

Modelling van de infectie: waar staan we nu en van waar komen we?

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COI: Chair in Evidence-based vaccinology (Pfizer & GSK, end 2019), projects outside work: JnJ, GSK, MSD

Acknowledgements: Sciensano, ULB, UCL, UNamur, VUB, UGent, KU Leuven, Inserm, EpiPose consortium, ...



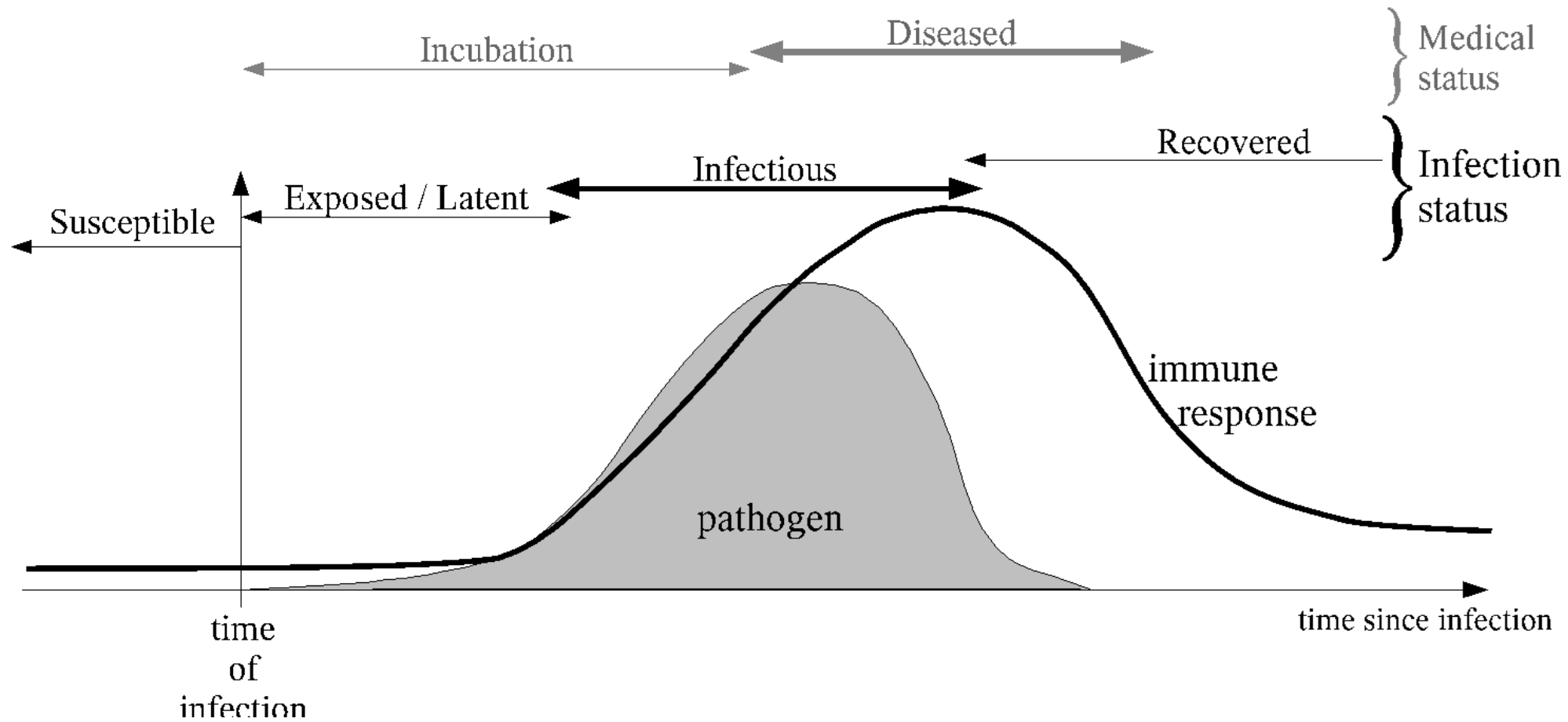
Wiskundige epidemiologie

- 1760: Daniel Bernoulli
 - pokken
 - simulatie eliminatie
 - concurrerende risico's
- ~ Jean le Rond d'Alembert
- Kermack & McKendrick (1927):
het SIR model
- Bartlett (1956):
kansmechanismen



Daniel Bernoulli (1700 – 1782)

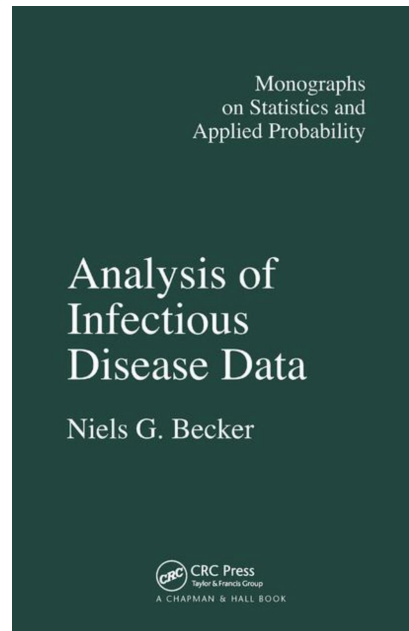
Modellen en data



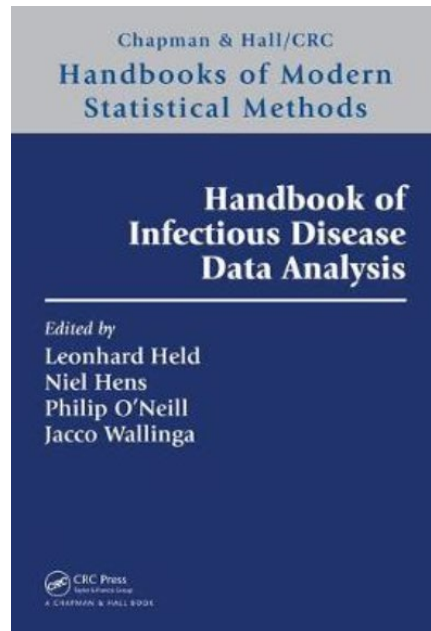
(Keeling & Rohani, 2008)

Infectieziekte data

- Complex
 - afhankelijkheid
 - onvolledige gegevens
- Observationele data
 - vertekening
 - associatie is geen causatie
 - ...
- Wetenschappelijke principes
 - vermoeden versus weerleggen
 - Bradford Hill criteria – vertrouwen in oorzakelijk verband
 - Robert Koch & microbiology



Becker (1989)



Held et al. (2019)

Wiskundige modellen



Mathematical Biosciences

Volume 285, March 2017, Pages 43-54



scientific reports

OPEN

Clustering of susceptible individuals within households can drive measles outbreaks: an individual-based model exploration

Elise Kuylen^{1,2}, Lander Willem¹, Jan Broeckhove³, Philippe Beutels¹ & Niel Hens^{1,2}



Journal of Theoretical Biology

Volume 476, 7 September 2019, Pages 5-18



The impact of behavioral interventions on co-infection dynamics: An exploration of the effects of home isolation

Diana M Hendrickx^{1,2}, Steven Abrams¹, Niel Hens^{1,2}

Structural differences in mixing behavior informing the role of asymptomatic infection and testing symptom heritability

Eva Santermans^{1,2}, Kim Van Kerckhove¹, Amin Azmon¹, W. John Edmunds¹, Philippe Beutels¹, Christel Faes¹, Niel Hens^{1,2}

Agent-based models for infectious disease transmission : exploration, estimation & computational efficiency

Willem, Lander

English

Antwerpen : Universiteit Antwerpen, Faculteit Geneeskunde en Gezondheidswetenschappen, 2015

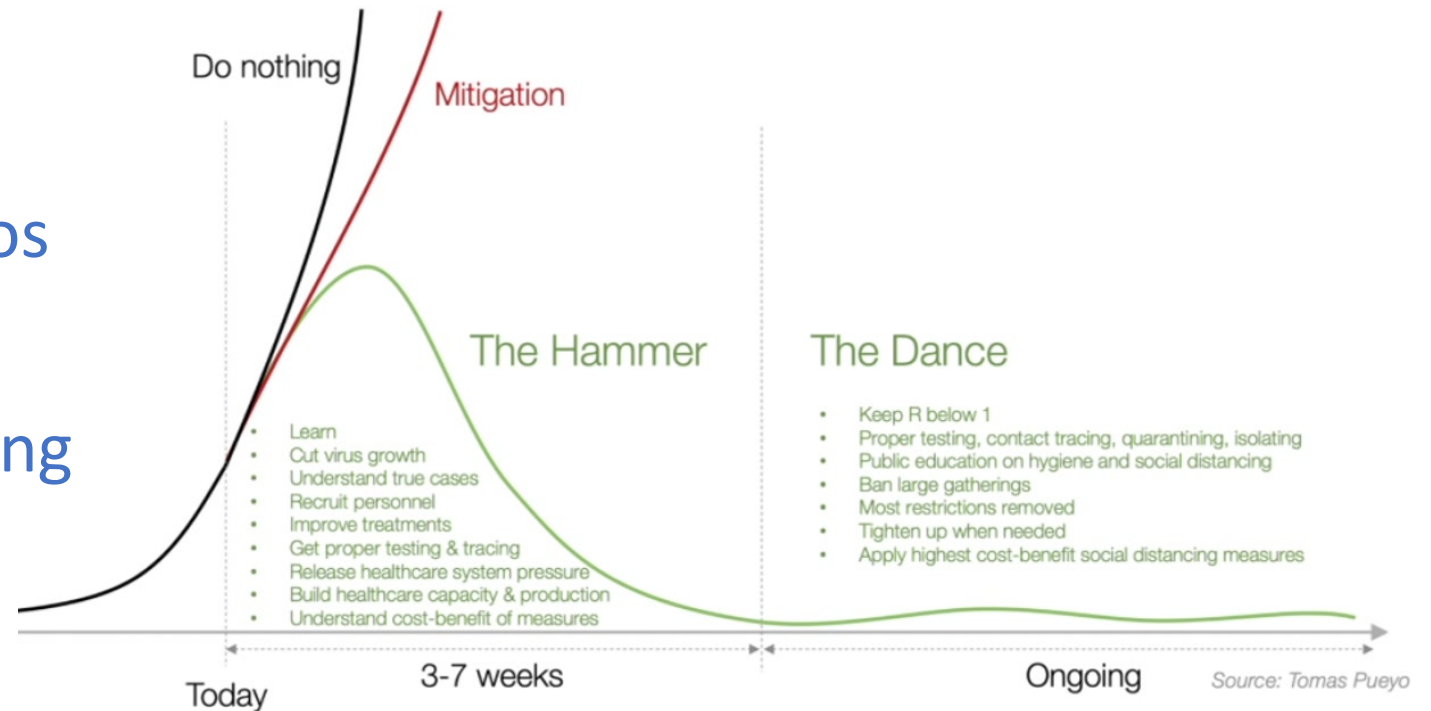
978-90-5728-491-5

194 p. : ill.

Wiskundige modellen voor corona

Doel:

- voorspellen van evolutie:
interventies & scenarios
- beter begrip
factoren die verspreiding
beïnvloeden



Wiskundige modellen voor corona

- Stochastisch model
 - Abrams et al. (medrxiv, 2020)
- Metapopulatiemodel
 - Coletti et al. (medrxiv, 2020)
- Individu-gebaseerd model
 - Willem et al. (Nat Comm, 2021)
- Deterministisch model
 - Franco et al. (medrxiv, 2020)

Eerste resultaten:

- basis reproductiegetal:

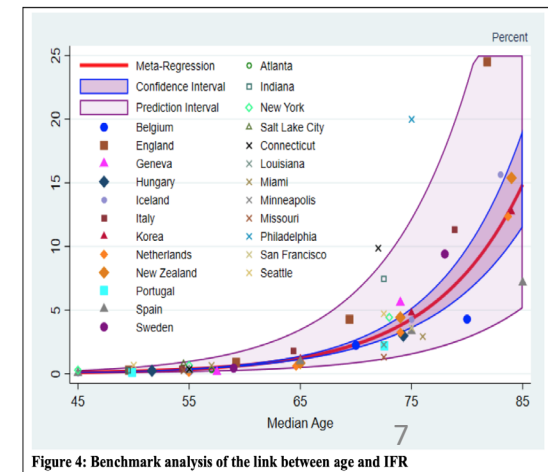
$$R_0=3.4$$

- lockdown:

$$R_t=0.7 \text{ (95\% CI: 0.70 – 0.76)}$$

- IFR (Molenberghs et al.):

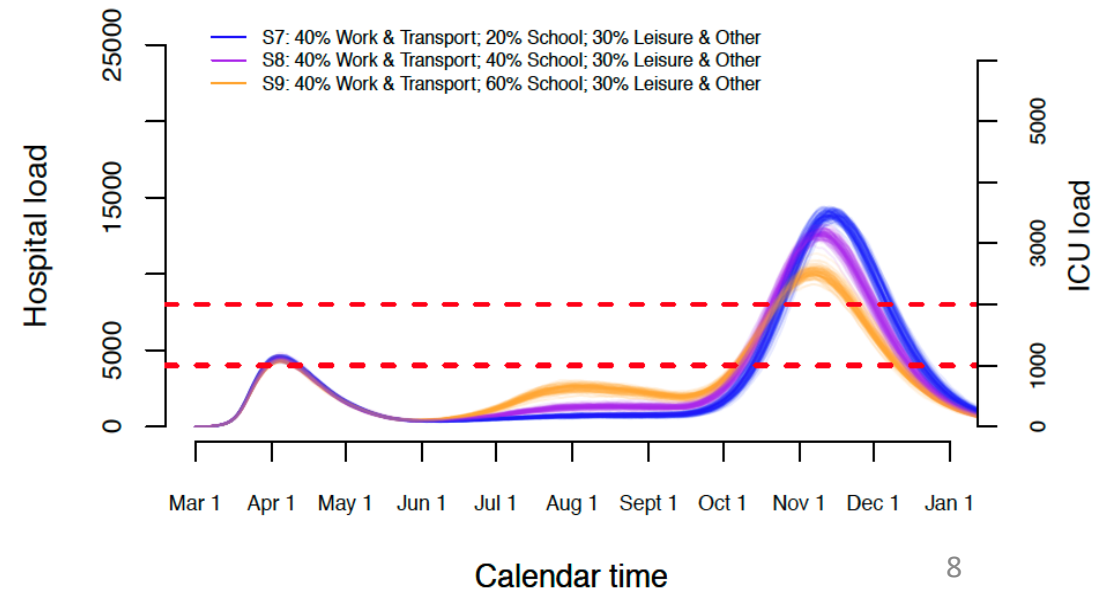
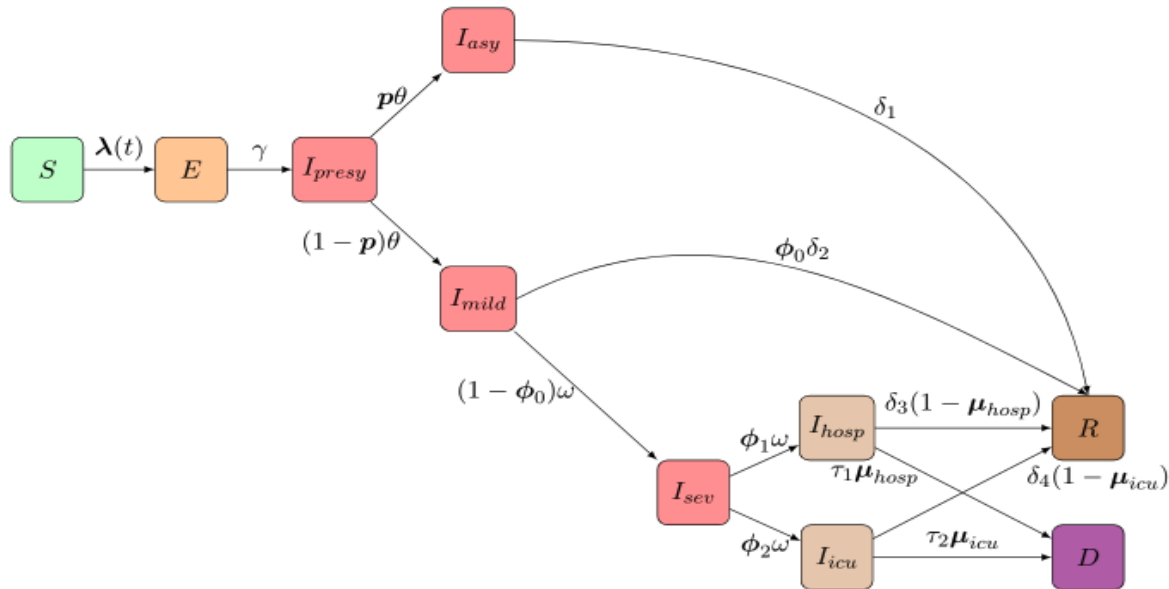
- 0.79-1.52% mannen
- 0.88-1.31% vrouwen



1. Een stochastic compartimenteel model

Abrams et al. (medrxiv, 2020) – doel:

- Het verloop van de COVID-19 pandemie voorspellen
- Impact van interventies (NPIs)



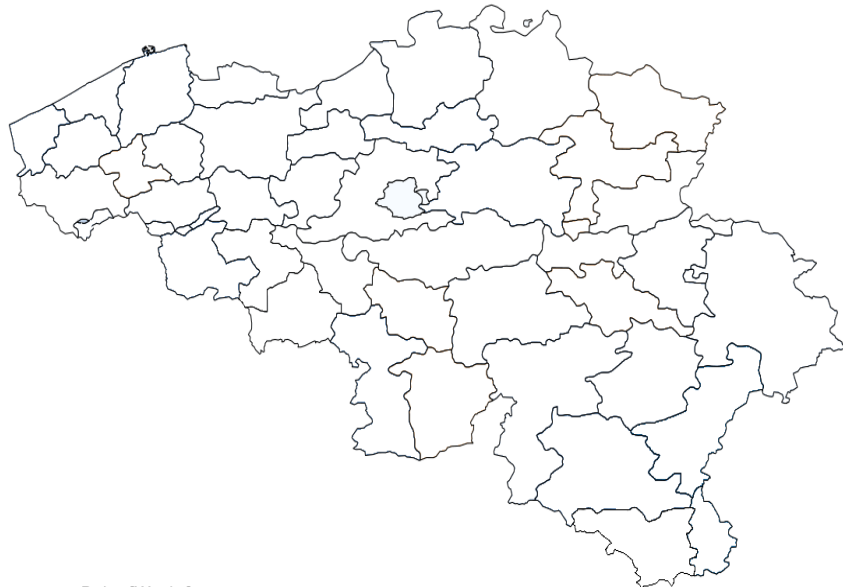
2. Een metapopulatiemodel

Coletti et al. (medrxiv, 2020) – doel:

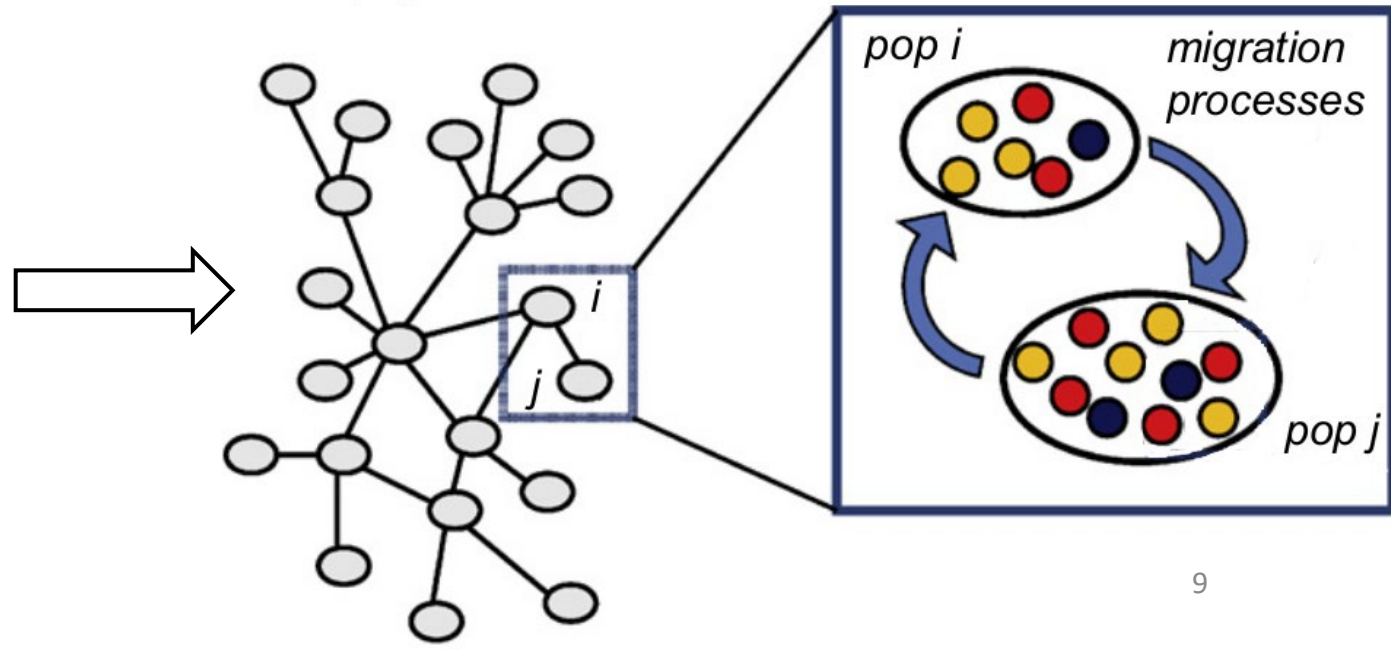
- Het verloop van de COVID-19 pandemie voorspellen
- De impact van NPIs inschatten

Model:

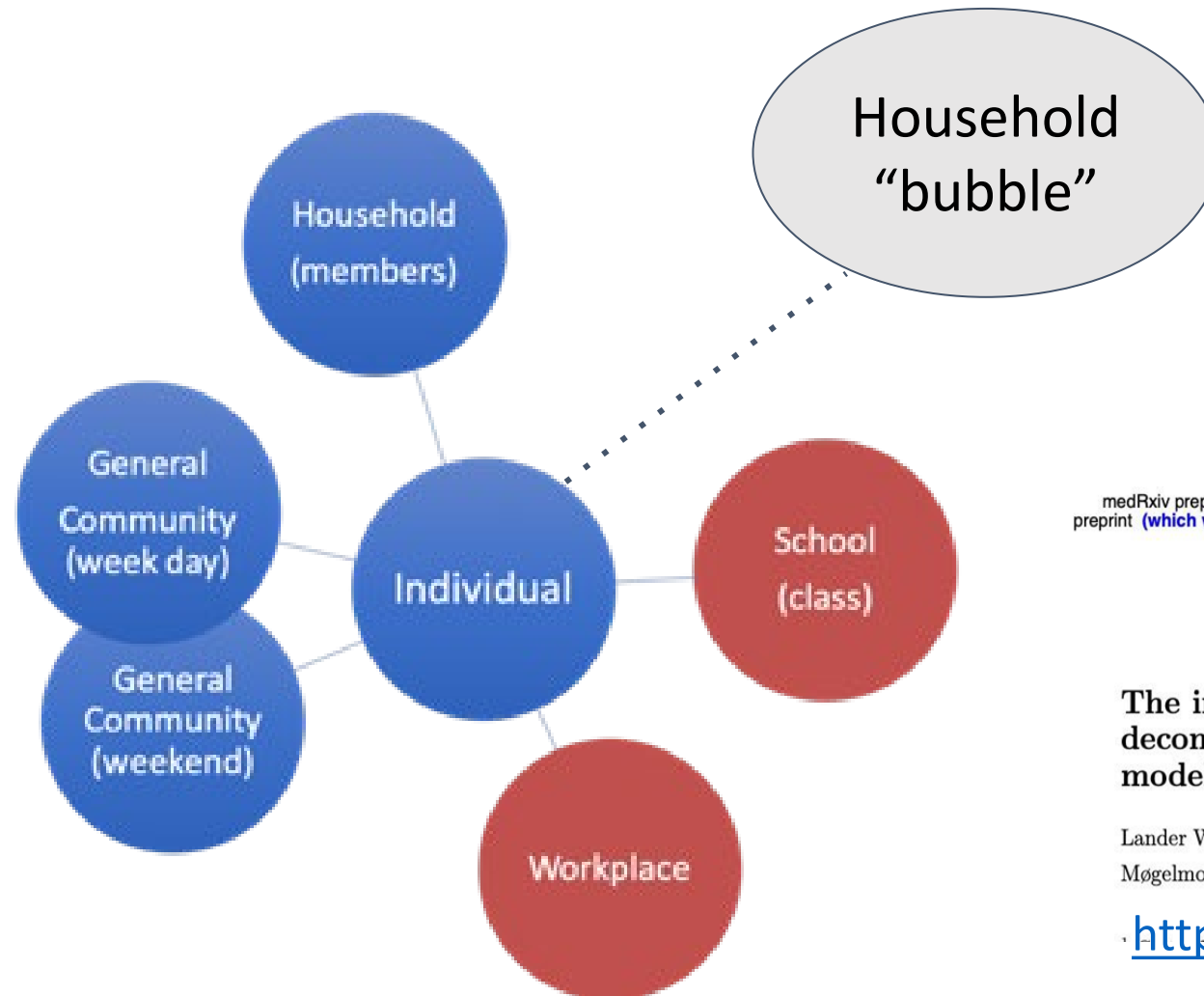
- **Spatiaal model** - gemeenteniveau
- **SEIR model** binnen elke gemeente



Dalau [Winkel]



3. Een individu-gebaseerd model



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The impact of contact tracing and household bubbles on deconfinement strategies for COVID-19: an individual-based modelling study

Lander Willem^{1*}, Steven Abrams^{2,3}, Pieter J. K. Libin², Pietro Coletti², Elise Kuylen^{1,2}, Oana Petrof², Signe Møgelmo^{2,4}, James Wambua², Sereina A. Herzog¹, Christel Faes², Philippe Beutels^{1,5}, Niel Hens^{1,2}

<https://doi.org/10.1101/2020.07.01.20144444>

Sociale contacten

- Sociale contact hypothese:
contacten = blootstelling
- Kinderen minder vatbaar/besmettelijk
lineair met leeftijd
impact van ongeveer 50%
- Verschillen tussen mensen met en
zonder symptomen
- Ref: grote coronastudie

Social Contact Rates (SOCRATES) Data Tool

Country: Belgium (Mossong 2008)

Age breaks (comma delimited): 0,18,60

Type of day: All contacts

Contact duration: All contacts

Contact intensity: All contacts

Gender: All

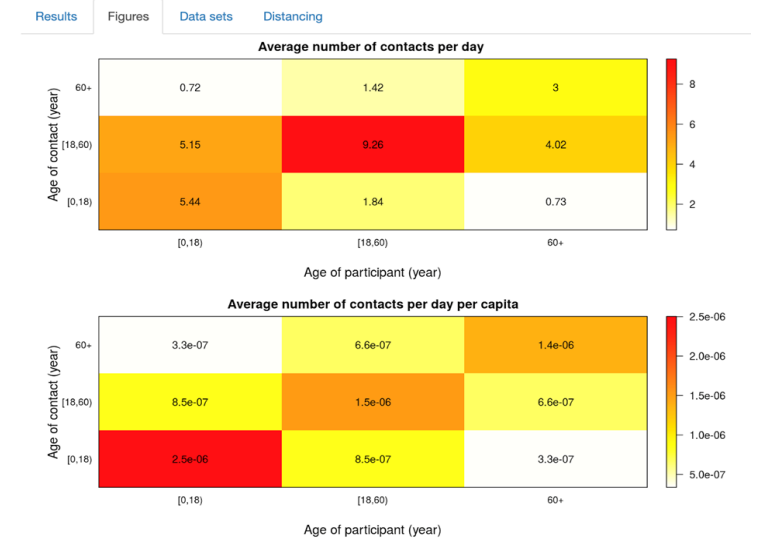
Contact features:
☒ Reciprocal
☒ Weigh by age
☒ Weigh by week/weekend

Transmission features:
☐ Age-specific transmission?
☒ Include all locations

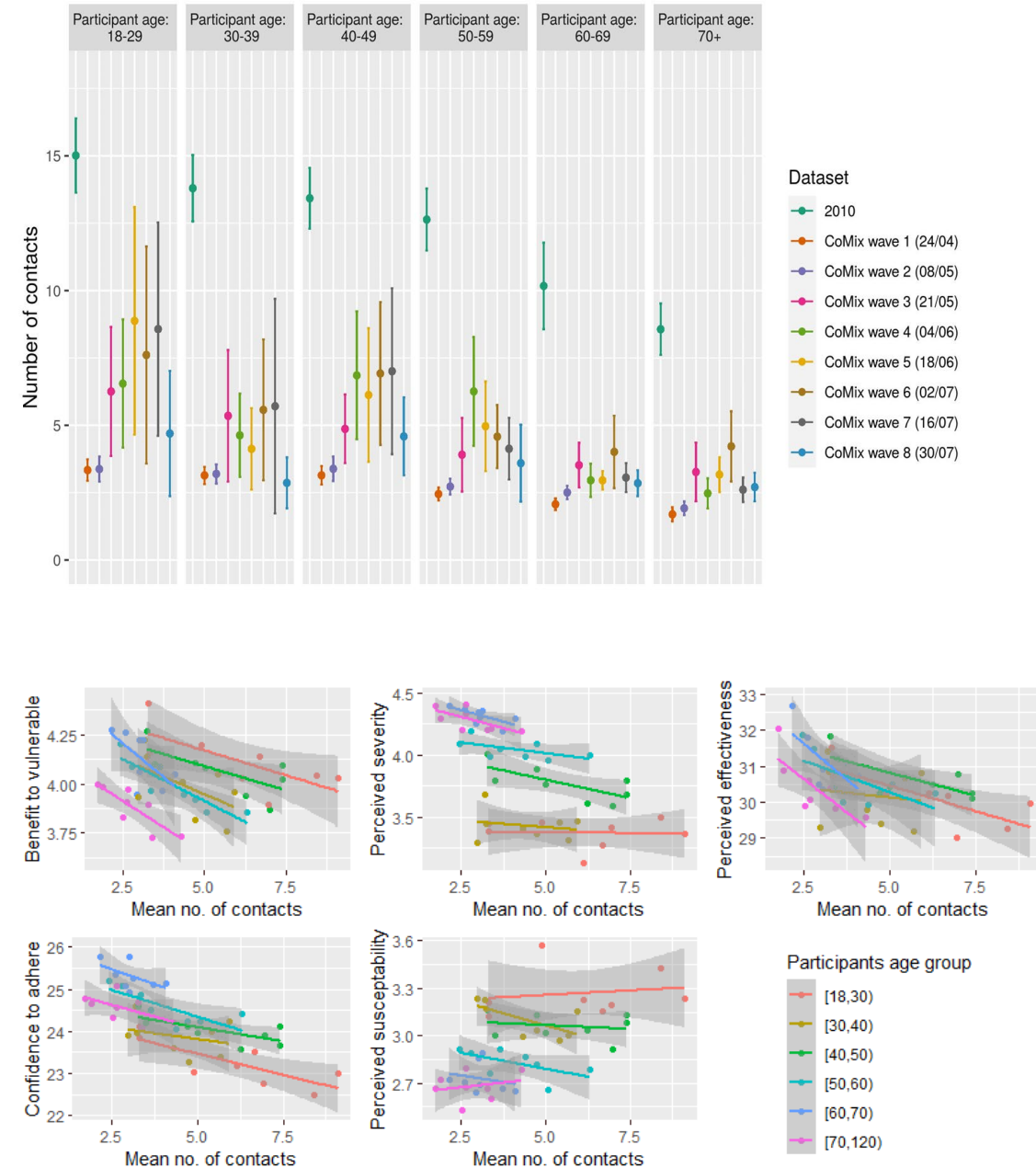
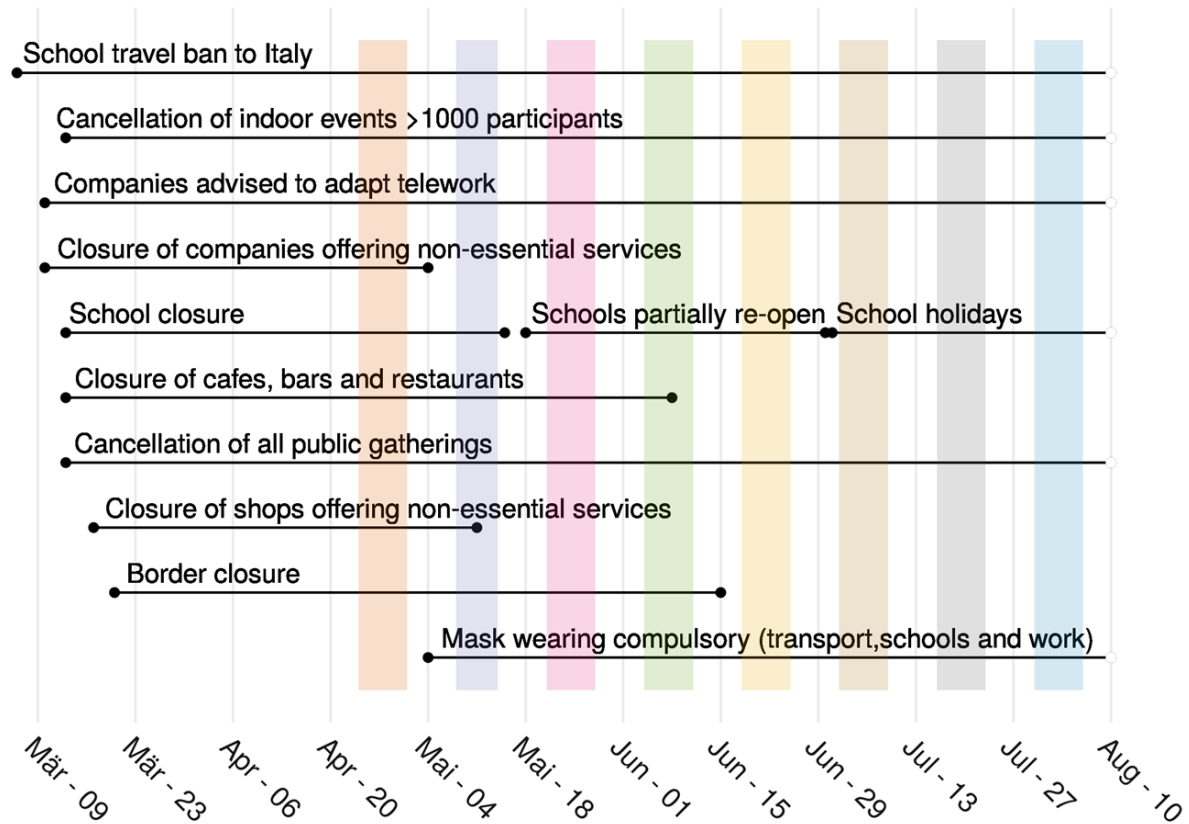
[Download matrix \(.csv\)](#)

[Download all results \(.RData\)](#)

More info: socialcontactdata.org
SOCRATES v1.17

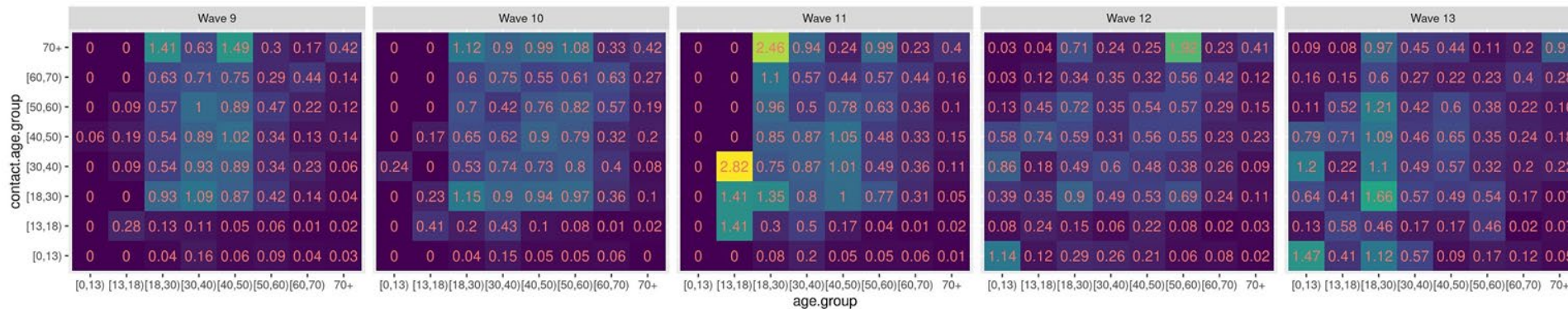
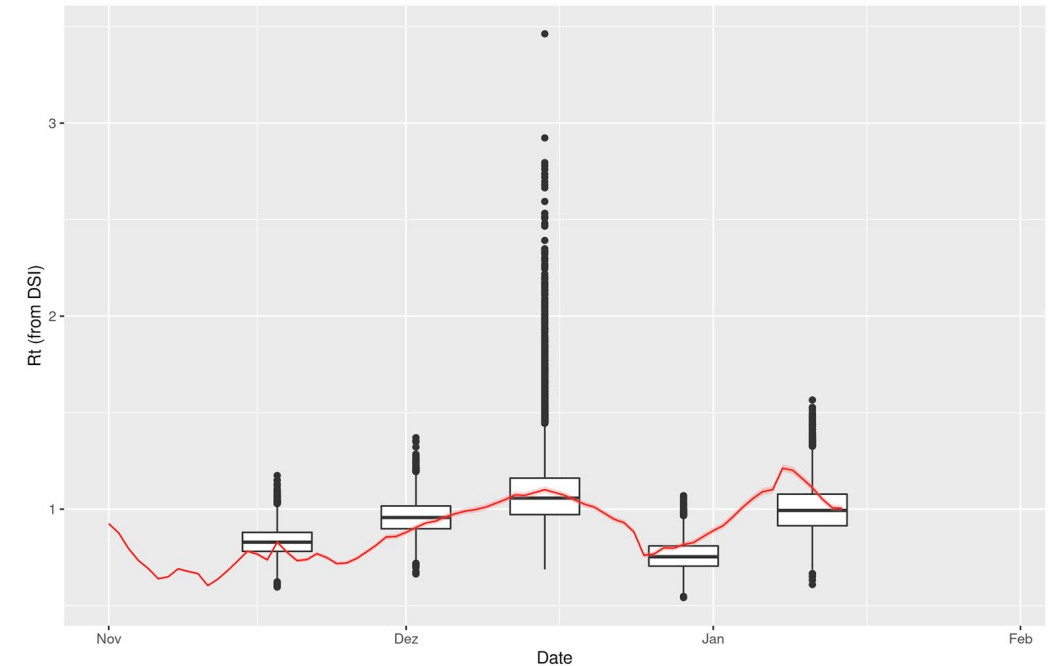


Sociale contacten



Sociale contacten

- Nieuwe ronde – 5/9 golven
 - inclusie van kinderen
 - vergelijking met R_t
 - voorloper op de curve met 7 dagen
- Verderzetting 2021



Het huidige werk

- **Universeel testen:** Libin et al. (PloS Comp Bio, 2021) & testing in scholen
- **Superverspreiding:** Kuylen et al. (in progress)
- **Nieuwe variant:** rapporten
- **Vaccinatie:** in voorbereiding

Bronnen:

- info:
www.simid.be
- socrates:
www.socialcontactdata.org
- blog:
covid-en-wetenschap.github.io

Oproep:

- Grote coronastudie
- Infectieradar



Bradford Hill (1965):

All scientific work is incomplete – whether it be observation or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time.



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