

BCoDe study: results from the Burden of Communicable Diseases in Europe study (2009-2013)

Mirjam Kretzschmar

The Burden of Communicable Diseases in Europe Project (BCoDE)

- Runtime project 2009 - 2013
- Disability-adjusted life years, based on surveillance data
- BCoDE methodology and toolkit
- Estimates of DALYs for 32 infectious diseases in Europe

PLoS Collection:

<https://collections.plos.org/burden-of-infectious-diseases>



Acknowledgements

Alessandro Cassini (ECDC)

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Marie-Josée Mangan, Dietrich Plass, Alies van Lier, Scott McDonald, Arie Havelaar, Cheryl Gibbons (methodology)

Juanita Haagsma (disability weights)

Daniel Lewandowski (programming)

Summary measure of population health

Disability Adjusted Life Years (DALYs) to express the burden of disease

$$\text{DALY} = \text{YLL} + \text{YLD}$$

Years of life lost due to mortality

Years of healthy life lost due to disability

$$= \sum (\mathbf{d} \times \mathbf{e})$$

d – sum of all fatal cases
e – remaining life expectancy
at age of death

$$= \sum (\mathbf{n} \times \mathbf{t} \times \mathbf{w})$$

n – number of cases
t – duration of illness
w – disability weight

Introduced by Murray & Lopez 1997: Global Burden of Disease Study

Incidence- and pathogen-based DALY approach

- Links sequelae to their infectious causes (pathogens) by means of outcome trees
- Based on incidence of infection per pathogen
- Burden attributed to time at infection

OPEN ACCESS Freely available online

PLOS MEDICINE

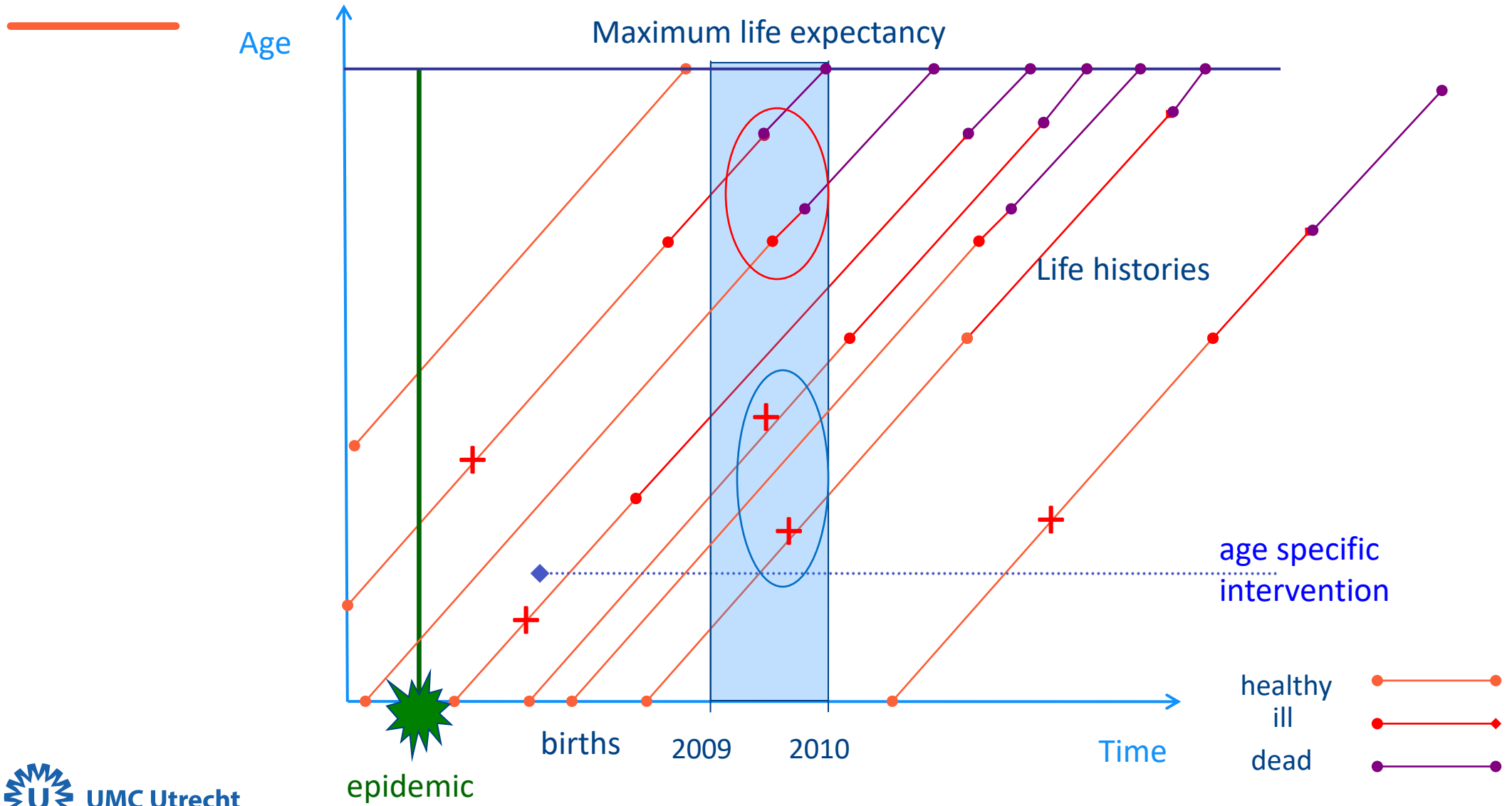
Published 2012

Policy Forum

New Methodology for Estimating the Burden of Infectious Diseases in Europe

Mirjam Kretzschmar^{1,2*}, Marie-Josée J. Mangen², Paulo Pinheiro³, Beate Jahn^{4,5}, Eric M. Fèvre⁶, Silvia Longhi⁷, Taavi Lai^{8,9}, Arie H. Havelaar^{1,10}, Claudia Stein¹¹, Alessandro Cassini¹², Piotr Kramarz¹², for the BCoDE consortium

Incidence vs prevalence based approach

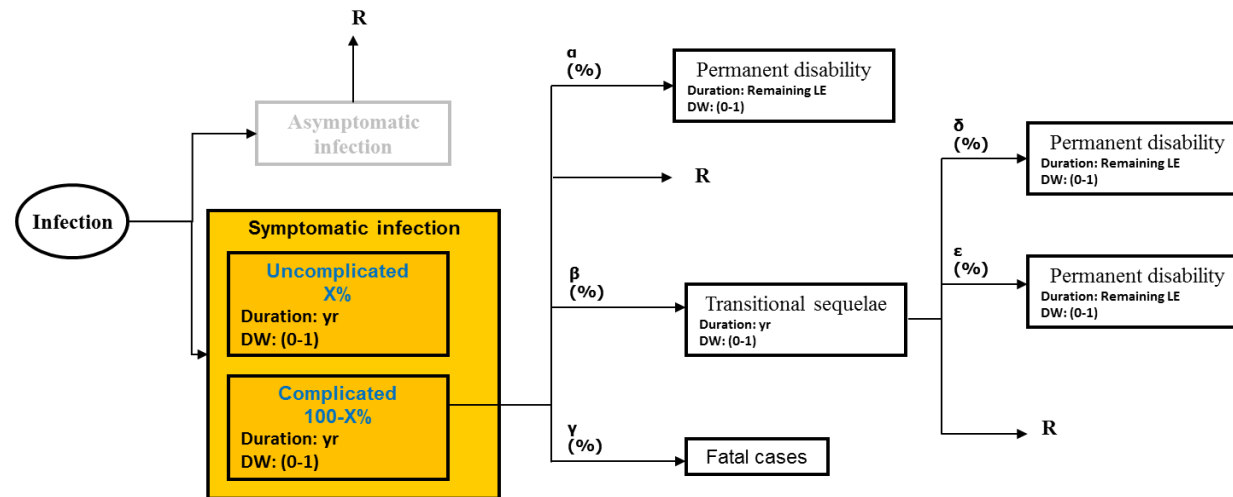


Steps in burden estimation

- Estimate population **incidence** of infection from notification or other surveillance data
- Use **multiplication factors** to account for underreporting and underascertainment
- Estimate incidence of sequelae attributed to one infection by use of an **outcome tree**
- Compute DALYs based on incidences, **durations, and disability weights**

Outcome tree

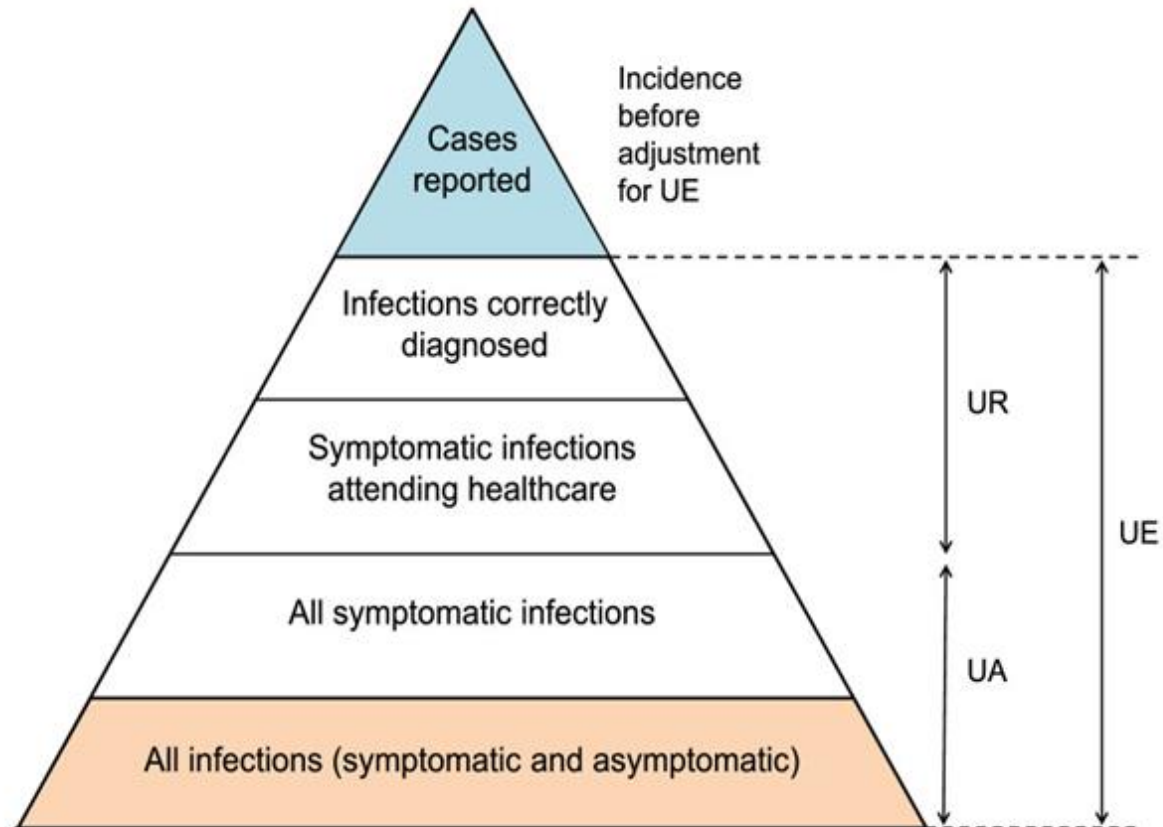
Disease model including infection, acute disease and all sequelae



For a specific pathogen

- Define primary health outcome(s), possibly distinguish health states
- Define associated long term sequelae
- Quantify transition probabilities and durations including possible recovery and death

Correcting for underreporting



Gibbons CL, et al. Measuring underreporting and under-ascertainment in infectious disease datasets: a comparison of methods. BMC Public Health. 2014;14:147.

Disability weights

Haagsma et al. *Population Health Metrics* (2015) 13:10
DOI 10.1186/s12963-015-0042-4



RESEARCH

Open Access

Assessing disability weights based on the responses of 30,660 people from four European countries

Juanita A Haagsma^{1,2*}, Charline Maertens de Noordhout³, Suzanne Polinder¹, Theo Vos², Arie H Havelaar^{4,5,6}, Alessandro Cassini⁷, Brecht Devleeschauwer⁸, Mirjam E Kretzschmar^{4,9}, Niko Speybroeck³ and Joshua A Salomon¹⁰

Disability weights were assessed in 4 European countries (project funded by ECDC and Institute for Health Metrics and Evaluation (IHME))

Disability weights for the Global Burden of Disease 2013 study



Joshua A Salomon, Juanita A Haagsma, Adrian Davis, Charline Maertens de Noordhout, Suzanne Polinder, Arie H Havelaar, Alessandro Cassini, Brecht Devleeschauwer, Mirjam Kretzschmar, Niko Speybroeck, Christopher J L Murray, Theo Vos



Summary

Background The Global Burden of Disease (GBD) study assesses health losses from diseases, injuries, and risk factors using disability-adjusted life-years, which need a set of disability weights to quantify health levels associated with non-

Lancet Glob Health 2015; 3: e712-23

The BCoDE toolkit

Software package for calculation of DALYs for different countries and infectious diseases



RESEARCH ARTICLE

A Software Tool for Estimation of Burden of Infectious Diseases in Europe Using Incidence-Based Disability Adjusted Life Years

Edoardo Colzani¹*, Alessandro Cassini^{1,2}*, Daniel Lewandowski³, Marie-Josée J. Mangen^{2,4}, Dietrich Plass⁵, Scott A. McDonald⁴, Alies van Lier⁴, Juanita A. Haagsma^{6,7}, Guido Maringhini¹, Alessandro Pini¹, Piotr Kramarz¹, Mirjam E. Kretzschmar^{2,4}

Published 2017

ECDC BCoDE toolkit [software application]. Version 1.1

Stockholm: European Centre for Disease Prevention and Control; 2015.

Available from: http://ecdc.europa.eu/en/healthtopics/burden_of_communicable_diseases/Pages/Tool.aspx

Stepwise approach for burden calculation

The screenshot shows the BCoDE web application interface. The browser window title is "BCoDE" and the menu includes "File", "Tools", and "Help". The left sidebar contains navigation buttons: "Tutorial" (highlighted), "Create models", "Edit model data", "Run models", "View detailed results", and "View aggregated results".

Tutorial

This tutorial is available in two modes: static pages and dynamic walkthrough.

- Static page: Click one of the buttons below to see its tutorial content in a popup dialog
- Dynamic walkthrough: Click button "1. Start walkthrough"

Generic concepts

Number formats, Uncertainty modelling, Tables, Editing parameters

Tutorial Flow Chart

The flow chart consists of six steps in chevron-shaped boxes:

1. Start walkthrough
2. Create models
3. Edit model data
4. Save/load models
5. Run models
6. View results

Below the flow chart, specific actions are listed in green boxes:

- Step 2:** Select countries, Select diseases, Generate models
- Step 3:** Model parameters, Population data, Outcome tree, Disease report
- Step 4:** Save models, Load models
- Step 6:** Outcome tree, Detailed results, Aggregated results, Exporting results

Selecting the countries and the diseases

The screenshot shows the BCoDE web application interface. The main title is "Select countries and diseases". The interface is divided into three main sections:

- Select countries (1 selected):** A map of Europe is shown with most countries highlighted in green. Below the map is a list of countries with checkboxes. The "Custom Population" option is selected, and "EU + EEA" is also checked. Other countries listed include Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, and Germany.
- Select diseases (38 selected):** A list of 38 diseases with checkboxes, all of which are checked. The diseases are: Campylobacteriosis, Chlamydia, Cryptosporidiosis, Diphtheria, Giardiasis, Gonorrhoea, Hepatitis A, Hepatitis B, Hepatitis C, HIV, Influenza, Invasive Haemophilus Influenzae, Invasive Meningococcal Disease, Invasive Pneumococcal Disease, Legionnaires' Disease, Listeriosis, Measles, Mumps, Pertussis, Poliomyelitis, Q Fever, Rabies, Rubella, Salmonellosis, and Shigellosis.
- Models:** A table showing the generated models. The table has columns for "Country", "Disease", and "Model name". All models are listed with "Custom Popul..." as the country and the disease name as the model name.

Country	Disease	Model name
Custom Popul...	Campylobacteriosis	model 1
Custom Popul...	Chlamydia	model 2
Custom Popul...	Cryptosporidiosis	model 3
Custom Popul...	Diphtheria	model 4
Custom Popul...	Giardiasis	model 5
Custom Popul...	Gonorrhoea	model 6
Custom Popul...	Hepatitis A	model 7
Custom Popul...	Hepatitis B	model 8
Custom Popul...	HIV	model 9
Custom Popul...	Influenza	model 10
Custom Popul...	Invasive Haemoph...	model 11
Custom Popul...	Invasive Meningo...	model 12
Custom Popul...	Invasive Pneumoc...	model 13
Custom Popul...	Legionnaires' Dise...	model 14
Custom Popul...	Listeriosis	model 15
Custom Popul...	Measles	model 16
Custom Popul...	Mumps	model 17
Custom Popul...	Pertussis	model 18
Custom Popul...	Q Fever	model 19
Custom Popul...	Rabies	model 20
Custom Popul...	Rubella	model 21
Custom Popul...	Salmonellosis	model 22
Custom Popul...	Shigellosis	model 23
Custom Popul...	STEC/VTEC	model 24

31 countries
EU+EEA
Custom population

32 infectious diseases
6 healthcare associated
syndromes

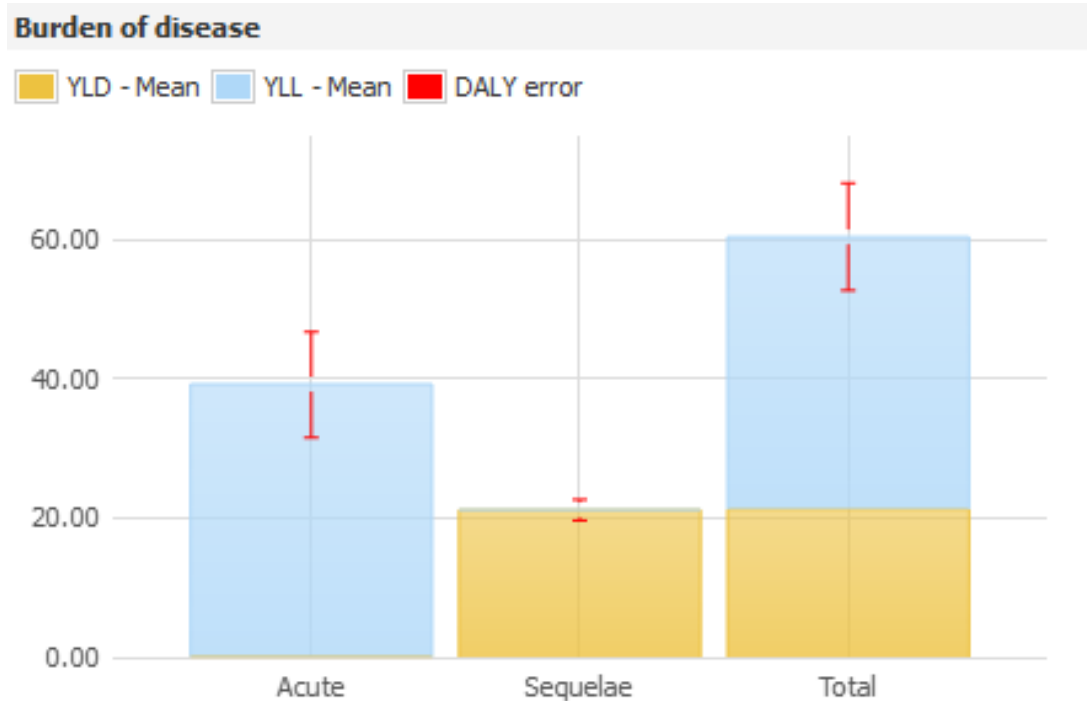
Data input

- Incident cases by sex and age from surveillance system
- Multiplication factor to correct for underreporting
- Inclusion of asymptomatic cases if they contribute to burden
- Definition of time discount factor

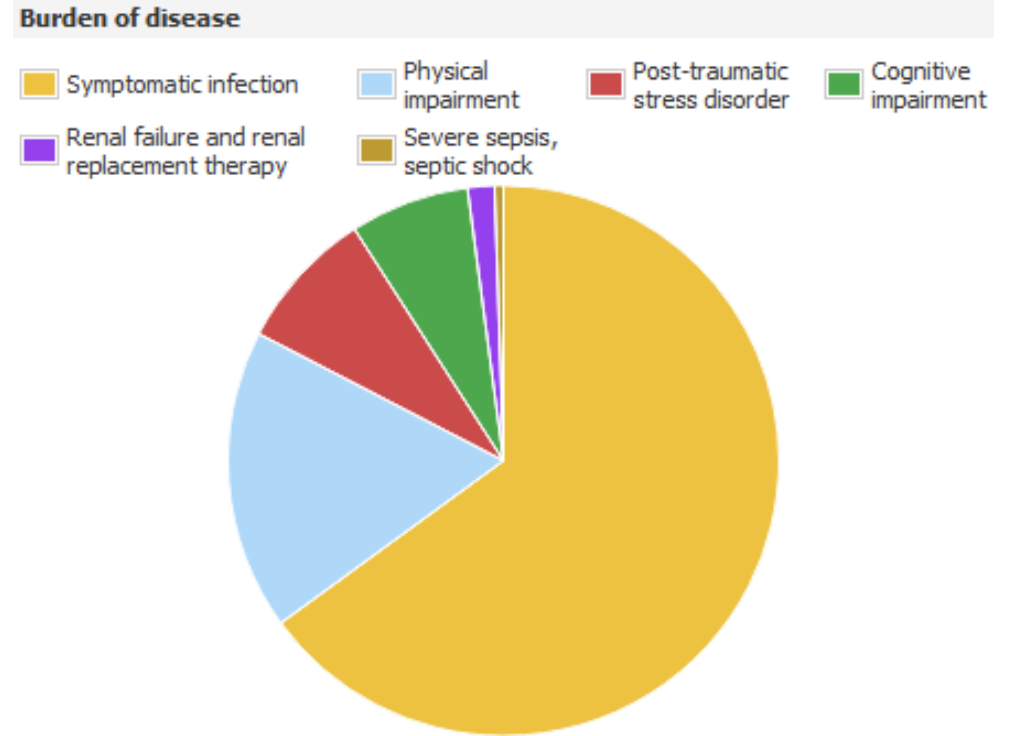
Result output

- Estimated „true“ incidence of acute infections
- DALYs
 - Pathogen, age-group and sex specific
 - Per year, per 100,000 and per infected case
 - By YLL and YLD
 - By acute illness and sequelae
- Ranking of diseases according to DALYs
- Uncertainty bounds

Stratification of burden by sequelae



Distribution by YLL and YLD



Distribution by sequelae

Stratification by age and gender



Burden of infectious diseases in Europe

RESEARCH ARTICLE

Impact of infectious diseases on population health using incidence-based disability-adjusted life years (DALYs): results from the Burden of Communicable Diseases in Europe study, European Union and European Economic Area countries, 2009 to 2013

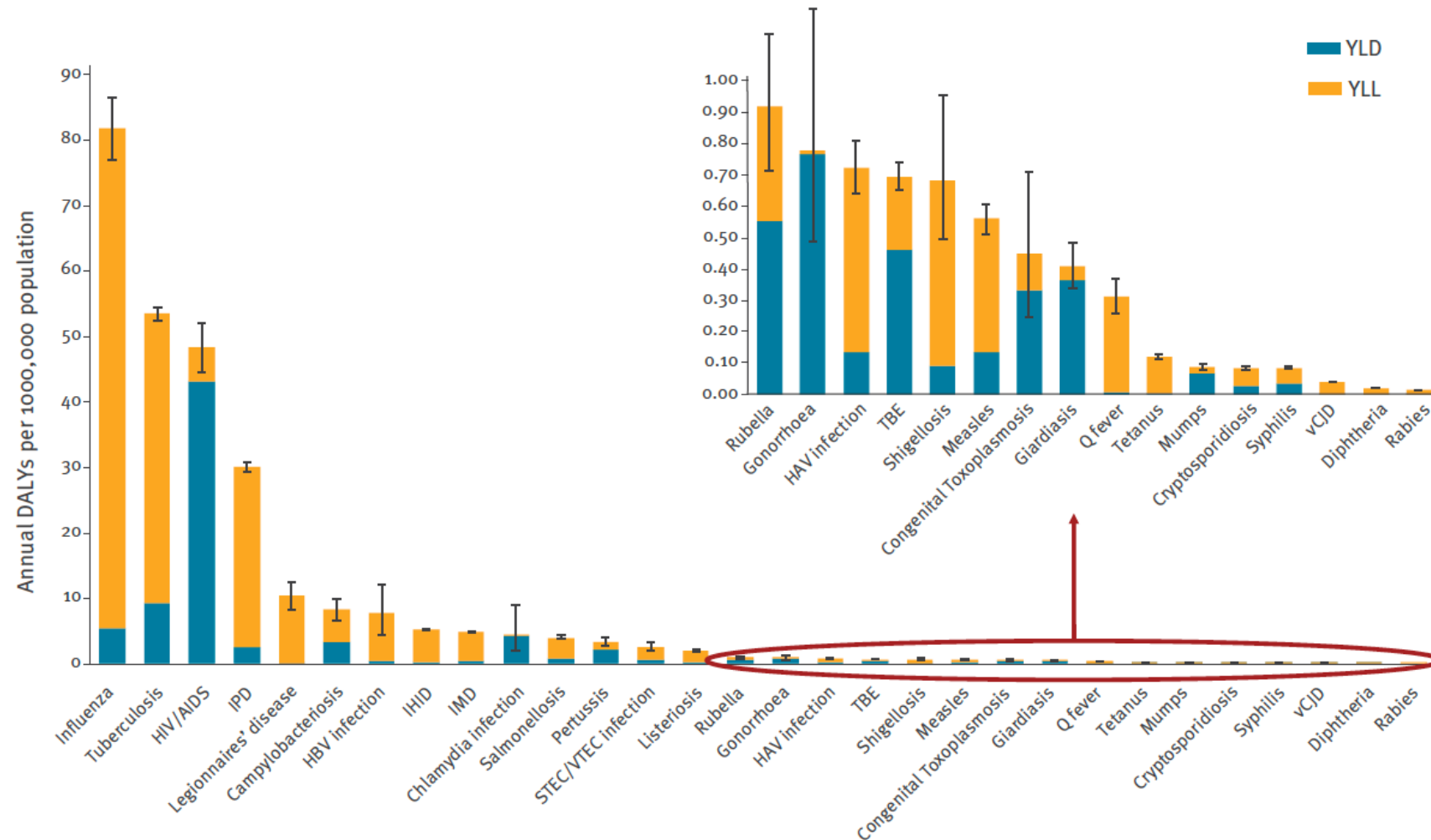
Alessandro Cassini^{1,2}, Edoardo Colzani¹, Alessandro Pini¹, Marie-Josée J Mangan^{2,3}, Dietrich Plass⁴, Scott A McDonald³, Guido Maringhini¹, Alies van Lier³, Juanita A Haagsma⁵, Arie H Havelaar^{3,6}, Piotr Kramarz¹, Mirjam E Kretzschmar^{2,3}, on behalf of the BCoDE consortium⁷

Eurosurveillance 2018

DALYs per 100,000 population per year

FIGURE 1

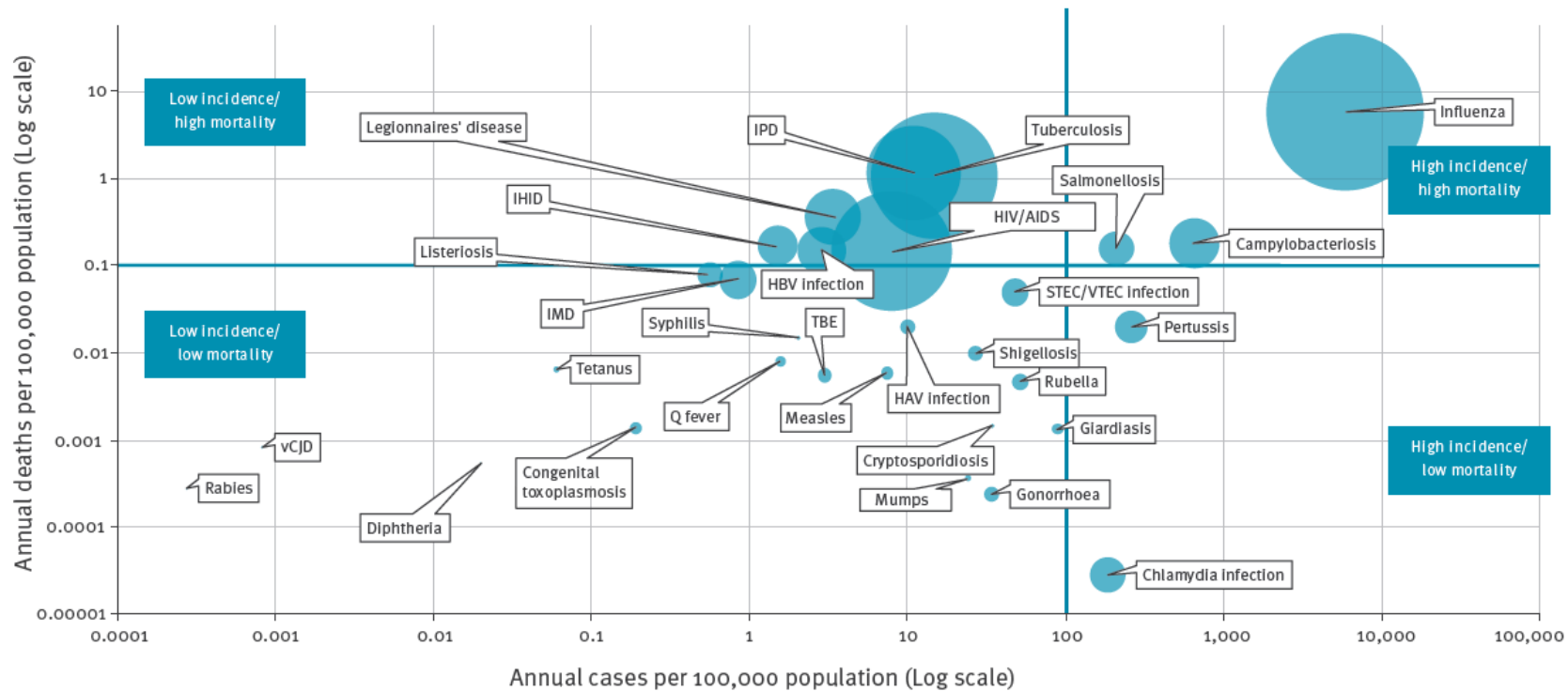
Median annual DALYs per 100,000 population for selected infectious diseases, EU/EEA countries, 2009–2013



Incidence, mortality, and disease burden

FIGURE 3

Bubble chart of the burden of selected infectious diseases in terms of mortality and incidence, EU/EEA countries, 2009–2013



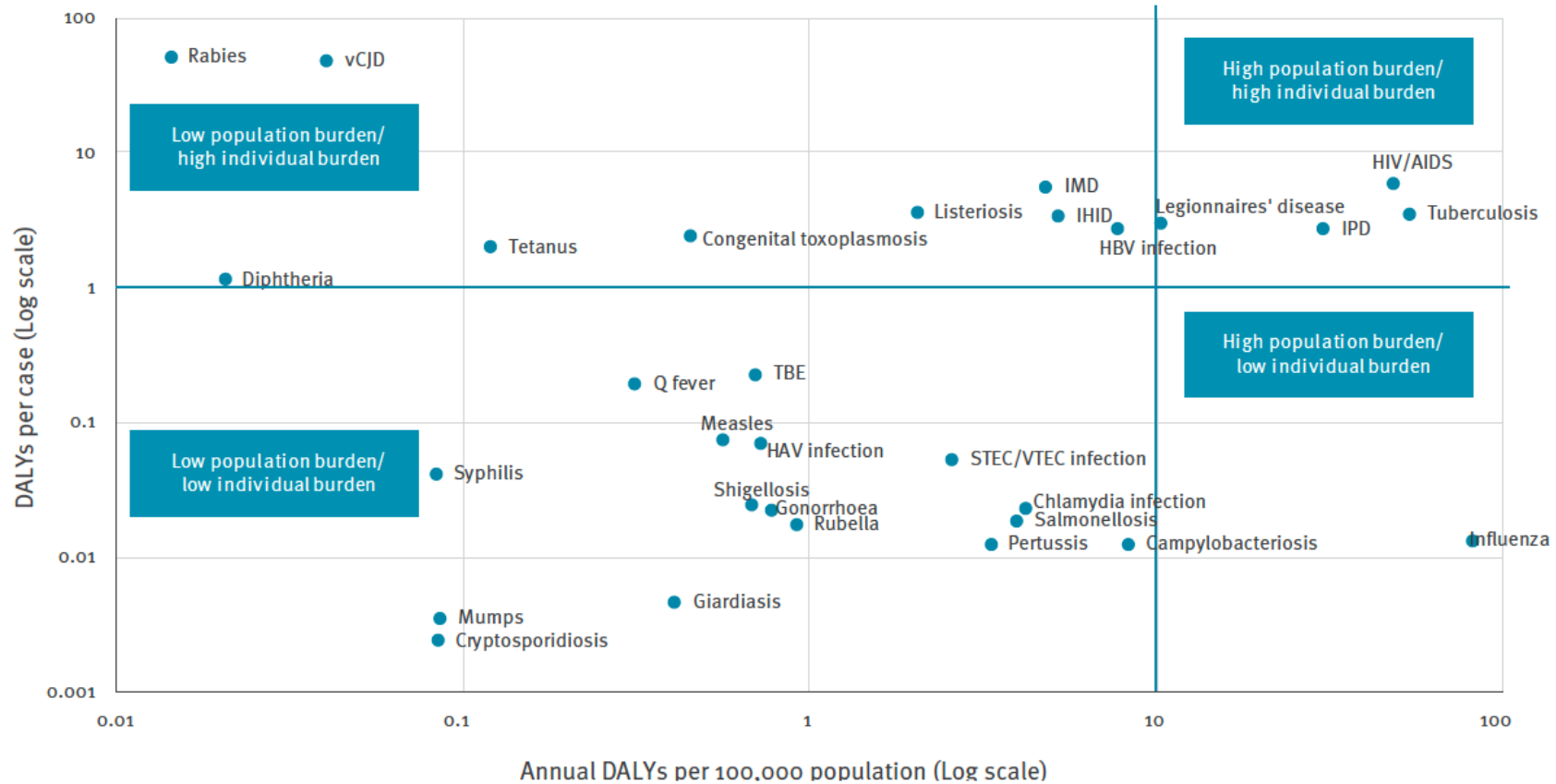
EU/EEA: European Union/European Economic Area; HAV: Hepatitis A virus; HBV: Hepatitis B virus; HIV/AIDS: Human immunodeficiency virus infection; IHID: Invasive *Haemophilus influenzae* disease; IMD: Invasive meningococcal disease; IPD: Invasive pneumococcal disease; STEC/VTEC: Shiga toxin/verocytotoxin-producing *Escherichia coli*; TBE: Tick-borne encephalitis; vCJD: variant Creutzfeldt–Jakob disease

The diameter of the bubble reflects the number of DALYs per 100,000 population per year.

Population burden versus individual burden

FIGURE 4

Scatterplot of the burden of selected infectious diseases in DALYs per case and DALYs per 100,000 population per year, EU/EEA countries, 2009–2013



EU/EEA: European Union/European Economic Area; HAV: Hepatitis A virus; HBV: Hepatitis B virus; HIV/AIDS: Human immunodeficiency virus infection; IHID: Invasive *Haemophilus influenzae* disease; IMD: Invasive meningococcal disease; IPD: Invasive pneumococcal disease; STEC/VTEC: Shiga toxin/verocytotoxin-producing *Escherichia coli*; TBE: Tick-borne encephalitis; vCJD: variant Creutzfeldt–Jakob disease

National Infectious Disease Burden Study Netherlands



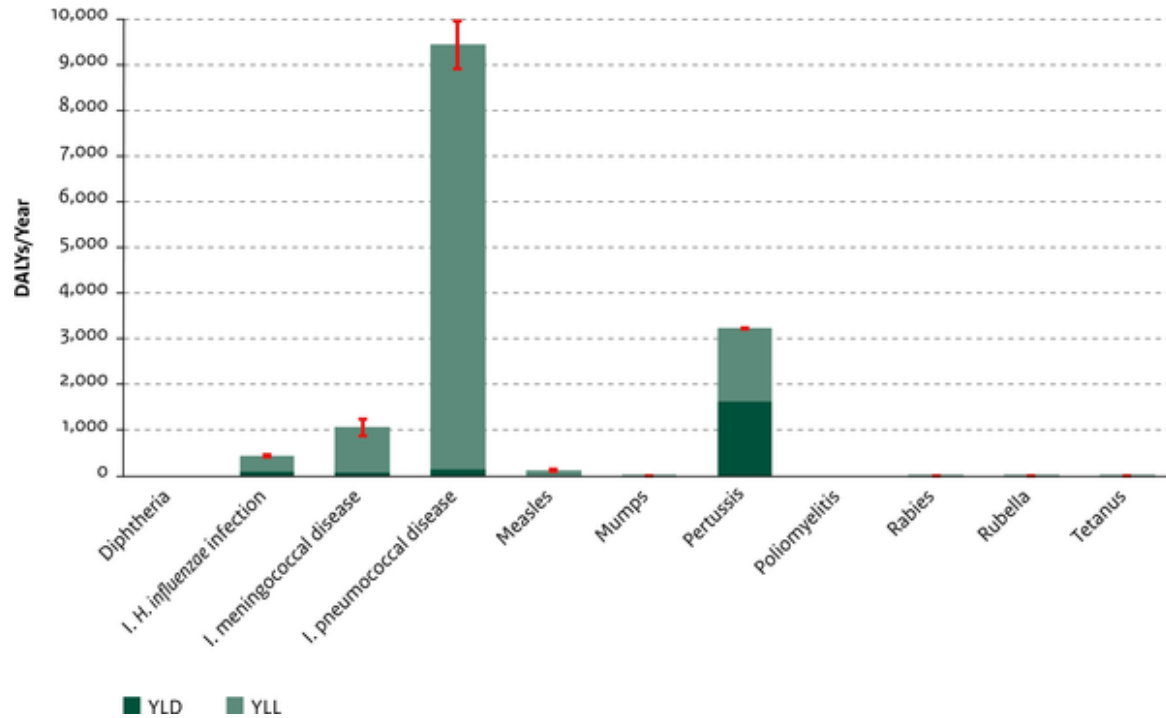
RESEARCH ARTICLE

Disease Burden of 32 Infectious Diseases in the Netherlands, 2007-2011

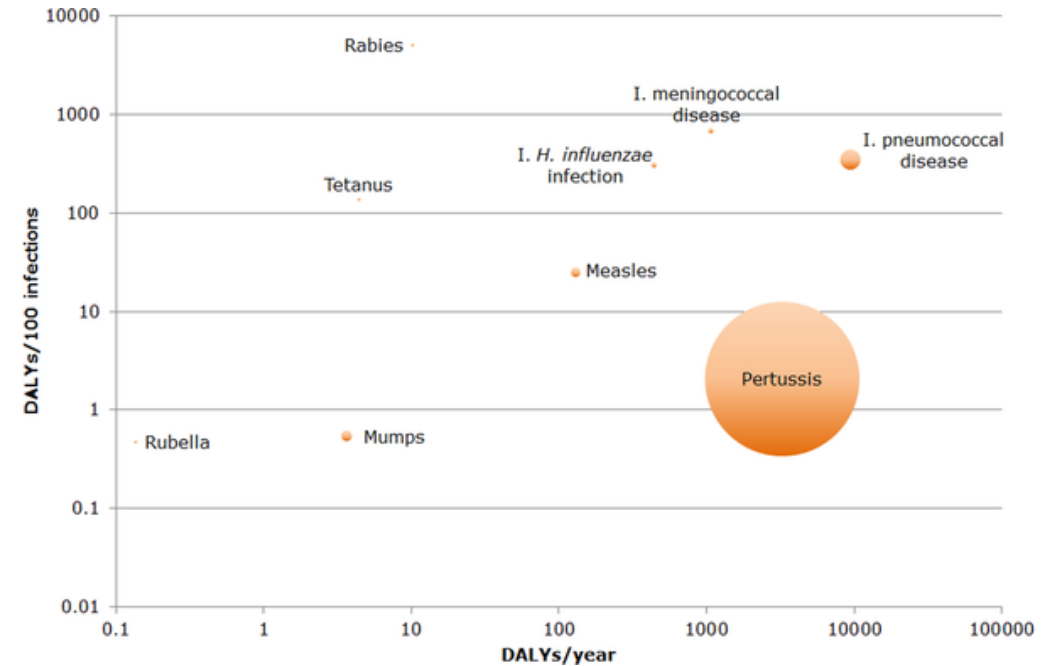
Alies van Lier¹✉, Scott A. McDonald¹✉*, Martijn Bouwknegt¹, EPI group¹¶, Mirjam
E. Kretzschmar^{1,2}, Arie H. Havelaar³, Marie-Josée J. Mangen^{1,2}, Jacco Wallinga¹, Hester
E. de Melker¹

Published April 2016

Results vaccine preventable diseases



Daly per year (average 2007-2011)



Population versus individual burden

Burden of infectious disease in the Netherlands

Since 2014 Annual report

“State of infectious diseases in the Netherlands”

→ Estimation disease burden >32 diseases

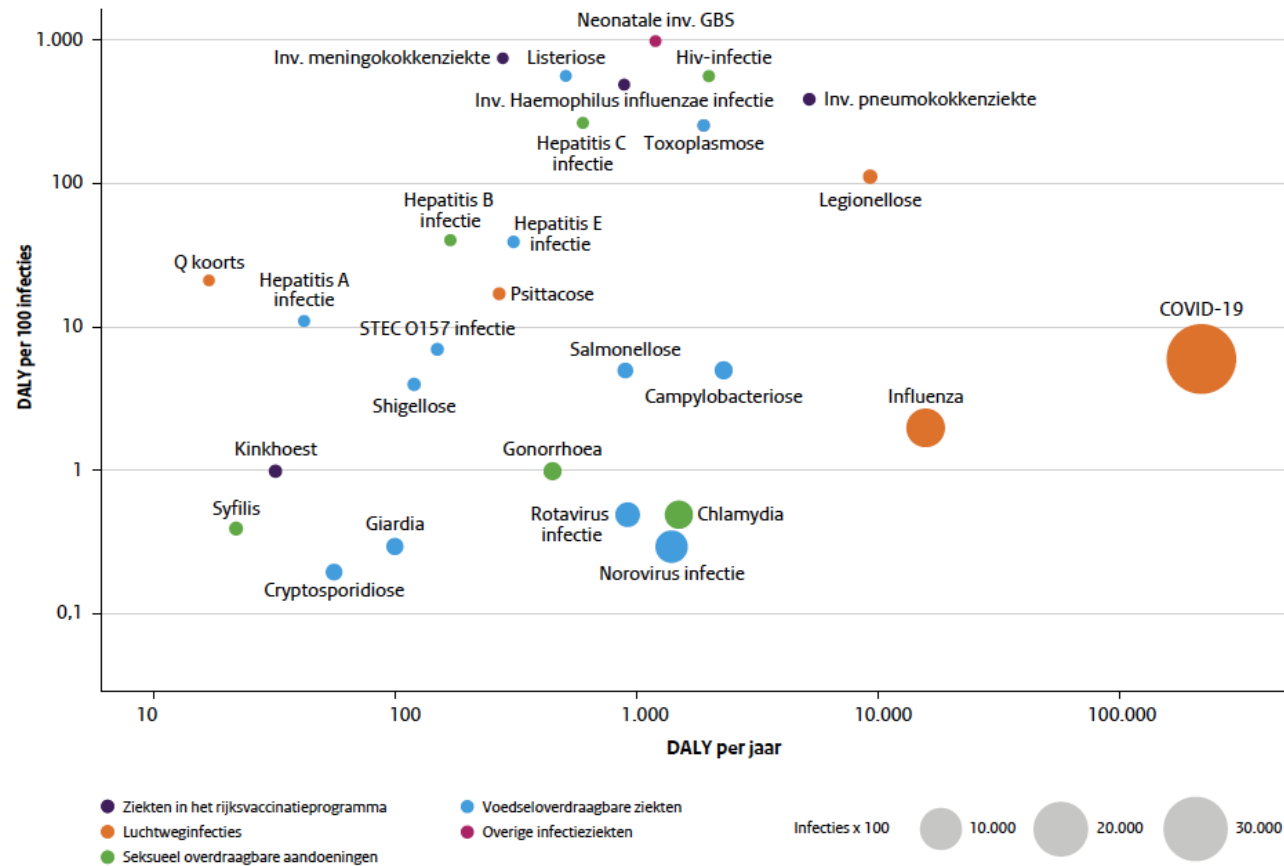
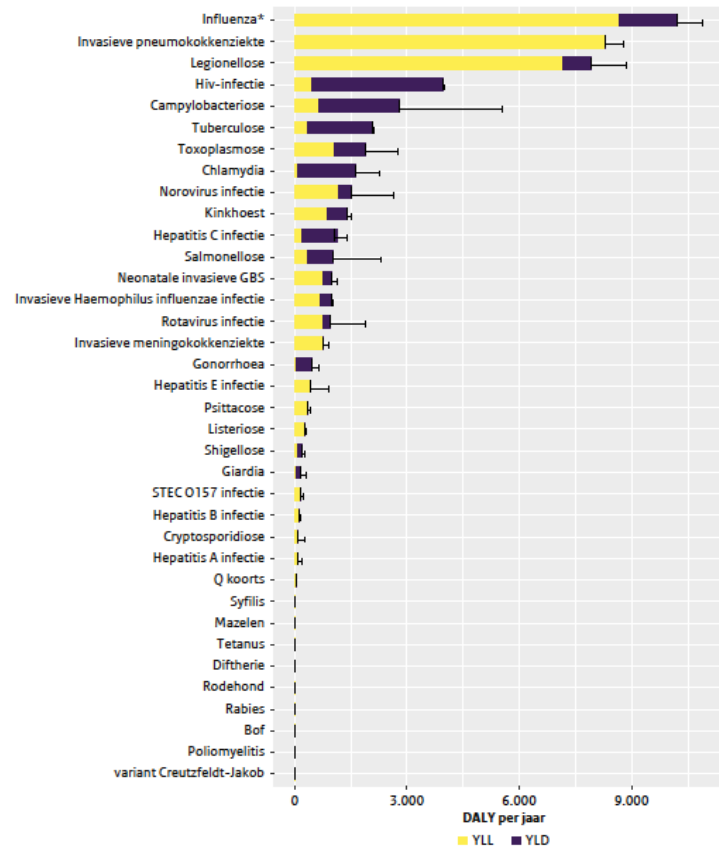
6 sexually transmitted infections
11 vaccine-preventable infections
11 foodborne diseases
4 respiratory diseases

Calculation disease burden: BCoDE-toolkit
Except for 9 foodborne diseases



Average burdens of infectious diseases 2017 - 2020

Figuur 3.2 Gemiddelde jaarlijkse ziektelast in DALY in Nederland in de periode 2017-2021 (2017-2020 voor chlamydia, gonorrhoe, syfilis, 2017 voor Lyme borreliose, en 2017/2018 - 2021/2021 voor influenza, uitgezonderd 2020/2021), uitgesplitst naar YLD en YLL



Disease burden, aging, and vaccination

Vaccine 34 (2016) 942–949



Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine



McDonald et al. *BMC Public Health* 2012, 12:1046
<http://www.biomedcentral.com/1471-2458/12/1046>



RESEARCH ARTICLE

Open Access

The impact of demographic change on the estimated future burden of infectious diseases: examples from hepatitis B and seasonal influenza in the Netherlands

Scott A McDonald^{1*}, Alies van Lier¹, Dietrich Plass² and Mirjam EE Kretzschmar^{1,3}

Burden of four vaccine preventable diseases in older adults

Maartje Kristensen^{a,1}, Alies van Lier^{a,1}, Renske Eilers^{a,b}, Scott A. McDonald^a, Wim Opstelten^c, Nicoline van der Maas^a, Wim van der Hoek^a, Mirjam E. Kretzschmar^{a,c}, Mark M. Nielen^d, Hester E. de Melker^{a,*}



McDonald et al. *BMC Infectious Diseases* 2013, 13:120
<http://www.biomedcentral.com/1471-2334/13/120>



RESEARCH ARTICLE

Open Access

Effects of an ageing population and the replacement of immune birth cohorts on the burden of hepatitis A in the Netherlands

Scott A McDonald^{1*}, Marie-Josée J Mangen², Anita Suijkerbuijk³, Edoardo Colzani⁴ and Mirjam EE Kretzschmar^{1,2}

RESEARCH

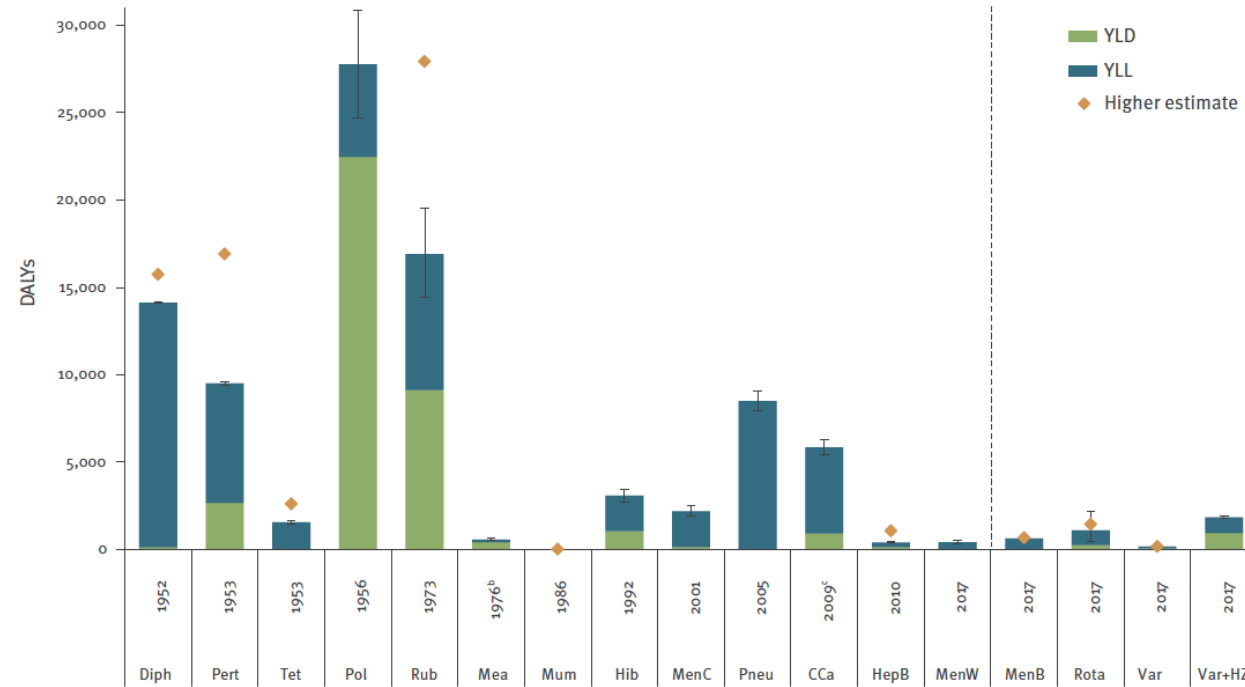
Disease burden of varicella versus other vaccine-preventable diseases before introduction of vaccination into the national immunisation programme in the Netherlands

Alies van Lier¹, Brechje de Gier¹, Scott A McDonald¹, Marie-Josée J. Mangen¹, Maarten van Wijhe^{1,2}, Elisabeth A.M. Sanders^{1,3}, Mirjam E. Kretzschmar^{1,4}, Hans van Vliet¹, Hester E. de Melker¹

Disease burden of vaccine-preventable diseases

FIGURE 1

Estimated disease burden^a of vaccine-preventable diseases in the year before introduction of vaccination into the national immunisation programme, or in 2017, with the years lived with disability and the years of life lost components shown separately, Netherlands, 1952–2017



Year before introduction of vaccination

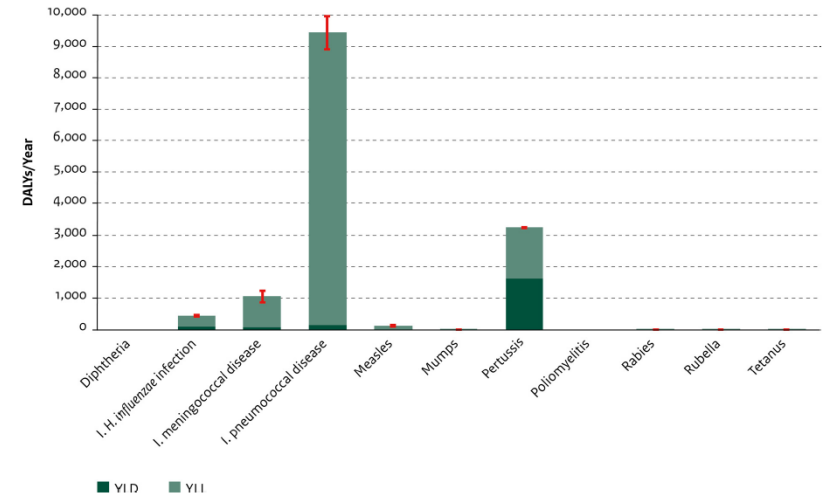


Fig 3. Average annual disease burden in the Netherlands in 2007–2011 for new cases of vaccine-preventable diseases. YLD and YLL components are shown separately. Red lines indicate 95% uncertainty intervals. (DALY = Disability-Adjusted Life Year, YLD = Years Lived with Disability, YLL = Years of Life Lost, I. = invasive).

Comparison: Average 2007 - 2011

Other spin-off projects

Comparing burden of influenza and Q fever

Disease burden of HAI and AMR

Epidemiol. Infect., Page 1 of 10. © Cambridge University Press 2014
doi:10.1017/S0950268813003531

Comparing the impact of two concurrent infectious disease outbreaks on The Netherlands population, 2009, using disability-adjusted life years

R. J. BROOKE^{1,2*}, A. VAN LIER², G. A. DONKER³, W. VAN DER HOEK²
AND M. E. E. KRETZSCHMAR^{1,2}

Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis

Alessandro Cassini, Liselotte Diaz Högberg, Diamantis Plachouras, Annalisa Quattrocchi, Ana Hoxha, Gunnar Skov Simonsen, Mélanie Colomb-Cotinat, Mirjam E Kretzschmar, Brecht Devleeschauwer, Michele Cecchini, Driss Ait Ouakrim, Tiago Cravo Oliveira, Marc J Struelens, Carl Suetens, Dominique L Monnet, and the Burden of AMR Collaborative Group*

Lancet Infectious Diseases 2019



PLoS Medicine 2016

RESEARCH ARTICLE

Burden of Six Healthcare-Associated Infections on European Population Health: Estimating Incidence-Based Disability-Adjusted Life Years through a Population Prevalence-Based Modelling Study

Alessandro Cassini^{1,2*}, Diamantis Plachouras^{1*}, Tim Eckmanns³, Muna Abu Sin³, Hans-Peter Blank³, Tanja Ducomble³, Sebastian Haller³, Thomas Harder³, Anja Klingeberg³, Madlen Sixtensson³, Edward Velasco³, Bettina Weiß³, Piotr Kramarz¹, Dominique L. Monnet¹, Mirjam E. Kretzschmar^{2,4}, Carl Suetens¹

