UNIVERSITÀ DI PISA

SCUOLA NORMALE SUPERIORE

Geographical and individual deprivation index to assess the risk of Sars-CoV-2 infection and disease severity in people at socioeconomic disadvantage

Sara Mazzilli, Ph.D. candidate in Data Science

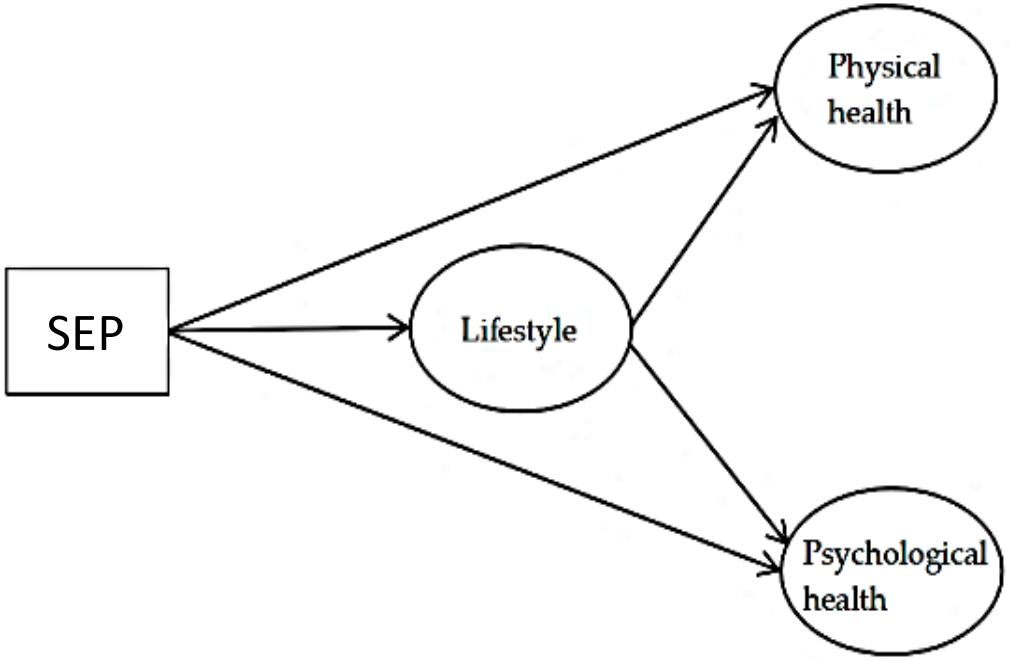
Email: sara.mazzill@gmail.com

At the beginning of the COVID-19 crisis the initial widespread opinion that the virus does not discriminate.

High risk groups

INTRODUCTION

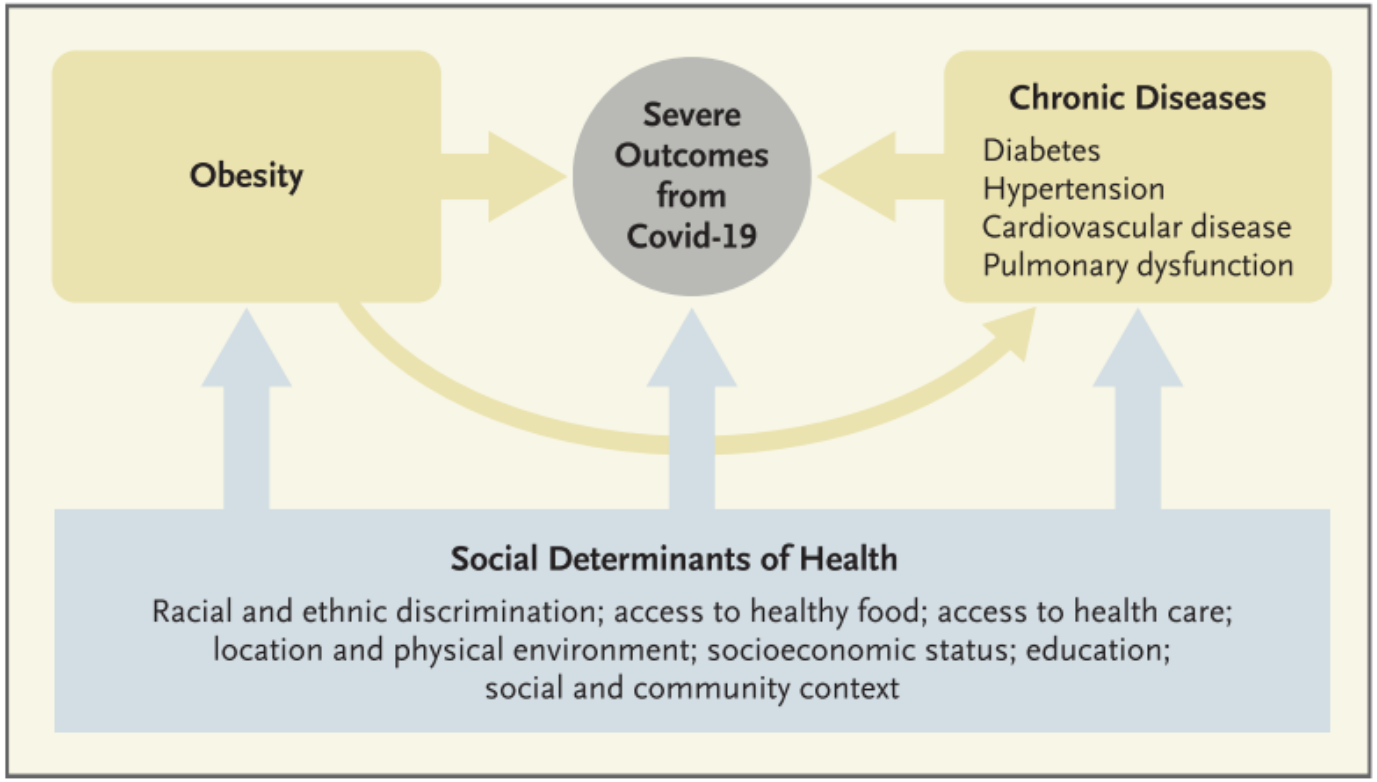
1978 Alma-Ata Conference



COVID-19 is not a pandemic

COVID-19 is a syndemic

The biological, economic, and social interactions between non-communicable diseases and COVID-19, increase a person's susceptibility to infection and worse health outcomes.



Social Determinants of Health as the Root Cause of Racial and Ethnic Health Disparities, Including Severe Negative Outcomes from Covid-19.

x_1: Percentuale di popolazione con istruzione pari o inferiore alla licenza elementare

1. Dimensione Culturale

Numeratore: Popolazione con istruzione pari alla licenza elementare, alfabeta o analfabeta

Denominatore: Popolazione di 6 anni ed oltre

x 100

x_2: Percentuale di popolazione attiva disoccupata o in cerca di prima occupazione

2. Dimensione Lavorativa

Numeratore: Forza lavoro - disoccupati o in cerca di prima occupazione

Denominatore: Forza lavoro

x 100

x_3: Percentuale di abitazioni occupate in affitto

3. Dimensione Materiale

Numeratore: Abitazioni occupate da persone residenti in affitto

Denominatore: Abitazioni occupate da persone residenti

x 100

x_4: Densità abitativa (per 100 m^2)

4. Dimensione Contesto

Numeratore: Popolazione totale

Denominatore: Superficie (m^2) delle abitazioni occupate da persone residenti

x 100

x_5: Percentuale di famiglie monogenitoriali con figli dipendenti conviventi

5. Dimensione Rete di Supporto

Numeratore: Padre o madre soli con figli (in famiglie mononucleari, con e senza membri isolati)

Denominatore: Famiglie totale

x 100

Indice di deprivazione

$$ID = \sum_{i=1}^{5} z_i \qquad z_i = \frac{x_i - m_{x_i}}{s_{x_i}}$$

x_i: indicatore; i=1,... ,5;

m_x: media dell'indicatore;

s_x: deviazione standard dell'indicatore

DEPRIVATION INDEX

3. Individual Deprivation Index

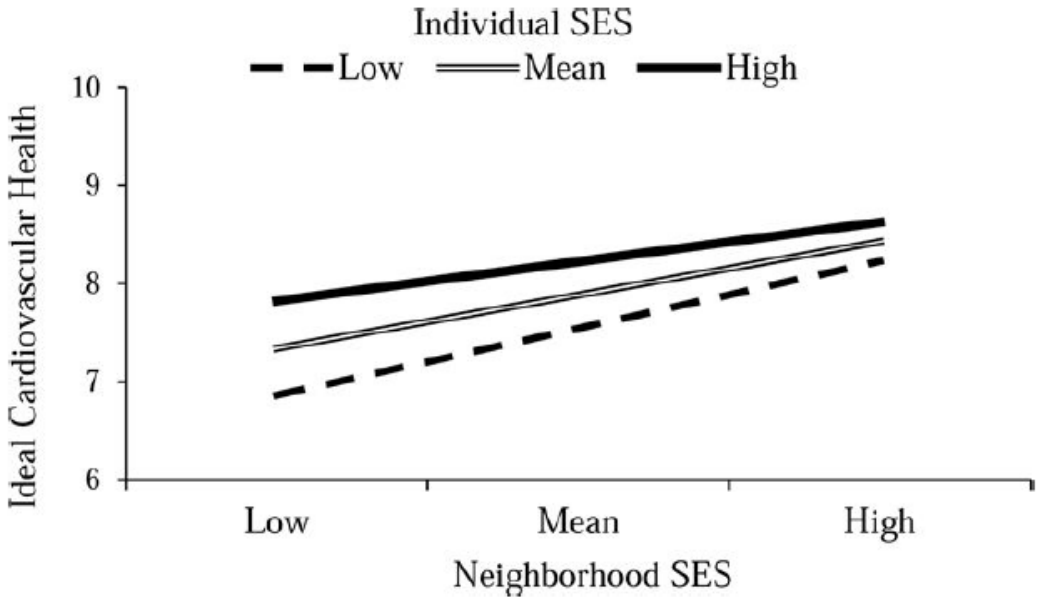


Figure 2.
Interaction between neighborhood and individual SES in the prospective prediction of cardiovascular health. Lines represent the association between neighborhood SES and cardiovascular health at the mean and plus and minus one standard deviation of individual SES. Simple slopes are significantly different from zero at low and mean levels of individual SES. Estimated values reflect statistical adjustment for age, gender, race, physical activity, smoking, chronic conditions, and hypertension, cholesterol, and diabetes medication at baseline.

METHODS

Time period: (March - December 2020) -> Second wave (15 Sept – 31 Dec)
Place: Apulia Region, Italy

Data on tested individuals linked with deprivation index & census data

Statistical analysis

- PCA & K-mean cluster for reduce the dimensions (n of variables) of the census related with the SEP and calculating the individual DI
- GLM logistic to assess association among level of deprivation and COVID-19 related outcomes

RR for

- Being Positive
- Being Hospitalized
- Death

Variable used from census

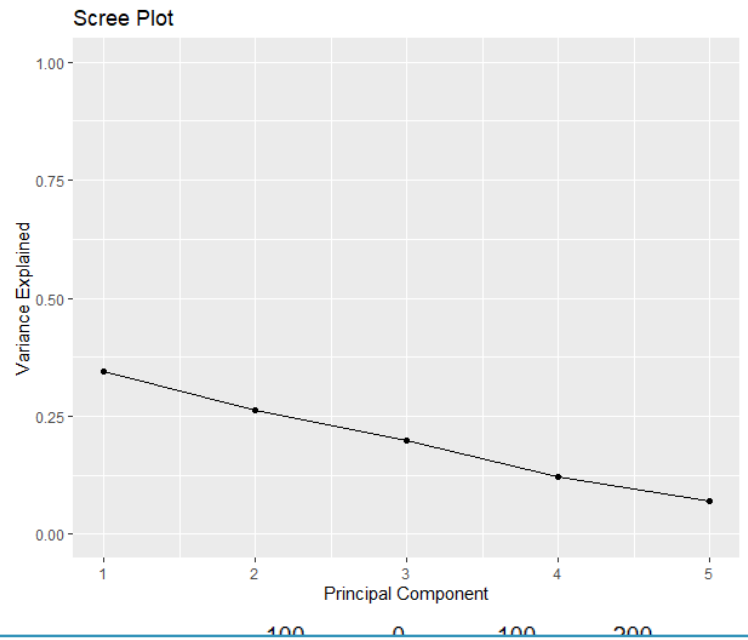
1. Nationality: Italian, stranger.
2. Level of education
3. Number of people living together
4. Type of family(nucleo famigliare) + housing condition
5. Work condition + type of job

- N = 244832 → median age 35 IQR: 21-58
- N with the 1st set of census variables = 60593 → median age 45 IQR: 23-56
- N with the 2nd set of census variables = 169841 → median age 42 IQR:25-59

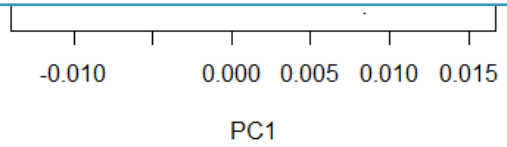
	Geo DI 1	Geo DI 2	Geo DI 3	Geo DI 4	Geo DI 5
Total sample	0.19	0.19	0.2	0.21	0.21
Sample with the first selection of census variables	0.22	0.22	0.22	0.19	0.14
Sample with the second selection of census variables	0.19	0.19	0.20	0.21	0.21

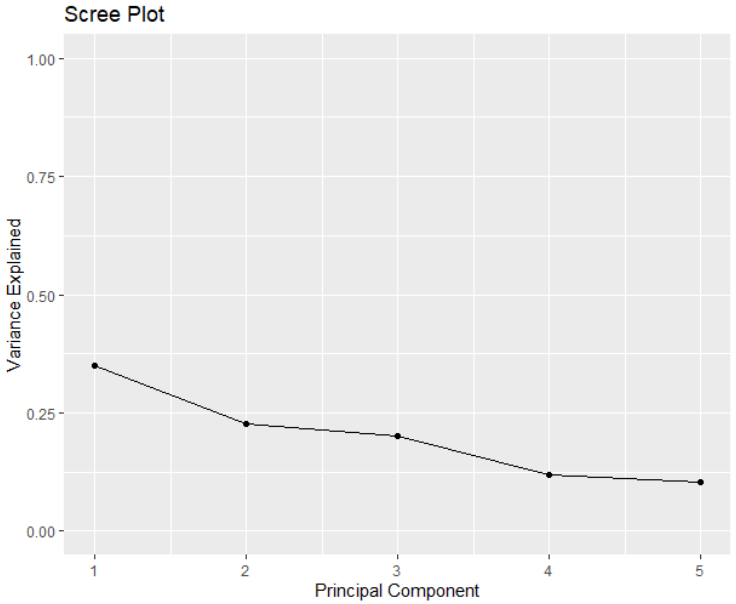
RESULTS

Individual deprivation index with PCA

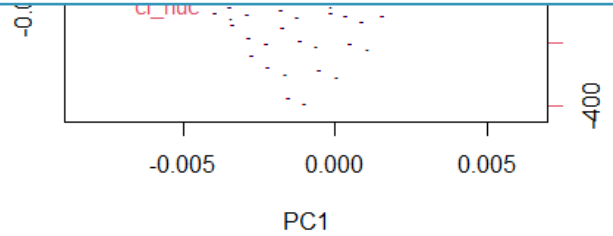


	PC1	PC2	PC3	PC4	PC5
Cittadinanza	0.11	-0.06	0.98	-0.14	-0.03
N componenti famiglia	0.29	0.64	-0.09	-0.70	0.02
Titolo di studio	0.65	-0.26	-0.10	0.02	-0.71
Tipo attività lavorativa	0.65	-0.27	-0.06	0.04	0.71
Tipo di nucleo famigliare e convivenza con altri nuclei	0.25	0.66	0.11	0.70	-0.01

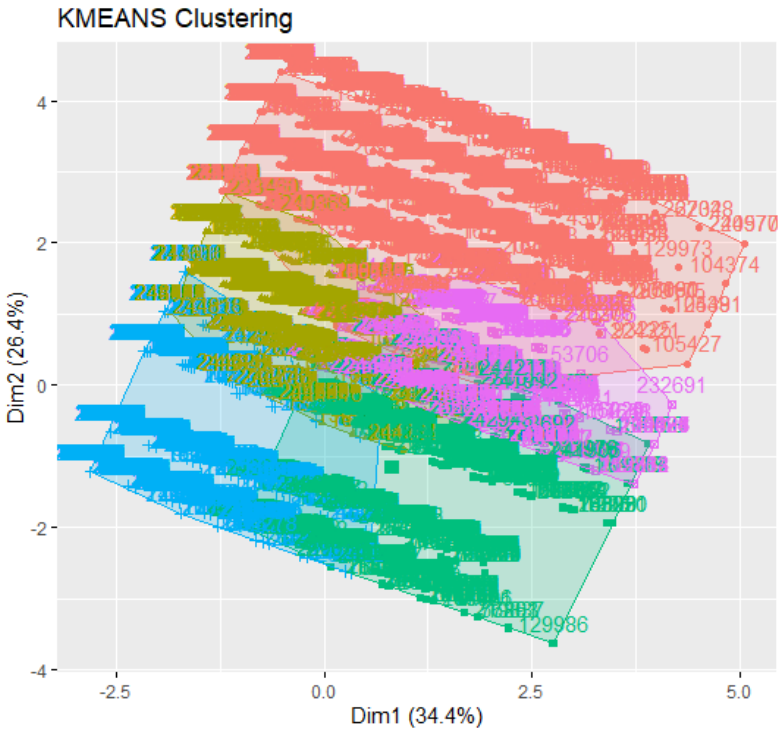


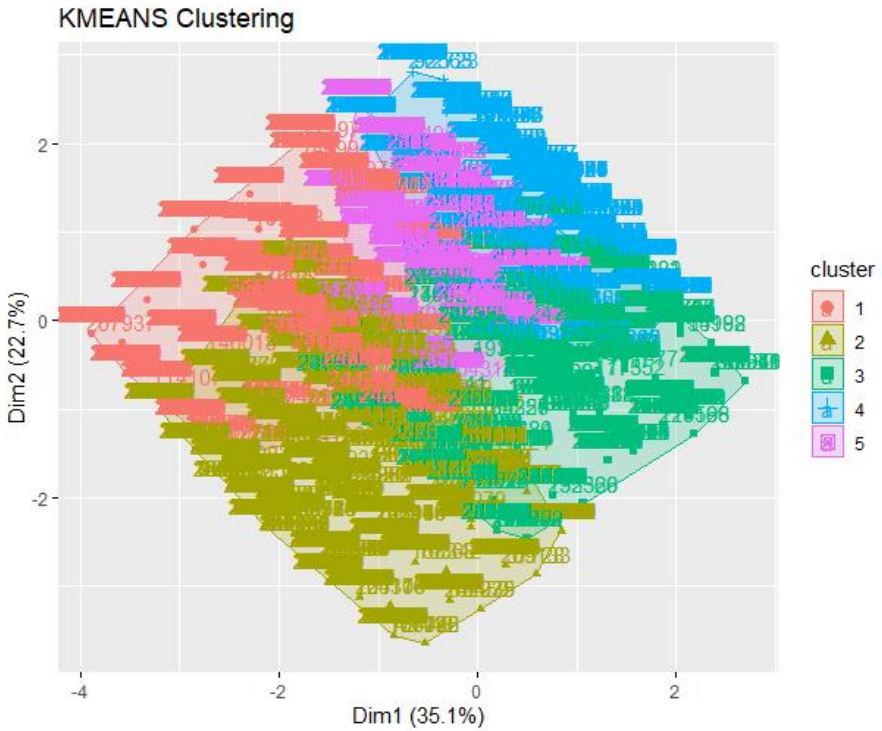


	PC1	PC2	PC3	PC4	PC5
Cittadinanza	0.02	-0.01	1.00	-0.05	0.01
N componenti famiglia	0.56	0.39	0.00	0.13	-0.72
Titolo di studio	-0.45	0.56	0.05	0.69	0.08
Condizione lavorativa	0.50	-0.47	0.02	0.68	0.26
Tipo di nucleo famigliare	-0.48	-0.56	0.03	0.21	-0.64

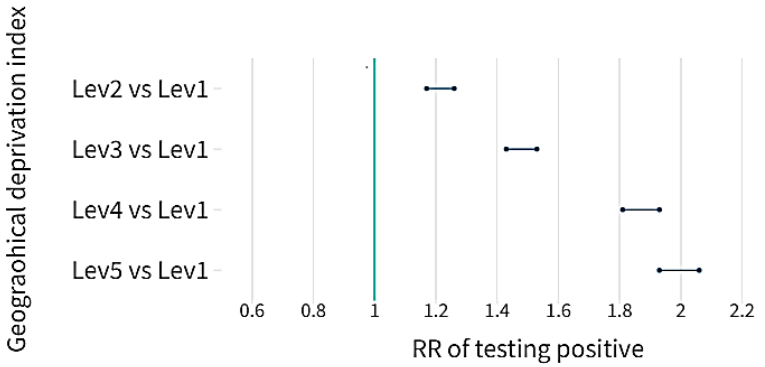


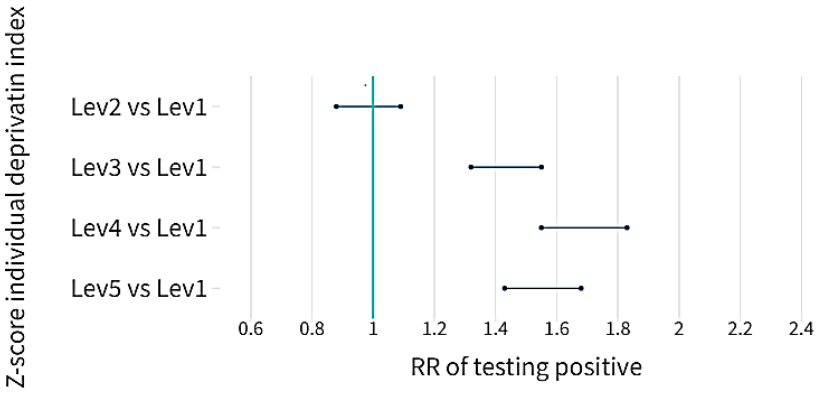
Individual deprivation with k-means

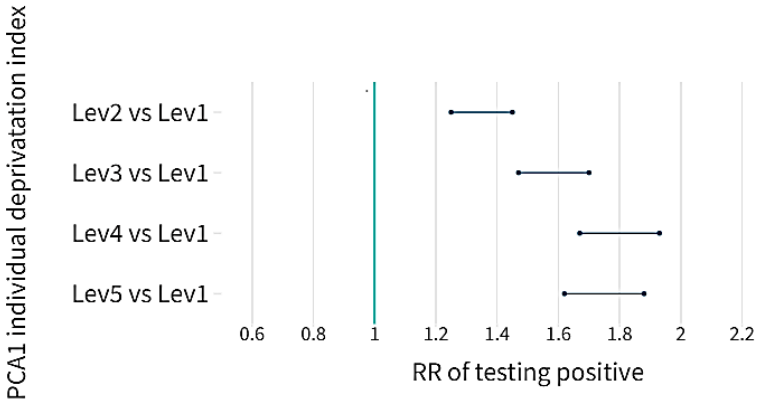


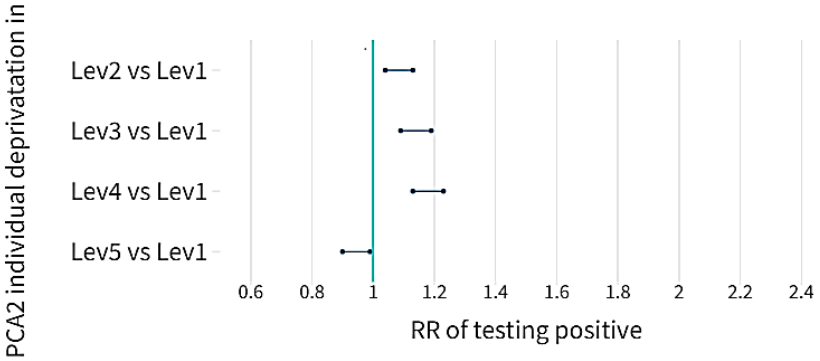


Adj. RR of testing positive

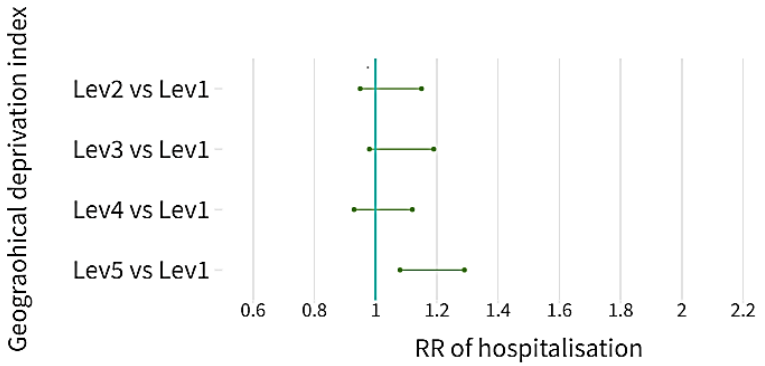


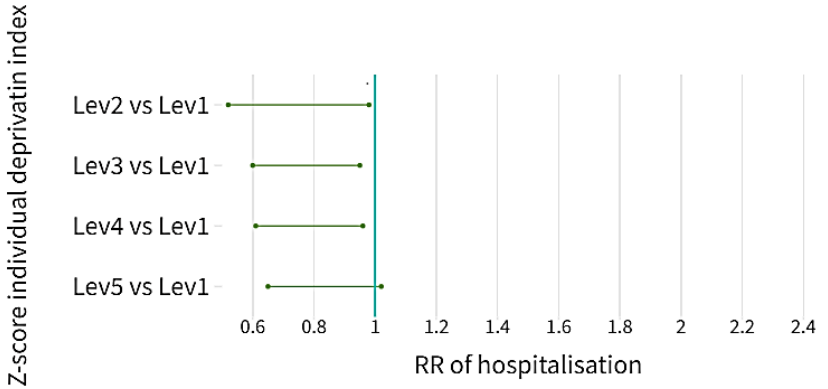


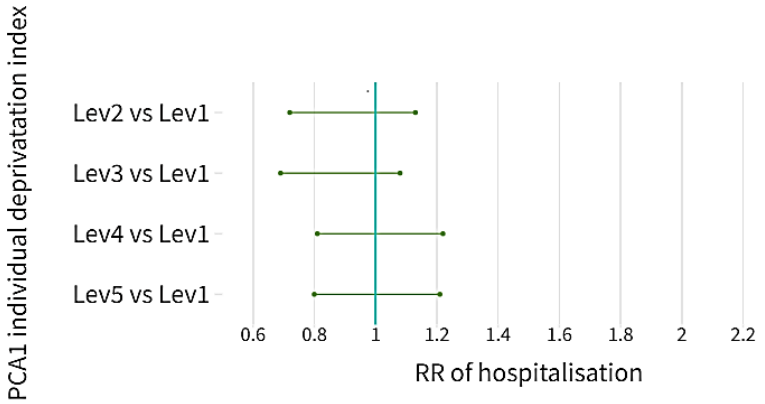


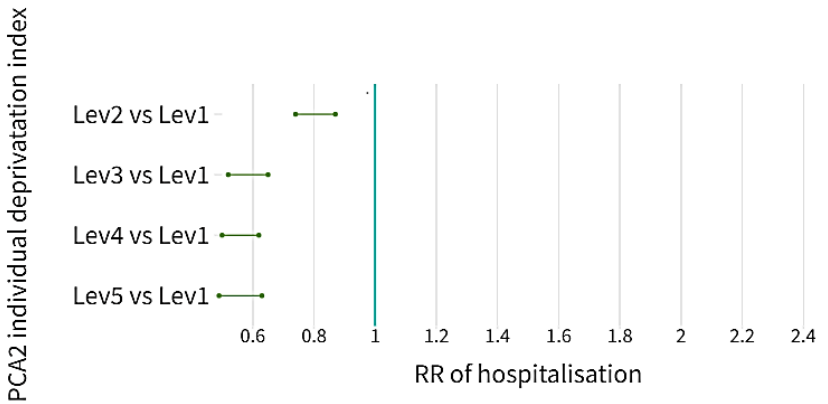


Adj. RR of being hospitalised if positive

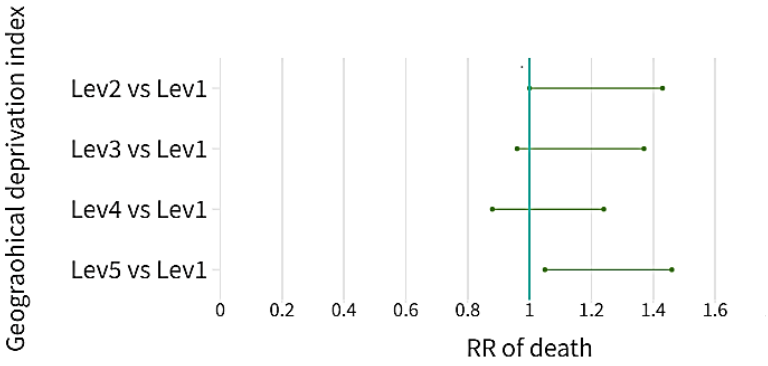


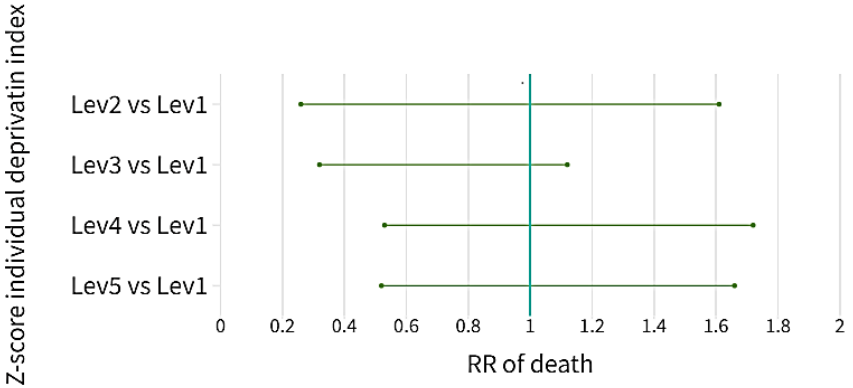


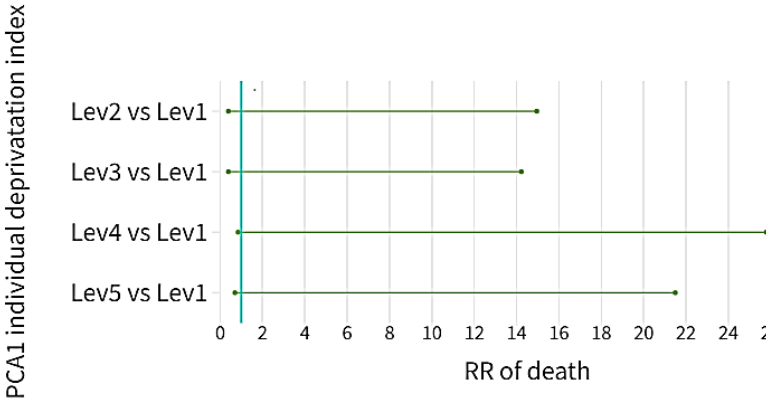


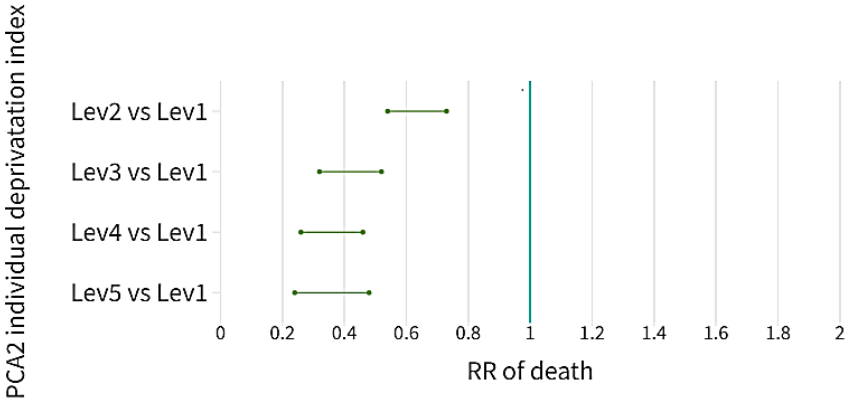


Adj. RR of death if positive





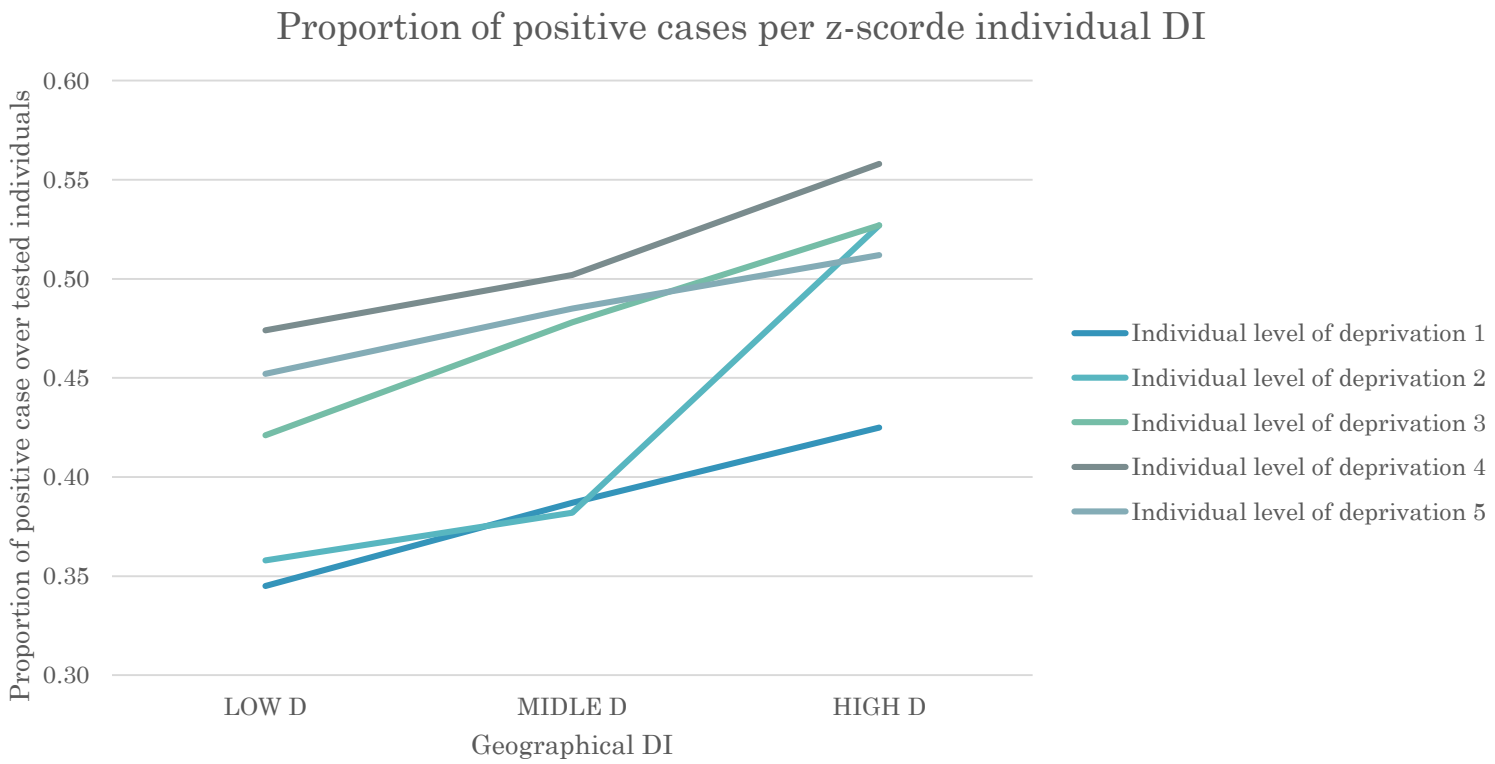




CONCLUSION

- PCA may be an instrument to design individual deprivation index
- People living in socioeconomic deprived area and having a lower SEP have an increased risk of acquiring COVID-19
- Geographical and individual deprivation index give different results when used for assessing the risk of hospitalisation and death
- Sars-CoV-2 is not democratic

Need for hierarchical regression



Census data are not updated anymore

Need to rethink the way we can calculate the socioeconomic deprivation index

UNIVERSITÀ DI PISA

SCUOLA NORMALE SUPERIORE

Geographical and individual deprivation index to assess the risk of Sars-CoV-2 infection and disease severity in people at socioeconomic disadvantage

Sara Mazzilli, Ph.D. candidate in Data Science

Email: sara.mazzill@gmail.com

Supplemental material

Cross table:

geographical deprivation index X PCA1 individual deprivation index

	df_merge$pcadixindi					
df_merge$deprindex	1	2	3	4	5	Row Total
1	4008	3209	2519	2103	1588	13427
	0.299	0.239	0.188	0.157	0.118	0.222
2	2731	3099	2556	2567	2334	13287
	0.206	0.233	0.192	0.193	0.176	0.219
3	2411	2786	2484	2879	2621	13181
	0.183	0.211	0.188	0.218	0.199	0.218
4	1959	2290	2244	2577	2628	11698
	0.167	0.196	0.192	0.220	0.225	0.193
5	1158	1418	1616	2048	2755	8995
	0.129	0.158	0.180	0.228	0.306	0.148
Column Total	12267	12802	11419	12174	11926	60588

Supplemental material

Cross table:

geographical deprivation index X PCA2 individual deprivation index

	df_merge2$pcadix2					
df_merge2$deprindex	1	2	3	4	5	Row Total
1	6332	6033	6815	6102	6660	31942
	0.198	0.189	0.213	0.191	0.209	0.188
2	6233	6049	7051	7092	5534	31959
	0.195	0.189	0.221	0.222	0.173	0.188
3	6638	6552	7600	7653	5430	33873
	0.196	0.193	0.224	0.226	0.160	0.199
4	6952	7214	8367	8287	5589	36409
	0.191	0.198	0.230	0.228	0.154	0.214
5	7891	8047	7890	7552	4258	35638
	0.221	0.226	0.221	0.212	0.119	0.210
Column Total	34046	33895	37723	36686	27471	169821

Supplemental material

Cross table:

geographical deprivation index X z-score individual deprivation index

	df_merge2$qindi					
df_merge2$deprindex	1	2	3	4	5	Row Total
1	2628	1936	4408	2351	2028	13351
	0.197	0.145	0.330	0.176	0.152	0.222
2	1648	1698	4307	2830	2736	13219
	0.125	0.128	0.326	0.214	0.207	0.220
3	1427	1535	4013	3031	3084	13090
	0.109	0.117	0.307	0.232	0.236	0.218
4	1146	1312	3463	2764	2911	11596
	0.099	0.113	0.299	0.238	0.251	0.193
5	659	765	2283	2121	3076	8904
	0.074	0.086	0.256	0.238	0.345	0.148
Column Total	7508	7246	18474	13097	13835	60160

References

1. Belanger MJ, Hill MA, Angelidi AM, Dalamaga M, Sowers JR, Mantzoros CS, et al. Covid-19 and Disparities in Nutrition and Obesity. N Engl J Med. 2020;69(1):10–2.

2. Horton R. Offline: COVID-19 is not a pandemic. Lancet [Internet]. 2020;396(10255):874. Available from: http://dx.doi.org/10.1016/S0140-6736(20)32000-6

3. Rosano A, Pacelli B, Zengarini N, Costa G, Cislaghi C, Caranci N. Aggiornamento e revisione dell ' indice di deprivazione italiano 2011 a livello di sezione di censimento Update and review of the 2011 Italian deprivation index calculated at the census section level. 2020;44:162–70.

4. Boylan JM, Robert SA. Neighborhood SES is particularly important to the cardiovascular health of low SES individuals. Soc Sci Med. 2017;60–8.

5. Evans MK. Covid's Color Line — Infectious Disease, Inequity, and Racial Justice Michele. N Engl J Med. 2020;408–10.

6. Mateo-Urdiales A, Fabiani M, Rosano A, Vescio MF, Del Manso M, Bella A, et al. Socioeconomic patterns and COVID-19 outcomes before, during and after the lockdown in Italy (2020). Heal Place [Internet]. 2021;71(March):102642. Available from: https://doi.org/10.1016/j.healthplace.2021.102642