

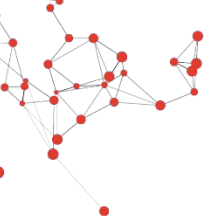
GEOGRAPHICAL VARIATION OF COVID-19 VACCINATION IN FLANDERS

Christel Faes



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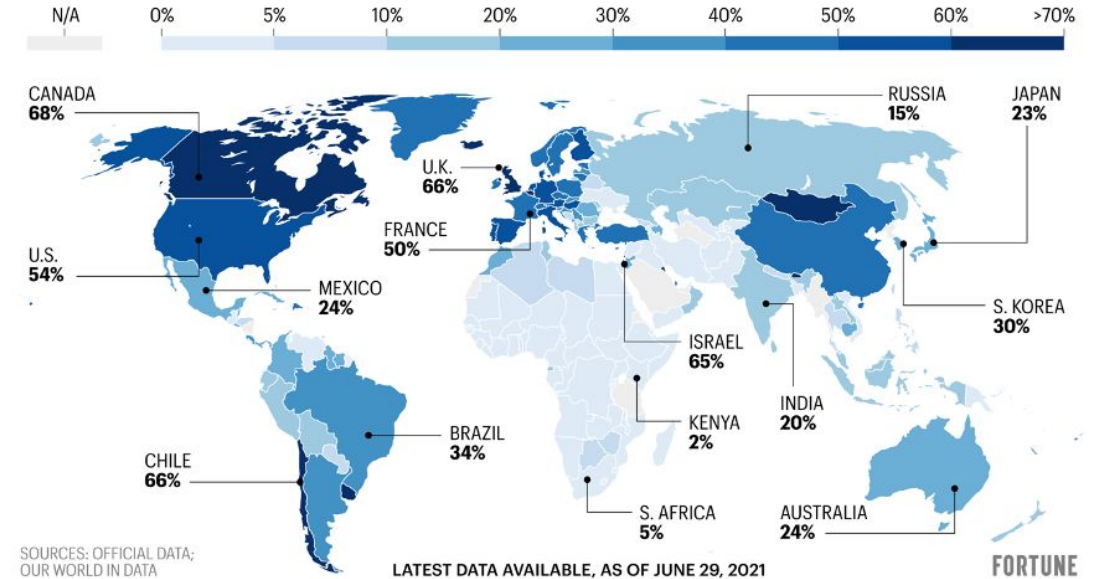
COVID-19 vaccination

COVID-19 vaccines in the fight against the global pandemic

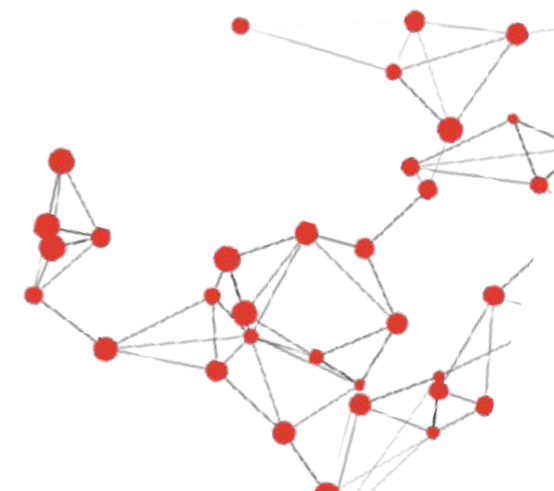
- ✓ Since 2021: national vaccination plans rolled out in many countries around the world
- ✓ Importance of good vaccination coverage to avoid continuous circulation of the virus
- ✓ Local differences in vaccine willingness are observed in many countries, including in Flanders

COVID-19 GLOBAL VACCINE TRACKER

SHARE OF PEOPLE WHO HAVE RECEIVED AT LEAST ONE DOSE OF COVID-19 VACCINE



<https://fortune.com/2021/06/30/covid-vaccines-global-vaccination-rates-by-country/>

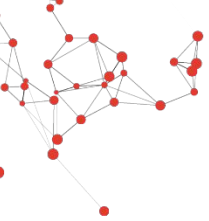




Vaccine hesitancy

- ✓ Vaccine hesitancy in various population subgroups
- ✓ US & UK (Murthy *et al* 2021; Hughes *et al* 2021; Kamal *et al* 2021; Bono *et al* 2021)
 - Lower coverage in rural counties as compared to urban counties
 - Lower coverage in counties with higher levels of social vulnerability
 - Increased hesitancy in minority groups
 - Higher vaccine acceptance with higher income, lower age and no earlier infection with COVID-19
- ✓ Flanders: Great Corona Study (Valckx *et al* 2021)
 - differences amongst locations
 - Lower vaccination willingness with lower educational background, larger household size, lower income and low mental well-being.





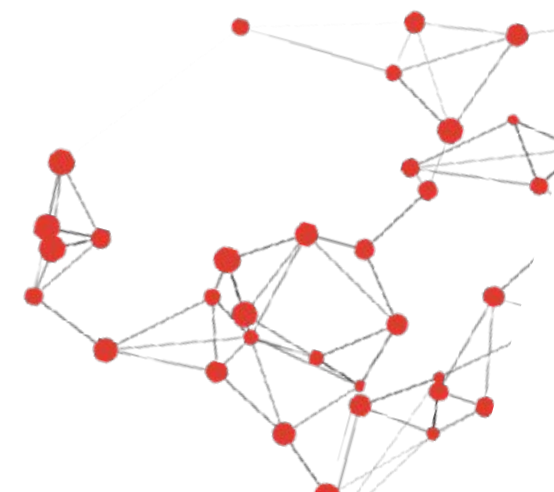
COVID-19 vaccination

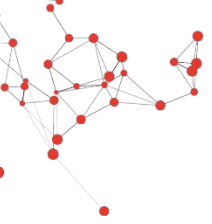
Questions of interest?

- ✓ Are there regions in Flanders with a lower vaccination coverage?
- ✓ If so, is this linked with ethnic diversity, age or composition of origin?
- ✓ Interest is in the primary care zone Maasland region.



www.zorg-en-gezondheid.be

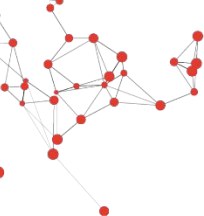




Data

- ✓ Flemish Control Tower
- ✓ Study population: Flanders, individuals above 12 yrs
- ✓ Number of vaccinated individuals and inhabitants
 - On Nov 10, 2021 (all inhabitants \geq age 12 years did have had opportunity to get fully vaccinated)
 - Per statistic sector (9,194 sectors in Flanders; mean area size of 1.55 km²)
 - Per age group (12-17, 18-44, 45-64, 65-84, 85+)
- ✓ Incomplete registration of statistical sectors in 5% of vaccinated individuals: multiple imputation

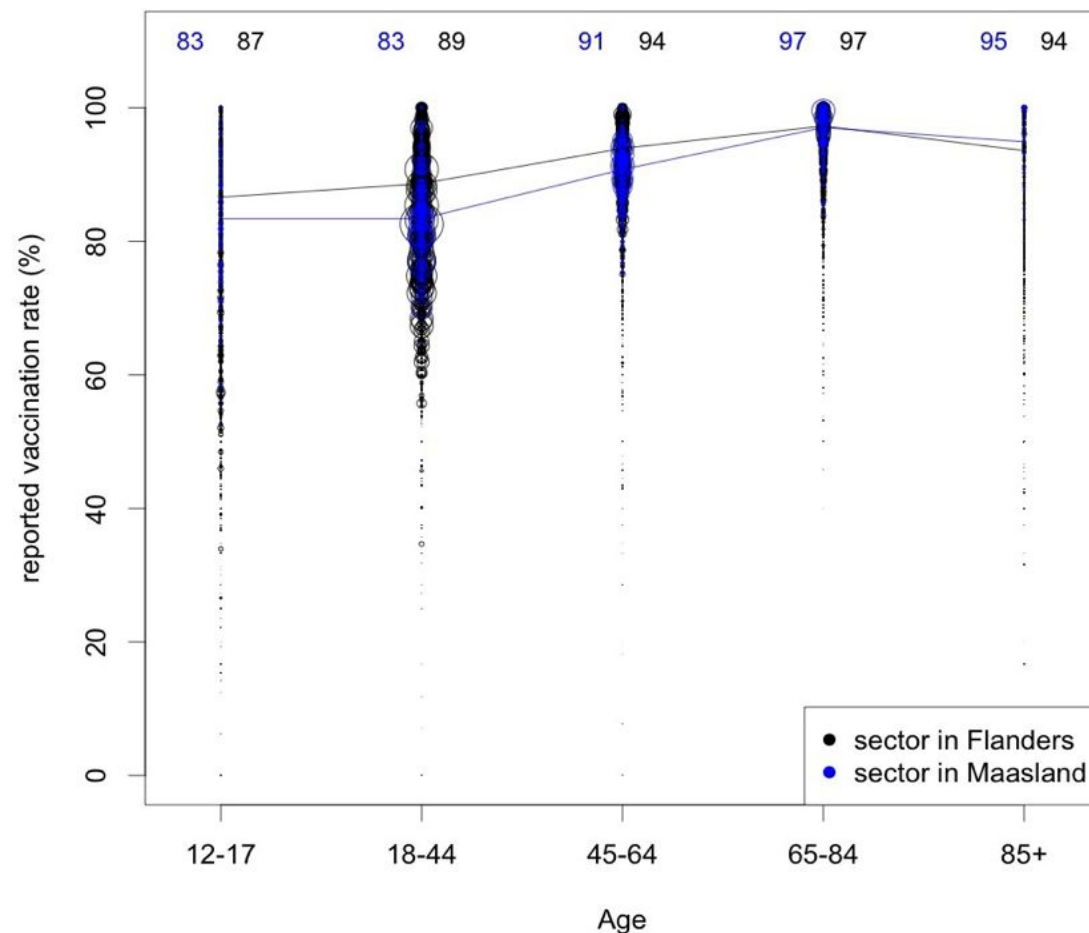


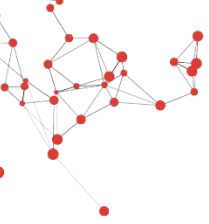


Vaccination rate

COVID-19 vaccines in the fight against the global pandemic

- ✓ High vaccination rate
- ✓ A lot of variation amongst statistical sectors
- ✓ Age group 12-17 and 18-44 shows higher vaccination hesitancy
- ✓ Difference Maasland-Flanders highest in age group 12-17 and 18-44
- ✓ Vaccination coverage is <80% in 12.1% of Flemish stat sectors; and in 17.9% of Maasland stat sectors





Are there geographical differences in vaccination rate, after correction for age distribution?

- ✓ Model the number of vaccinated individuals

$$Y_i \sim \text{Poisson}(\theta_i E_i)$$

- ✓ Compare with expected number based on age-specific vaccination rate in Flanders

$$E_i = \sum_j r_j N_{ij} \quad \text{with} \quad r_j = \frac{\sum_i Y_{ij}}{\sum_i N_{ij}}$$

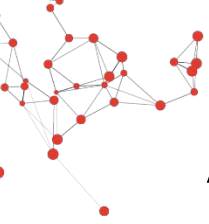
- ✓ Borrowing information from neighboring areas

$$\log(\theta_i) = \alpha + b_i \quad \text{with} \quad b_i = \frac{1}{\sqrt{\tau}} (\sqrt{1-\phi} v_i + \sqrt{\phi} u_i)$$

$$v_i \sim N(0, \sigma_v^2) \quad \text{and} \quad u_i \sim N(0, \frac{1}{\tau_{ii}} Q_{ii}^-)$$

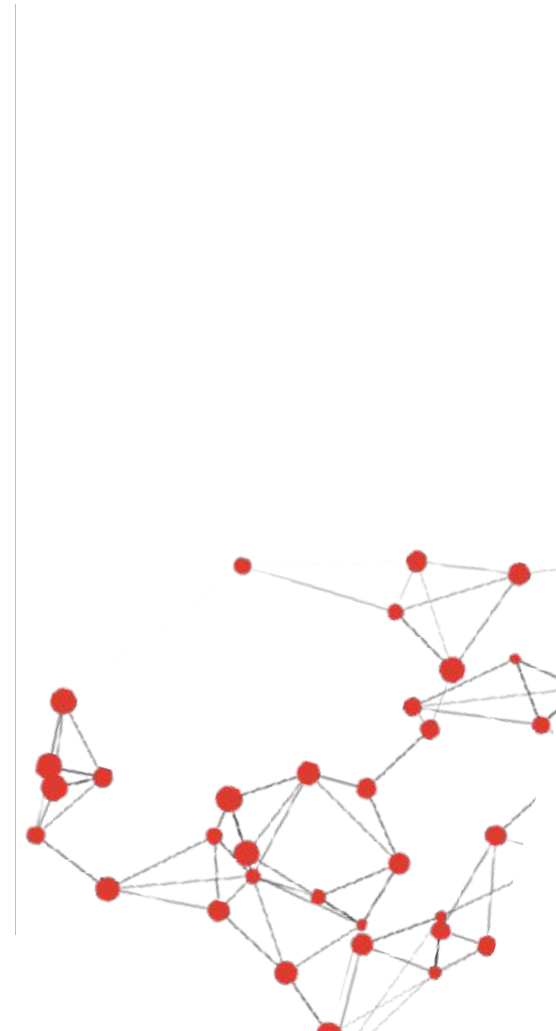
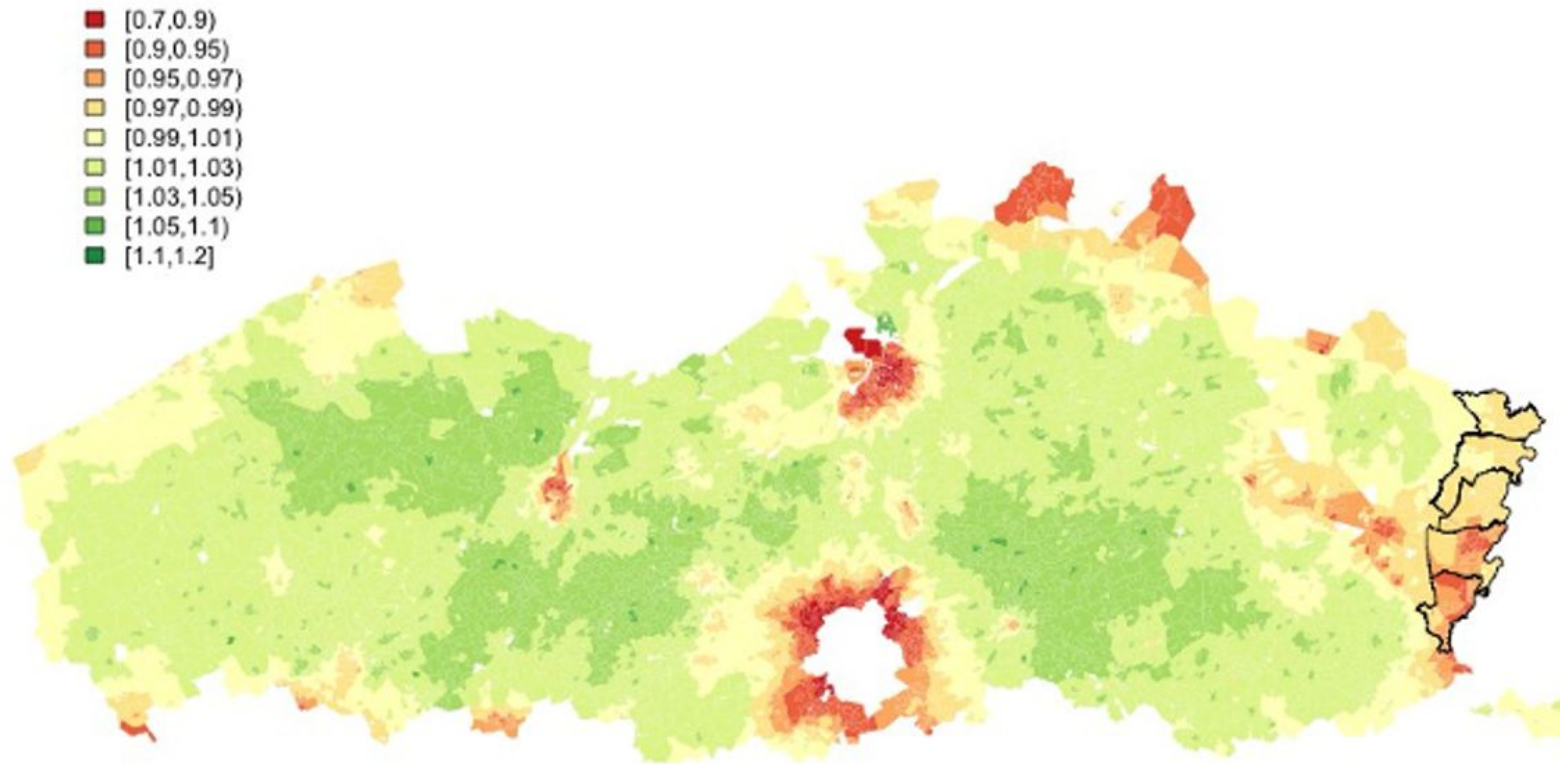
- ✓ Of interest: **age-standardized vaccination rate θ_i**

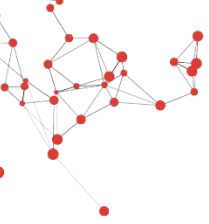




Age-standardized vaccination

Areas with $\theta_i < 1$ have lower vaccinated individuals than expected.





How different is population background, with respect to ethnic origin and SES?

✓ Population composition wrt ethnic origin:

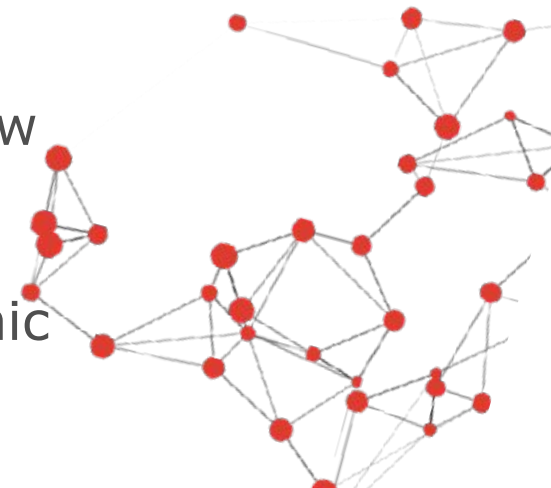
- % of individuals from non-Belgian origin

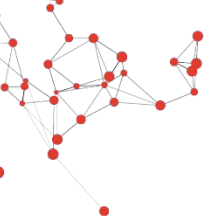
✓ Diversity index wrt ethnic origin:

- Shannon Equitability index

$$S_i = - \frac{\sum_{k=1}^K p_{ki} \log(p_{ki})}{\log(K)}$$

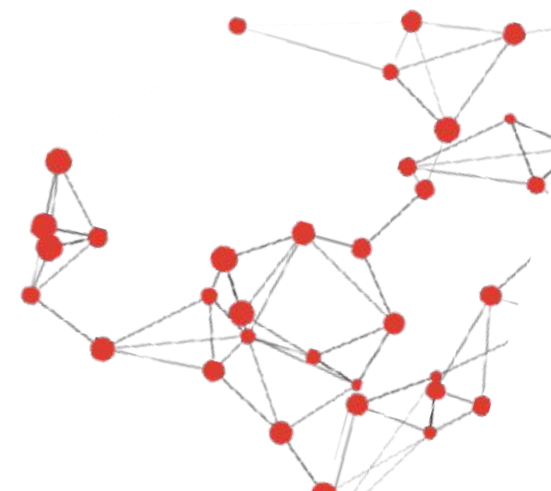
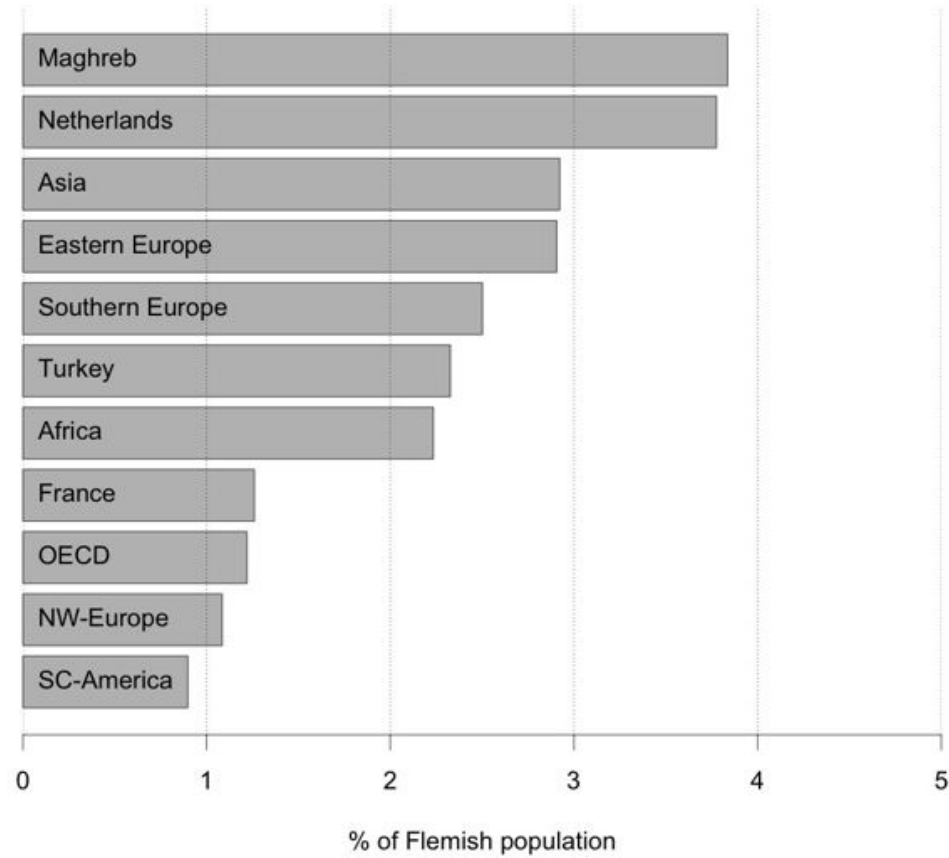
- Summary of population composition
- Higher values: more ethnic diversity in the population
- $S_i = 0$: community consists of only one population group (low ethnic diversity)
- $S_i = 1$: all population groups are equally common (high ethnic diversity)

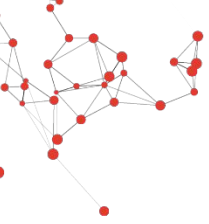




Population Composition

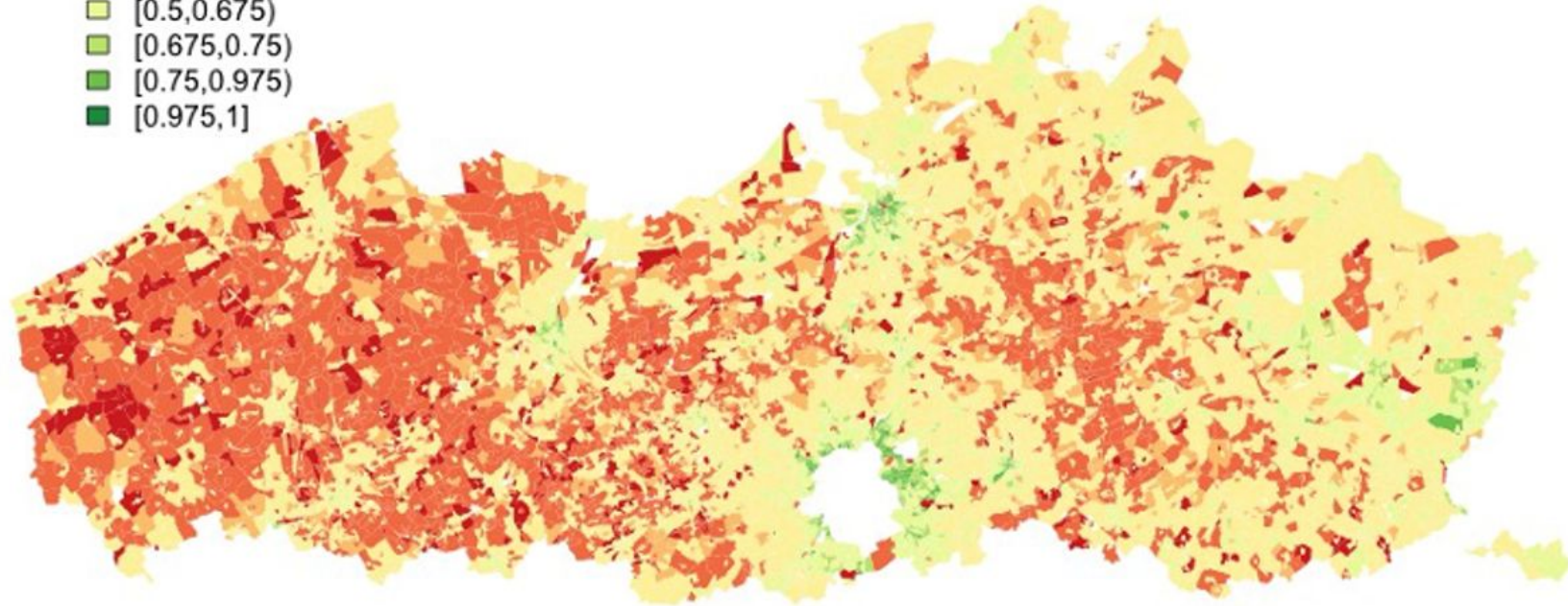
Percentage of Flemish population by (non-Belgian) origin

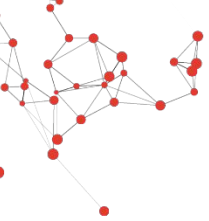




Diversity index

- [0,0.125)
- [0.125,0.25)
- [0.25,0.275)
- [0.275,0.5)
- [0.5,0.675)
- [0.675,0.75)
- [0.75,0.975)
- [0.975,1]

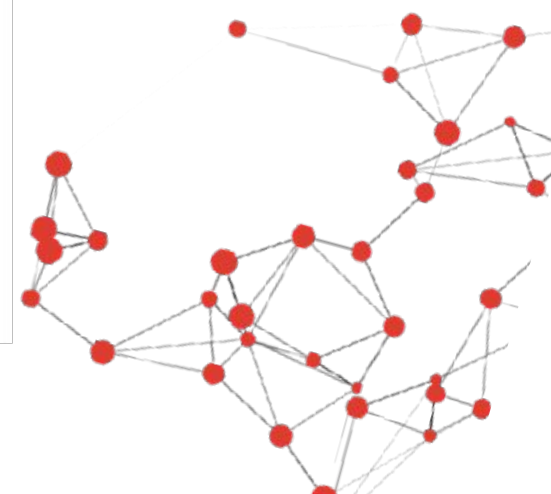
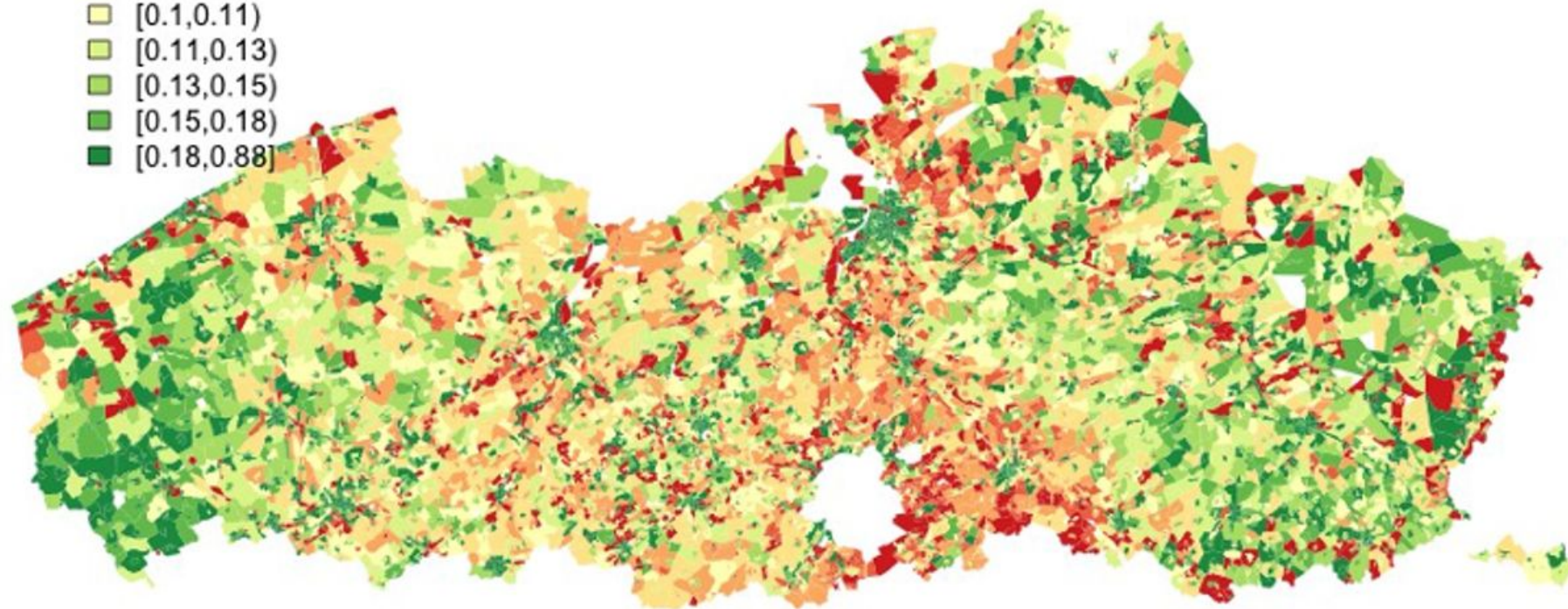


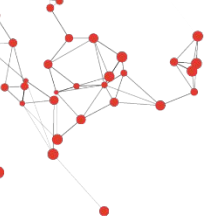


SES

Proportion of individuals with increased health insurance contribution as proxy for SES

- [0,0.03)
- [0.03,0.06)
- [0.06,0.08)
- [0.08,0.1)
- [0.1,0.11)
- [0.11,0.13)
- [0.13,0.15)
- [0.15,0.18)
- [0.18,0.88]





How does age, SES and ethnic composition/diversity impact vaccination rate?

- ✓ Model the number of vaccinated individuals per age group

$$Y_{ij} \sim \text{Binomial}(\pi_{ij}, N_{ij})$$

- ✓ **M1: Relation with diversity:**

$$\text{logit}(\pi_{ij}) = \alpha_j + f_j(S_i) + \beta \text{SES}_i$$

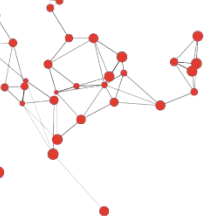
- $\text{expit}(\alpha_j)$ = age-specific vaccination rate in completely homogeneous area
- $f_j(S_i)$ = (non-)linear relationship of Shannon diversity index

- ✓ **M2: Relation with composition:**

$$\text{logit}(\pi_{ij}) = \alpha_j + \sum_{k=2}^K \delta_k (p_{ki} - p_k)$$

- $\text{expit}(\alpha_j)$ = age-specific vaccination rate in area with same ethnic composition as Flanders
- $p_{ki} - p_k$ = deviation of population k amongst region i and Flanders





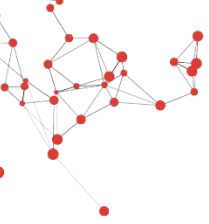
Effect of age and SES

Odds ratio estimates based on model M1 (age effects as compared to age group 12-17)

Parameter	<i>OR</i>	LL	UL
Age 18-44	1.106	1.082	1.131
Age 45-64	1.901	1.858	1.945
Age 65-84	4.577	4.443	4.714
Age 85+	1.651	1.592	1.713
LowSES	0.688	0.650	0.728

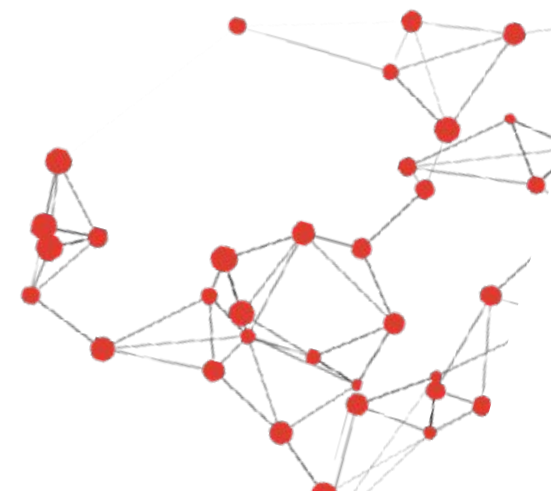
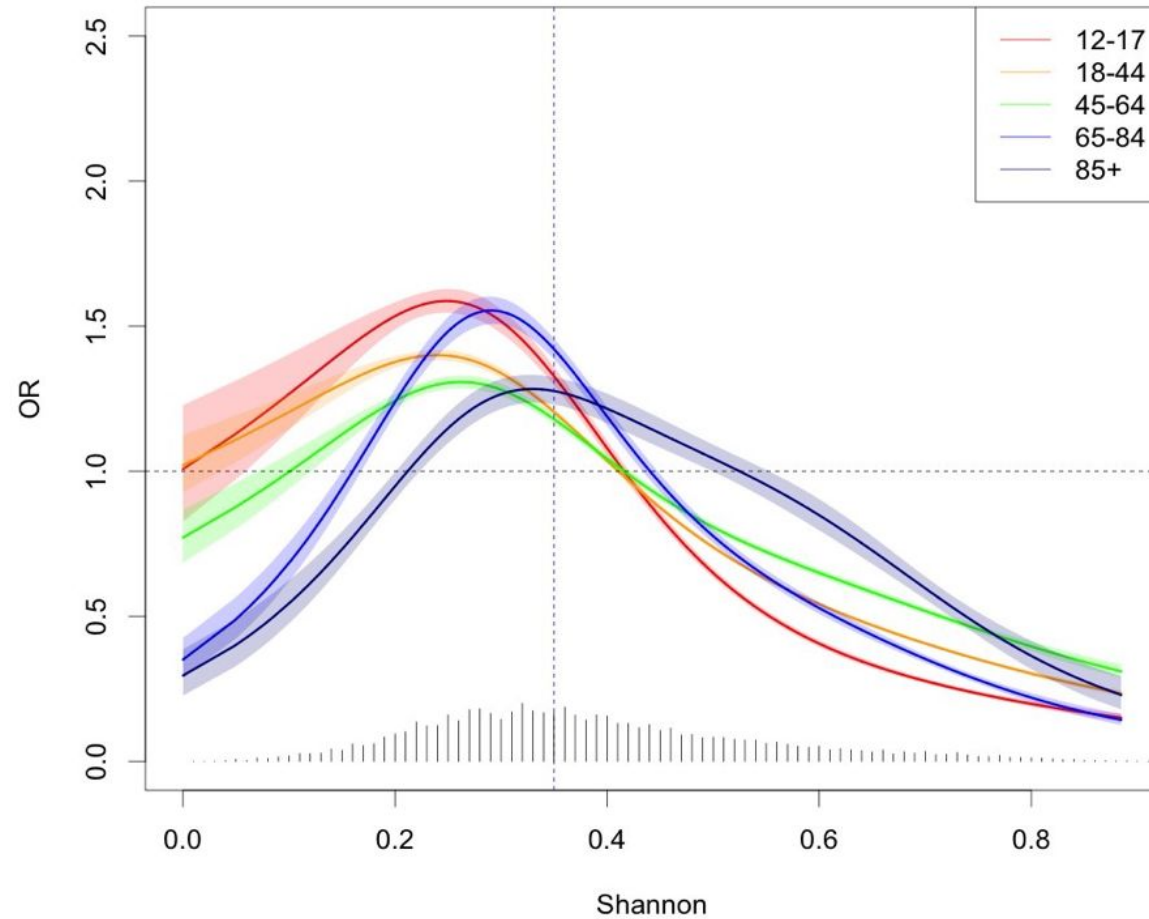
- Important differences amongst age-groups
- Regions with lower SES rate have lower vaccination rate

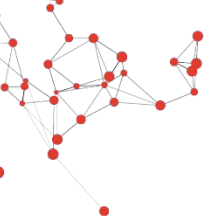




Effect of diversity

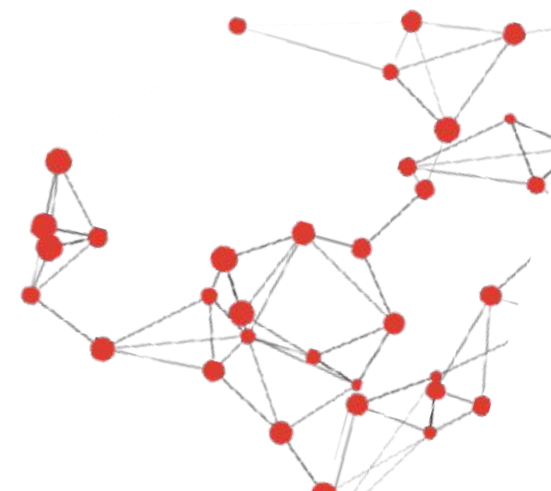
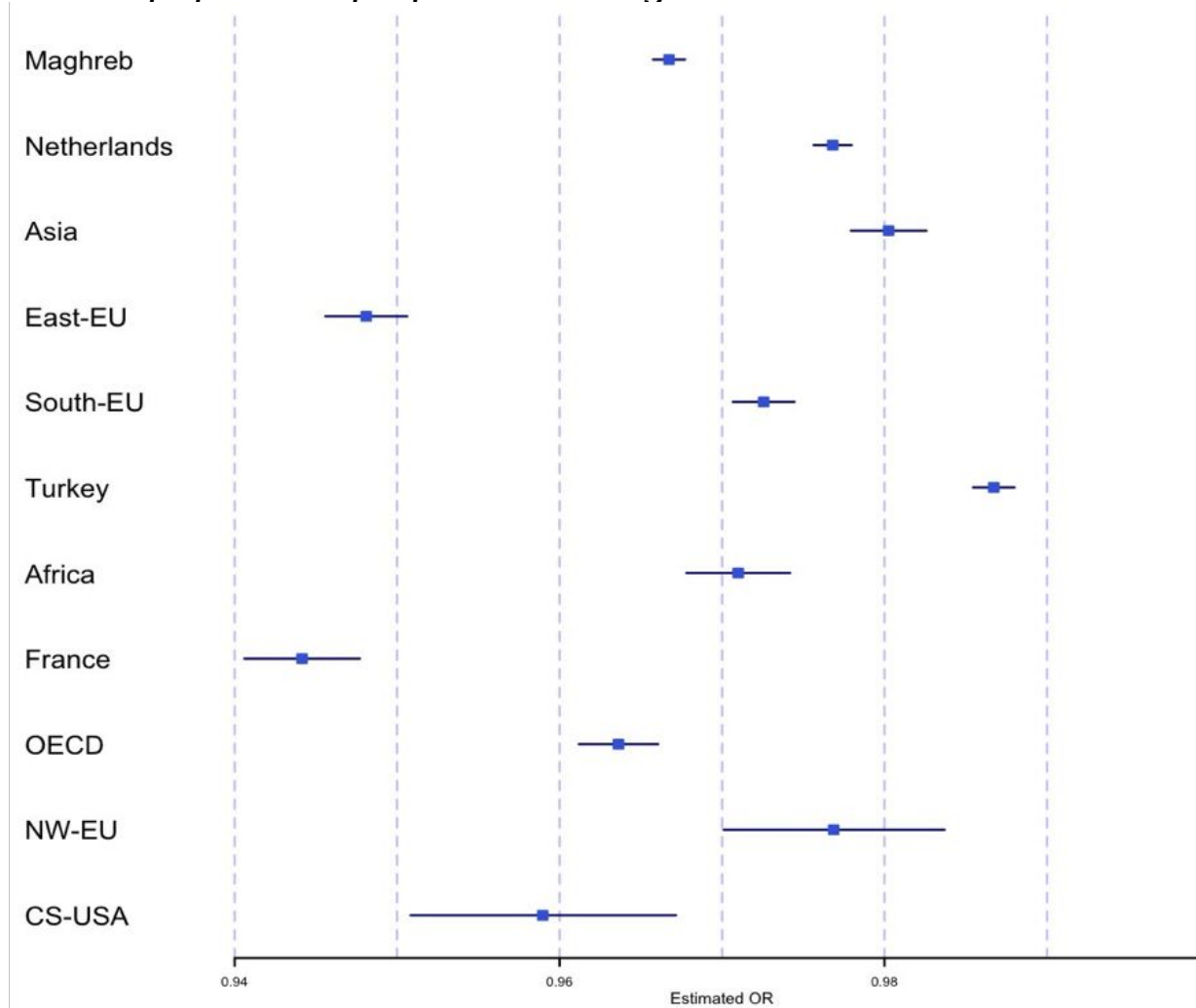
Multiplicative effects of diversity (Shannon index) on the odds to be vaccinated in an area





Effect of composition

Multiplicative effect of composition on the odds to be vaccinated in an area, corresponding to a 1% increase in population proportion of origin





Conclusions

- ✓ Vaccination campaign in Flanders has been a success
But, large heterogeneity among regions

- ✓ Differences are due to
 - Age composition of population
 - Composition wrt ethnicity
 - SES

- ✓ Ethnicity explains for Maasland a reduction of 35.2% of the odds to get vaccinated.

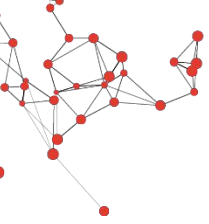




Conclusions

- ✓ Possible reasons:
 - Influence from homeland
 - Influence by peer community
 - Language <-> brochures in different languages
 - Information not reaching population
 - Lack of volunteers of non-Belgian origin in vaccination centers
- ✓ Results in line with the low vaccination rates in Eastern Europe and France.
- ✓ Final note: based on official numbers of vaccinated individuals (therefore, results from especially Turkey, Eastern Europe and the Netherlands have to be interpreted with care)





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For any questions or suggestions



Christel Faes

✉ christel.faes@uhasselt.be



Universiteit Hasselt,

Data Science Institute

