOH included also a formal evaluation by the audience, which was helpful to develop myself further by keeping my strong points (teaching style) and strengthening my weaker points (adapting more to the level of the audience). During the case studies I was able to develop my own teaching style, which also included experiences from my own professional career. I received feedback that this was appreciated by the audience, as this brought the theory closer to the daily practise of the group. During the teaching at the NSPOH and the Radboud University I also had direct supervision from a more experienced teacher in the subject and received direct positive feedback from their site as well.

6. EPIET/EUPHEM modules attended

1. Introductory course, Spetses, 26 September to 14 October 2016
2. EPIET Outbreak Investigation Module, Berlin, 5 to 9 December 2016
3. EPIET Multivariable Analysis module, Zagreb, 13 to 17 March 2017
4. EPIET RAS module, Athens, 8 to 13 May 2017
5. Project Review Module, Lisbon, 28 August to 1 September 2017
6. EPIET Time Series Analysis module, Bristol, 20 to 24 November 2017
7. EPIET Vaccinology module, Cardiff, 11 to 15 June 2018
8. Project Review Module, Lisbon, 27 to 31 August 2018

Discussion

Supervisor's conclusions

During this EPIET fellowship, Diederik showed that he is very capable of combining different jobs. The fellowship resulted in good output, including two articles in international peer reviewed journals and one in preparation, and three presentations at ESCAIDE. The projects Diederik was involved in were all applied projects that were close to the daily work of the GGD and therefore have direct impact on public health, for example withdrawal of products from the market (*Salmonella* Bovismorbificans outbreak and hepatitis A outbreak), a national guideline for swimming events in canals, and a signalling tool for local outbreaks. During his fellowship, Diederik applied and learned a lot of different

methods and techniques, including designing a questionnaire, setting up the logistics for a prospective study, merging of different datasets, time series analysis, multivariable analysis and writing scientific articles. A good learning point for Diederik during his fellowship was to always start with writing a protocol before jumping into the analyses.

Diederik is a pleasant and relaxed person to work with. He can work very independently on writing protocols, doing analyses and writing manuscripts. He is a flexible person who is willing to take up a new project, although sometimes his time planning is too optimistic and therefore not all projects which were started could be finished. For me it was really fruitful to get to know the 'local level' side of the story and I often asked him how things were organized at the GGD level. This was especially the case for invasive meningococcal disease, where we can change the work flow/data flow to improve surveillance and reduce the workload for GGDs.

I am confident that Diederik will use the knowledge, skills and network from this EPIET experience in his future work at the GGD and beyond.

Coordinator's conclusions

Diederik has had a successful fellowship strengthening his skills across all the competency domains and making an important contribution to work at his site. He has navigated very well the challenges of split site and team working and turned this into an advantage whereby he could draw on the range of experience and opportunities of both a national institute and a local public health department. He has demonstrated strong skills in self and project management. Diederik already had some experience in teaching but has been able to extend his skills in this area making a contribution to strengthening epidemiology skills and capacity. He has the potential to be a successful public health leader of the future.

Personal conclusions of fellow

Before I started my fellowship, I thought I already knew everything about communicable disease control in the Netherlands, but I was wrong. The combination of both working at the local level at two GGDs and at the national level at the RIVM was not always easy to do, but was really helpful in learning a lot and understanding why the systems are working in the Netherlands as they do, and also why some systems are maybe not working as they should. The programme itself was a very educational experience to me. The different courses provide a very good theoretical background of different methods and techniques for different situations, of which I could bring many into practise during the different projects and during my daily work at the GGD. The level of the course materials and supervision was high but was flexible to the competencies of different fellows. The programme helped me in becoming an overall public health professional, with skills in both in control and communication, as in surveillance and research. Therefore I think being part of an EPIET-programme will be a major boost for my future career. Thanks to the programme, I was able to boost epidemiological knowledge at the GGD, by demonstrating some techniques that are also useful at a local level, and to involve colleagues in some of my projects. Therefore I highly recommend to program to anyone interested in infectious disease epidemiology and I also recommend local health services to allow and stimulate their employees to apply for the programme, as it can be beneficial for both of them. Finally, the fellowship provided a chance to work together with colleagues from different fields, and led to a network with many valuable connections all over Europe.

Acknowledgements of fellow

I want to thank the ECDC and the Public Health Service Utrecht region, for giving me the opportunity to participate in the EPIET programme. I am very thankful to my supervisors, Mirjam Knol and Ewout Fanoy, who supervised some of my projects directly and were helpful with other projects. They commented on study protocols and abstracts and helped me with the planning of the fellowship, which was not always an easy task with two or even three different jobs. I also thank my frontline coordinator Louise Coole for her feedback on all the project proposals and study protocols (not my favourite part but so important), catch-up phone calls on my progress, in which she also had interest for the impact on my others jobs and personal life. I also thank all the other supervisors and collaborators on the different projects, their assistance and constructive feedback on study designs, analyses, different version of many manuscripts, really helped me further in developing my skills. Of course I also thank the other fellows at the RIVM (Susana, Zsofia, Anna and Jossy) and my roommates Alies and Tjallie, that were maybe not directly involved in my projects but were always there for assistance with problems and social talks in between the work. Furthermore I want to thank all my colleagues at the GGD Utrecht region and GGD Kennemerland, for the extra workshifts they had to do during my EPIET modules and the days I was working at the RIVM, but also for their support during the fellowship. Finally, I would like to thank all my colleagues from the 2016 cohort, it was a wonderful experience to collaborate with you during the different modules, including the out-of-office hours. Last, but not least, I would like to thank my family and friends for their support, and especially I thank my wife Mojca for her love and encouragement during my fellowship.

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