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)
Eduardo Colzani (ECDC)

BCoDE Consortium (RIVM, UMCU, ECDC, Bielefeld University, others)
Marie-Josee Mangen, 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

\[ = \sum (d \times e) \]

- \( d \) – sum of all fatal cases
- \( e \) – remaining life expectancy at age of death

Years of healthy life lost due to disability

\[ = \sum (n \times t \times w) \]

- \( n \) – 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

Published 2012
Incidence vs prevalence based approach

Maximum life expectancy

Life histories

age specific intervention

healthy ill
dead

epidemic births 2009 2010
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

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

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

Published 2017

ECDC BCoDE toolkit [software application]. Version 1.1
Stockholm: European Centre for Disease Prevention and Control; 2015.
Stepwise approach for burden calculation
Selecting the countries and the diseases

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

**Example:** hospital acquired pneumonia
Stratification by age and gender

Burden is attributed to age at infection
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 Cassini1,2, Edoardo Colzani1, Alessandro Pini1, Marie-Josée J Mangen2,3, Dietrich Plass4, Scott A McDonald4, Guido Maringhini5, Alies van Lier1, Juanita A Haagsma6, Arie H Havelaar7,8, Piotr Kramarz2, Mirjam E Kretzschmar9, on behalf of the BCoDE consortium

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


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

National Infectious Disease Burden Study Netherlands

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

Published April 2016
Results vaccine preventable diseases

Daly per year (average 2007-2011)

Population versus individual burden

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0153106
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 burden of infectious diseases 2017 - 2020

For Covid-19 the burden is for 2021
Disease burden, aging, and vaccination

Burden of four vaccine preventable diseases in older adults
Maartje Kristensen a,1, Ales van Lier a,1, Renske Eilers b,1, Scott A. McDonald a, Scott A. McDonald a, Wim Opstelten c, Nicoline van der Maas a, Wim van der Hoek a, Hester de Melker a, Mark M. Nielen a, Mark M. Nielen a, Hester E. de Melker a, Mark M. Nielen a, Hester E. de Melker a

Effects of an ageing population and the replacement of immune birth cohorts on the burden of hepatitis A in the Netherlands
Scott A. McDonald a, Marie-Josée J. Mangen b, Anita Suijerbuik c, Edoardo Colan d and Mirjam E. Kretzschmar d, e

Disease burden of varicella versus other vaccine-preventable diseases before introduction of vaccination into the national immunisation programme in the Netherlands
Alies van Lier a, Brechtje de Gier a, Scott A. McDonald a, Marie-Josée J. Mangen b, Maarten van Wijhe a, d, Elisabeth A.M. Sanders a, b, Mirjam E. Kretzschmar a, Hans van Vliet a, Hester E. de Melker a
Disease burden of vaccine-preventable diseases

Comparison: Average 2007 - 2011

Year before introduction of vaccination
Other spin-off projects

Comparing burden of influenza and Q fever

Disease burden of HAI and AMR

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

Lancet Infectious Diseases 2019

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

PLoS Medicine 2016