Determinants and spatio-temporal changes in morbidity curves of Italian population

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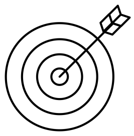
MORBIDITY CURVE

Morbidity is the state of being symptomatic or unhealthy for a disease or condition.

The **morbidity curve** reflects the relationship between age and the probability of being unhealthy for a given population.



Understanding the mechanisms that drive the changes of morbidity curve in order to help local authorities in designing interventions and policies and improve life quality of people.

PASSI SURVEILLANCE SYSTEM

PASSI surveillance system collects sample information on **behavioural** and **risk factors** of the Italian 18-69 y.o. population since 2008. Yearly, around 30k units are interviewed.

It provide detailed information at **local level**, allowing comparisons between the different health local units (ASLs) within the same region, with respect to the following aspects of the individuals:

Health status

Diagnoses
diabetes, kidney failure, respiratory failures, heart diseases, tumors.

Feelings and disabilities
Physical and psycological feelings, abilities,...

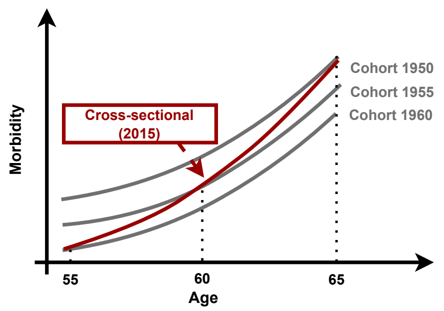
Personal information

Unit information
sex, age, economic status, education, municipality, ...

Habits and lifestyle
Smoking, alcohol consumption, sport activities, ...

Other information: The statistical units belong to different ASLs, of which we have geographical information (regional belonging, position, altitude), as well as historical information regarding the incidence of certain diseases, or their social habits and attitudes.

CROSS-SECTIONAL OR PSEUDO-PANEL?



Cross-sectional

Pros
- simple and used in the literature (Pastore et al., 2022)
- unbiased with respect to the current situation
- uses all the data

Cons
- do not consider any cohort-dependence
- biased with respect to cohort specific curves

Pseudo-panel

Pros
- unbiased with respect to survivals' cohort specific curves
- easier to account cohort-dependence
- interpretable

Cons
- focus on a limited number of ages
- do not provide directly a snapshot of current situation

THE MODEL

We consider the **morbidity response** variable y_i such that $y_i = 1$ if **at least one chronic disease** was diagnosed, $y_i = 0$ otherwise.

$$y_i \sim Be(\pi_i), \quad \pi_i = \text{logit}(\eta_i), \quad \eta_i = \mathbf{d}_i^\top \gamma^{(a,c)} + \mathbf{z}_i^\top \beta + \mathbf{i}_i^\top \delta$$

$$\mathbf{d}_i = \begin{bmatrix} 1 & x_{ec,i} \end{bmatrix}^\top \quad \mathbf{z}_i = \begin{bmatrix} x_{a,i} & x_{s,i} & x_{ed,i} & x_{sm,i} \end{bmatrix}^\top$$

$$\mathbf{i}_i = \begin{bmatrix} x_{a,i}x_{s,i} & x_{ed,i}x_{s,i} & x_{sm,i}x_{s,i} & x_{ec,i}x_{s,i} \end{bmatrix}^\top$$

Covariates: x_a: age in years (continuous), x_s: sex at birth(binary) x_{ec}: economic difficulties (binary), x_{ed}: high educational level (binary), x_{sm}: smoker or former smoker (binary).

About dynamic parameters

We consider the A-variate dynamic parameter vectors for a specific cohort c: $\boldsymbol{\gamma}_j^{(c)} = [\gamma_j^{(1,c)}, \dots, \gamma_j^{(A,c)}]^\top$, for $j \in \{0, 1\}$.

We specify a random walk dynamic

$$\boldsymbol{\gamma}_j^{(c)} = \boldsymbol{\gamma}_j^{(c-1)} + \boldsymbol{\xi}_j^{(c)}, \quad \boldsymbol{\xi}_j^{(c)} \sim N_A(0, C^{(j)})$$

and prior for the the starting cohort vector

$$\boldsymbol{\gamma}_j^{(0)} \sim N_A(\beta_j \mathbf{1}, C^{(j)} + p_0 I_A).$$

Prior knowledge on ASL similarities is integrated in the model through the matrix C_j that regulates the prior covariance of the cohort shifts $\boldsymbol{\xi}_j^{(c)} \sim N_A(0, C^{(j)})$.

$$C^{(j)} = \sum_{f=1}^{F} w_f^{(j)} C_f^{(j)} + {\sigma^{(j)}}^2 I_A,$$

$${\sigma^{(j)}}^2 \sim IG(a_\sigma, b_\sigma), \; w_f^{(j)} \sim IG(a_w, b_w)$$

where $C_f^{(j)}$ are covariance matrices such that

$$C_f^{(j)} = \{c_{f;a_1,a_2}^{(j)}\}_{AA},$$

$$c_{f;a_1,a_2}^{(j)} = e^{-\alpha_f^{(j)} d_f(a_1,a_2)}, \; \alpha_f^{(j)} \sim IG(a_\alpha, b_\alpha)$$

with $d_f(a_1, a_2)$ suitable distance measure between ASL a_1 and a_2.

RESULTS

We restrict our analysis to cohorts 1957–1964 and an age span of 49–58 years old.

Regression parameters

Coef.	$\hat\beta_j$ **(s.e.)**	**Coef.**	$\hat\beta_j$ **(s.e.)**
Intercept	−4.68(0.394)	Smoking (yes)	0.41(0.046)
Age	0.06(0.005)	Sex × Age	−0.03(0.007)
Sex (F)	1.87(0.427)	Sex × Ec. Dif.	0.06(0.061)
Ec. Dif. (no)	−0.26(0.044)	Sex × Edu. Level	0.06(0.057)
Edu. Level (high)	−0.49(0.089)	Sex × Smoking	−0.09(0.061)

Factor	$100 \cdot \hat w_f^{(0)}$ **(s.e.)**	%	$100 \cdot \hat w_f^{(1)}$ **(s.e.)**	%
Idiosyncratic	0.72(0.01)	7.6	0.97(0.04)	8.1
Region (Veneto)	0.77(0.01)	8.1	1.44(0.02)	12.1
Geo-traits	1.06(0.02)	11.2	2.19(0.14)	18.3
Pollution	0.99(0.02)	10.1	4.11(0.11)	**34.3**
Cancer risk	3.03(0.09)	**32.1**	1.40(0.02)	11.7
Lifestyle	0.93(0.02)	9.9	1.09(0.02)	9.2

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