Introduction. A socio-economic (SE) deprivation index is a measure that aims to provide an indication of SE hardship and disadvantage in the population. Our aim was constructing 10 Socio-Economic and Health Deprivation Indexes (SEHDI) by means of the same method. This particular method enables these indexes to be used to investigate the relationships between SE inequalities and aspects of health and prevention in the population.

Materials and Methods. Data on the demographic and SE situation of the populations were taken from the 2011 Census at the Census Tract (CT) level (2001 for Rome municipality). To construct the SEHDIs, variables displaying a statistically significant correlation with the SMRs of overall mortality were subjected to a tolerance test of linearity, in order to eliminate collinear variables. The variables selected underwent PCA factor analysis, in order to obtain the factors to be linearly combined into the SEHDI. The final values were scaled from minimum to maximum deprivation, and the quantitative scale was converted into five ordinal normalized population groups. The SEHDIs were validated at the SE level by comparing them with the trends of the main SE indexes used in the 2011 Census (2001 for Rome municipality), and at the health level by comparing them with the trends of some causes of death. Both comparisons were made by means of ANOVA.

Results. The 10 areas considered were: the municipalities of Cagliari, Ferrara, Florence, Foggia, Genoa, Rome, Palermo, Sassari, Siena, and the ULSS 7 Veneto area. For each one, a specific SEHDI was computed and the different variables comprising each index focused on particular aspects of SE and health deprivation at the area level. The SEHDIs showed good percentages of explained variance (from 72.2% to 49.1%) and a linear distribution of the main statistical SE indices and of overall mortality in each area; these findings were in line with the literature on the relationship between the SE condition and health status of the population. The distribution of cause-specific mortality across the SEHDIs deprivation clusters is analyzed in other articles, which deal with the findings of the study in each area.

Conclusions. The SEHDI showed good ability to identify the elements of SE inequalities that impact on the health conditions of populations; to depict the distribution of causes of death that are sensitive to SE differences concerning aspects of the social and family support structure. From a public health perspective, these results are relevant because they enable interventions of health promotion and prevention to be implemented on the basis of the characteristics that define deprivation groups.
Materials and methods

Materials

Data on the demographic and socio-economic situation of the populations involved in the study were taken from the 2011 ISTAT Census of Population and Housing (2001 for Rome municipality).

We considered all variables made available publicly by ISTAT on its website [10] (a total of 152), plus a set of variables made available ad hoc for this study (a total of 24). The complete list is presented in Table S1, in the Supplementary Materials section of this article.

For the 10 geographical areas participating in the study (municipalities of Cagliari, Ferrara, Florence, Foggia, Genoa, Rome, Palermo, Sassari, Siena, and the ULSS 7 Veneto area) all the variables were considered at Census Tract (CT) level.

The maps used to produce a geographical representation of the indexes were taken from the ISTAT website in shapefile format; the reference system for representing the coordinates is the ED 1950 UTM Zone 32n [10].

To select the ISTAT variables composing the SEHDIs, we collected data on observed deaths due to all causes, at the CT level, in the 5-year period centered around 2011 (year of the Census; 2001 for Rome municipality), i.e. the period 2009-2013.

To validate the SEHDIs, we collected data on observed deaths (again at the CT level), broken down according to the main causes and to causes concerning the respiratory system (particularly relevant for the study) in the 5-year period 2009-2013. The complete list is shown in Table I, in which the observation periods and any local changes in these (depending on local updating of mortality data) are also indicated.

Collection of mortality data was enabled by collaboration among Municipalities, Regional Statistical Offices and, where present, Regional Mortality Registries. In some areas, ICD-9 codes were assigned to mortality data; these codes were then translated into ICD-10 codes. Table I also reports the correspondence between the two coding revisions.

Some Operating Units adopted slightly different observation periods, depending on the availability of the data. However, it was deemed that these differences would not compromise the reliability of the final result, as they were always close to the period in which the demographic and socio-economic data of the Census were gathered.

Methods

To construct the SEHDI, a consolidated method was implemented in every area [4]; this used a combination of bivariate and multivariate statistical techniques [11].

The variables from the Census were first examined in order to eliminate any outliers in the data; they were then converted into percentages of the total population. Subsequently, all the percentages obtained were correlated with the general mortality rate in each area, standardized by age on a regional basis (Standard Mortality Rates - SMR). Correlations were computed by means of the Pearson correlation index, with the statistical significance of the correlation being set at \( p < 0.05 \).

After this procedure, only the variables that were statistically significantly correlated with the SMRs were considered. A tolerance test of linearity was applied (statistical significance at \( p < 0.05 \)), in order to eliminate all the ISTAT variables that were excessively collinear (level of tolerance \( p < 0.001 \)) [11].

A Principal Component factor Analysis (PCA) was then carried out on the variables selected (with varimax rotation of the components, in order to orthogonalize them and make them independent of each other). Only components with eigenvalues \( \geq 1 \) were considered [11]. These components expressed a substantial part of the variance, i.e. the variability of the distribution of the socio-demographic characteristics of the population observed, and were therefore the basic elements for the final computation of the SEHDI.

The SEHDI was calculated as a linear combination of factors coming from the PCA. The variable obtained was

| Causes of death (observation period: 2009-2013) | ICD-10 | ICD-9 |
|-----------------------------------------------|-------|-------|
| All causes (A00-Y89)                          | 001.0-E999.9 |
| Cardiovascular system (I00-I99)               | 390.0-459.9  |
| Respiratory system (J00-J99)                  | 460.0-519.9  |
| Flu and pneumonia (J10-J18)                   | 480.0-487.9  |
| COPD (J40-J47)                                | 490.0-496.9  |
| Digestive system (K00-K93)                    | 520.0-579.9  |
| Diabetes (E10-E14)                            | 250.0-250.9  |
| All cancers (except non-melanoma skin cancers) (C00-C43, C46-C95) | 140.0-172.9,176.0-208.9 |
| Upper aero-digestive tracts cancers (C00-C15) | 140.0-150.9  |
| Stomach cancers (C16)                         | 151.0-151.9  |
| Colorectal and intestinal cancers, not otherwise specified (C18-C21, C26.0) | 153.0-154.9, 159.0  |
| Lung cancers (C33-C34)                        | 162.0-162.9  |
| Female breast cancers (C50)                   | 174.0-174.9  |
| Prostate cancers (C61)                        | 185       |

1 Different periods for the following areas: Cagliari: 2013-2015 Palermo: 2009-2016; Ferrara: 2010-2015 Sassari: 2013-2015.
The local socio-economic health deprivation index: methods and results

In the literature on the relationships between socio-economic differences, in which the aspects of socio-economic inequalities that impact on health status, family and social support structure are also relevant; some causes of death that are particularly relevant to the state of health of the populations involved in the study; employment rates; the same 2001 indexes for Rome municipality; and ii) at the health level, by comparison with the available data on causes of death.

In both comparisons, One-Way ANOVA was used with the F test and linearity test (p < 0.05) [11], in order to assess whether the trends yielded by the ordinal version of the index corresponded adequately to what is known in the literature on the relationships between socio-economic inequalities and causes of death. In addition to obtaining an adequate validation of all the indices, this procedure also yielded a fairly detailed evaluation of the state of health of the populations involved in the study.

The statistical analyses were conducted by means of SPSS 19.0 and STATA 13.0 software.

Results

For the 10 areas considered, a specific SEHDI was computed. In accordance with the methodology used, each local index comprised variables that focused on specific aspects of socio-economic and health deprivation at the local level. Table II reports the composition of each index.

On PCA, all the indices showed a good percentage of explained variance (from 72.2% to 49.1%), indicating an adequate ability to describe the distribution of deprivation in the population studied. Moreover, in every area, the validation procedures showed a good linear distribution of the main ISTAT socio-economic indexes and of overall mortality; this is in line with the hypothesis underlying this computation method and with the scientific literature on the relationships among the deprivation, general socio-economic condition and health status of a population (Tabs. IIIa, IIIb).

Several analyses were carried out in order to investigate the association between the SEHDI and cause-specific mortality, mainly as a validation tool. In some cases, the findings were discussed in detail by some of the other groups participating in the study (data not shown).

Finally, Table IV reports the distribution of the population in deprivation clusters in every area.

Discussion and conclusions

The indexes calculated in this study cannot be considered “pure” socio-economic deprivation indexes, because they use standardized general mortality as the very first tool for the selection of the Census variables. Indeed, only variables that correlated with overall mortality were included in the indexes. However, they enabled SE inequalities across the different deprivation groups to be assessed, even though connected to their health status.

For example (Tab. II), some aspects that are common to every area distinguish subjects mainly on the basis of their need for social and practical support, and thus, the family structure that may help or hinder prevention or care patterns and the implementation of a healthy lifestyle [15-17]. Other characteristics, such as educational level and/or housing conditions, display a differential impact on stratification by socio-economic conditions from area to area (i.e., they express more or less variance) according to the specific situation of the labor market, of the housing market etc.

These peculiarities makes the SEHDI particularly suitable for studying the relationship between socio-economic and health aspects (of care, prevention, etc.) in a population (which was exactly the objective of this project). They are therefore indexes that could be defined as “purpose-built” [3-6].

Another important feature that enables them to describe the peculiarities of a specific area efficiently is their territorial detail: the Italian CTs are usually small in demographic terms (around 800 people on average). This characteristic allows us to consider the smallest available area of officially validated demographic and socio-economic information and, at the same time, an area small enough to be able to describe the reference context attributable to individual patients [5, 6], i.e. every person can be described by the demographic and socio-economic characteristics of his/her CT of residence, with a low risk of ecological bias [5, 6].

Starting from these latter considerations, the SEHDI showed:

- good descriptive ability to identify the relevant elements of socio-economic inequalities that impact on the health conditions of the different populations involved in the study;
- good ability to describe health problems related to some causes of death that are particularly relevant to socio-economic differences, in which the aspects of family and social support structure are also relevant;
- good description of the characteristics that underlie the differences in VC across the different deprivation groups.
### Tab. II. Composition of the SEHDI in each area, by 2011 (2001 for Rome municipality) Census variables. SEHDI factors and explained variance.

| Area          | Factors                                      |
|---------------|----------------------------------------------|
| Cagliari (56.4%) | ![Factors](https://example.com/factors.png)  |
| Ferrara (62.3%) | ![Factors](https://example.com/factors.png)  |
| Florence (60.7%) | ![Factors](https://example.com/factors.png)  |
| Foggia (68.9%) | ![Factors](https://example.com/factors.png)  |
| Genoa (72.2%) | ![Factors](https://example.com/factors.png)  |
| Palermo (64.3%) | ![Factors](https://example.com/factors.png)  |
| Rome (59.3%) | ![Factors](https://example.com/factors.png)  |
| Sassari (56.5%) | ![Factors](https://example.com/factors.png)  |
| Siena (63.5%) | ![Factors](https://example.com/factors.png)  |
| ULSS7 - Veneto (49.1%) | ![Factors](https://example.com/factors.png)  |

*Total explained variance.*
### Tab. IIIa. SEHDI general validation.

| Area | Deprivation groups | SMR - Overall mortality | Replacement index | Old-age index | Index of structural dependence | Activity rate | Employment rate | Unemployment rate |
|------|---------------------|-------------------------|-------------------|--------------|--------------------------------|---------------|----------------|------------------|
| Cagliari | High deprivation | 1.93 | 271.98 | 566.28 | 106.07 | 43.26 | 60.79 | 11.59 |
|        | Medium-high deprivation | 1.48 | 265.22 | 572.47 | 61.41 | 49.30 | 59.23 | 12.53 |
|        | Medium deprivation | 1.20 | 219.61 | 301.22 | 54.49 | 52.59 | 60.55 | 11.32 |
|        | Medium-low deprivation | 0.76 | 206.15 | 242.88 | 50.81 | 51.99 | 59.25 | 12.40 |
|        | Low deprivation | 0.33 | 127.10 | 100.38 | 40.40 | 43.26 | 60.13 | 10.02 |
|        | Total | 1.16 | 223.78 | 311.50 | 58.08 | 51.99 | 60.13 | 11.77 |
|        | Trend | p<0.05 L | NS | NS | NS | NS | NS | NS |
| Ferrara | High deprivation | 2.25 | 243.49 | 633.07 | 144.78 | 40.02 | 68.52 | 6.99 |
|        | Medium-high deprivation | 1.46 | 271.62 | 404.00 | 78.28 | 69.71 | 47.32 | 6.65 |
|        | Medium deprivation | 1.07 | 251.50 | 310.70 | 52.94 | 71.61 | 52.94 | 6.60 |
|        | Medium-low deprivation | 0.82 | 219.24 | 229.42 | 50.72 | 72.52 | 47.32 | 6.47 |
|        | Low deprivation | 0.47 | 152.62 | 104.97 | 34.08 | 75.57 | 57.57 | 4.61 |
|        | Total | 1.20 | 236.09 | 332.27 | 70.21 | 71.57 | 53.28 | 4.99 |
|        | Trend | p<0.05 L | p<0.05 NL | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L |
| Florence | High deprivation | 1.22 | 152.46 | 292.92 | 70.59 | 52.59 | 66.21 | 7.01 |
|        | Medium-high deprivation | 1.04 | 167.14 | 230.77 | 64.89 | 52.16 | 68.14 | 5.58 |
|        | Medium deprivation | 1.10 | 203.88 | 253.72 | 66.32 | 52.22 | 70.77 | 4.60 |
|        | Medium-low deprivation | 1.13 | 262.18 | 274.88 | 64.17 | 53.39 | 72.32 | 4.53 |
|        | Low deprivation | 1.00 | 271.15 | 273.66 | 54.19 | 74.28 | 74.28 | 4.61 |
|        | Total | 1.09 | 211.38 | 259.99 | 63.98 | 53.45 | 70.75 | 4.99 |
|        | Trend | p<0.05 NL | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L |
| Foggia | High deprivation | 0.83 | 139.3 | 135.4 | 53.3 | 44.7 | 45.5 | 11.1 |
|        | Medium-high deprivation | 0.77 | 102.3 | 97.2 | 51.6 | 44.7 | 41.6 | 11.5 |
|        | Medium deprivation | 0.85 | 196.7 | 212.7 | 59.3 | 53.4 | 68.7 | 4.9 |
|        | Medium-low deprivation | 0.79 | 178.4 | 140.6 | 54.2 | 58.6 | 68.9 | 5.4 |
|        | Total | 0.95 | 139.7 | 177.3 | 57.8 | 43.8 | 46.3 | 10.6 |
|        | Trend | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | NS | NS |
| Genoa | High deprivation | 3.40 | 256.3 | 606.0 | 84.7 | 45.6 | 60.0 | 7.7 |
|        | Medium-high deprivation | 1.10 | 208.0 | 346.4 | 72.8 | 46.2 | 64.9 | 6.6 |
|        | Medium deprivation | 1.02 | 203.3 | 261.3 | 69.8 | 49.4 | 65.9 | 5.7 |
|        | Medium-low deprivation | 0.85 | 196.7 | 212.7 | 59.3 | 53.4 | 68.7 | 4.9 |
|        | Low deprivation | 0.79 | 178.4 | 140.6 | 54.2 | 58.6 | 68.9 | 5.4 |
|        | Total | 1.10 | 203.8 | 279.9 | 67.8 | 49.8 | 66.2 | 5.9 |
|        | Trend | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L | p<0.05 L |

L = linear trend; NL = non-linear variation; NS = not statistically significant; NA = not available. Replacement Index = \( \left( \frac{\text{Pop. 60-64 yrs}}{\text{Pop. 15-19 yrs}} \right) \times 100 \); Old-age Index = \( \left( \frac{\text{Pop. 65 yrs+}}{\text{Pop. 0-14 yrs}} \right) \times 100 \); Structural Dependency Index = \( \left( \frac{\text{Pop. 0-14 yrs} + \text{Pop. 65 yrs+}}{\text{Pop. 15-64 yrs}} \right) \times 100 \); Activity Rate = \( \left( \frac{\text{Work Force 15-64 yrs}}{\text{Pop. 15-64 yrs}} \right) \times 100 \); Employment Rate = \( \left( \frac{\text{Employed 15+ yrs}}{\text{Pop. 15+ yrs}} \right) \times 100 \); Unemployment rate = \( \left( \frac{\text{Unemployed 15+ yrs}}{\text{Work Force 15+ yrs}} \right) \times 100 \).
| Area       | Deprivation groups | SMR - Overall mortality | Replacement index | Old-age index | Index of structural dependence | Activity rate | Employment rate | Unemployment rate |
|------------|--------------------|-------------------------|-------------------|---------------|--------------------------------|---------------|----------------|------------------|
| Palermo    | High deprivation   | 1.02                    | 132.62            | 234.06        | 90.61                          | 58.70         | 41.12          | 13.24            |
|            | Medium-high        | 1.04                    | 127.95            | 173.27        | 60.86                          | 43.48         | 42.11          | 12.10            |
|            | Medium deprivation | 1.02                    | 125.02            | 143.57        | 51.31                          | 47.43         | 46.48          | 10.71            |
|            | Medium-low         | 0.95                    | 122.47            | 115.85        | 41.47                          | 51.50         | 48.49          | 10.02            |
|            | Low deprivation    | 0.96                    | 115.38            | 100.44        | 29.98                          | 58.37         | 54.28          | 9.55             |
| Total      |                    | 1.00                    | 124.52            | 142.80        | 50.72                          | 48.16         | 46.52          | 10.82            |
| Trend      |                    |                         |                   |               |                                |               |                |                  |
|            | High deprivation   | 1.53                    | 296.98            | 323.60        | 91.42                          | 46.75         | 53.14          | 10.33            |
|            | Medium-high        | 1.23                    | 236.64            | 217.12        | 53.37                          | 49.69         | 58.20          | 8.17             |
|            | Medium deprivation | 1.05                    | 176.50            | 163.71        | 48.17                          | 51.71         | 58.65          | 7.26             |
|            | Medium-low         | 0.88                    | 129.21            | 122.97        | 41.94                          | 53.82         | 58.23          | 6.35             |
|            | Low deprivation    | 0.67                    | 92.96             | 110.51        | 31.74                          | 53.29         | 54.89          | 5.46             |
| Total      |                    | 1.08                    | 184.10            | 176.48        | 47.96                          | 51.27         | 57.75          | 7.42             |
| Trend      |                    |                         |                   |               |                                |               |                |                  |
|            | High deprivation   | NA                      | 138.21            | 284.73        | 94.86                          | 43.54         | 48.89          | 14.34            |
|            | Medium-high        | NA                      | 163.46            | 245.58        | 56.59                          | 50.26         | 54.75          | 13.54            |
|            | Medium deprivation | NA                      | 184.64            | 249.63        | 51.95                          | 51.63         | 56.66          | 12.82            |
|            | Medium-low         | NA                      | 152.84            | 148.52        | 40.16                          | 57.86         | 58.52          | 12.10            |
|            | Low deprivation    | NA                      | 150.81            | 182.59        | 59.86                          | 63.15         | 65.78          | 10.06            |
| Total      |                    | NA                      | 172.04            | 242.04        | 57.24                          | 51.56         | 56.08          | 12.88            |
| Trend      |                    |                         |                   |               |                                |               |                |                  |
|            | High deprivation   | 1.29                    | 189.7             | 524.6         | 70.1                           | 61.7          | 83.0           | 7.8              |
|            | Medium-high        | 1.25                    | 271.8             | 336.6         | 67.8                           | 55.2          | 73.8           | 6.4              |
|            | Medium deprivation | 0.98                    | 249.6             | 317.4         | 65.0                           | 53.0          | 72.1           | 3.8              |
|            | Medium-low         | 0.92                    | 203.3             | 264.7         | 66.9                           | 50.5          | 69.0           | 2.8              |
|            | Low deprivation    | 0.80                    | 220.2             | 165.2         | 60.3                           | 49.7          | 61.4           | 1.2              |
| Total      |                    | 1.02                    | 237.3             | 317.6         | 65.9                           | 53.5          | 71.9           | 4.3              |
| Trend      |                    |                         |                   |               |                                |               |                |                  |
|            | High deprivation   | 1.02                    | 133.8             | 133.5         | 53.8                           | 56.1          | 67.9           | 6.2              |
|            | Medium-high        | 1.01                    | 114.0             | 121.9         | 52.7                           | 57.5          | 69.2           | 5.2              |
|            | Medium deprivation | 0.97                    | 135.1             | 146.1         | 56.2                           | 54.0          | 67.5           | 4.9              |
|            | Medium-low         | 0.90                    | 144.1             | 194.8         | 60.5                           | 51.5          | 66.6           | 5.8              |
|            | Low deprivation    | 0.87                    | 142.2             | 157.6         | 55.4                           | 54.5          | 69.0           | 4.1              |
| Total      |                    | 0.96                    | 131.5             | 142.1         | 55.2                           | 55.0          | 68.1           | 5.1              |

L = linear trend; NL = non-linear variation; NS = not statistically significant; NA = not available. Replacement Index = (Pop. 60-64 yrs) / (Pop. 15-19 yrs)*100; Old-age Index = (Pop. 65+ yrs) / (Pop. 0-14 yrs)*100; Structural Dependency Index = (Pop. 0-14 yrs + Pop. 65+ yrs) / (Pop. 15-64 yrs)*100; Activity Rate = (Work Force 15-64 yrs / Pop. 15-64 yrs) * 100; Employment Rate = (Employed 15+ yrs / Pop. 15+ yrs) * 100; Unemployment rate = (Unemployed 15+ yrs / Work Force 15+ yrs) * 100.
From a public health perspective, these results are very relevant, as they enable interventions of health promotion and prevention to be oriented on the basis of the characteristics that define the deprivation groups.

However, there are two limits to this procedure. The first is the potential ecological bias, albeit reduced owing to the small dimensions of the Italian CTs [2, 6]. Indeed, studies that apply synthetic multi-factorial descriptions of small geographical areas to single individuals must be evaluated in the light of good knowledge of the areas considered, in order to avoid mis-attribution of peculiarities and, consequently, any misdirected health and social policy. From this point of view, it must be remembered that local indicators, such these, are tools useful only to local policy-makers, who should have a good knowledge of the area they administer.

The second limit is more of a characteristic of these indexes than a flaw: in interpreting the territorial descrip-

| Area  | Deprivation groups | 2011 resident population | %  | Area  | Deprivation groups | 2011 resident population (2001 for Rome municipality) | %  |
|-------|--------------------|--------------------------|----|-------|--------------------|-----------------------------------------------------|----|
| Cagliari | High deprivation | 4369 | 2.9 | Palermo | High deprivation | 17705 | 2.7 |
|        | Medium-high deprivation | 28603 | 19.1 |        | Medium-high deprivation | 104476 | 15.9 |
|        | Medium deprivation | 79276 | 53.0 |        | Medium deprivation | 299408 | 45.6 |
|        | Medium-low deprivation | 35009 | 23.4 |        | Medium-low deprivation | 213778 | 32.6 |
|        | Low deprivation | 2405 | 1.6 |        | Low deprivation | 20783 | 3.2 |
|        | Total | 149662 | 100.0 |        | Total | 656150 | 100.0 |
| Ferrara | High deprivation | 14986 | 11.3 |        | High deprivation | 211082 | 8.4 |
|        | Medium-high deprivation | 30682 | 23.1 |        | Medium-high deprivation | 602638 | 24.0 |
|        | Medium deprivation | 49151 | 37.1 |        | Medium deprivation | 1016150 | 40.4 |
|        | Medium-low deprivation | 27858 | 21.0 |        | Medium-low deprivation | 569461 | 22.7 |
|        | Low deprivation | 9668 | 7.4 |        | Low deprivation | 112879 | 4.5 |
|        | Total | 132545 | 100.0 |        | Total | 2512190 | 100.0 |
| Florence | High deprivation | 35471 | 9.4 |        | High deprivation | 9486 | 7.7 |
|        | Medium-high deprivation | 59143 | 16.5 |        | Medium-high deprivation | 15782 | 12.8 |
|        | Medium deprivation | 181077 | 50.6 |        | Medium deprivation | 75391 | 60.9 |
|        | Medium-low deprivation | 50414 | 14.1 |        | Medium-low deprivation | 13374 | 10.8 |
|        | Low deprivation | 53849 | 9.5 |        | Low deprivation | 9756 | 7.9 |
|        | Total | 357954 | 100.0 |        | Total | 123769 | 100.0 |
| Foggia | High deprivation | 10721 | 7.3 |        | High deprivation | 2599 | 5.0 |
|        | Medium-high deprivation | 47794 | 32.7 |        | Medium-high deprivation | 9324 | 18.0 |
|        | Medium deprivation | 57617 | 39.5 |        | Medium deprivation | 27126 | 52.4 |
|        | Medium-low deprivation | 20288 | 13.9 |        | Medium-low deprivation | 9914 | 19.2 |
|        | Low deprivation | 9591 | 6.6 |        | Low deprivation | 2762 | 5.3 |
|        | Total | 146011 | 100.0 |        | Total | 51725 | 100.0 |
| Genoa | High deprivation | 17380 | 3.0 |        | High deprivation | 19016 | 8.8 |
|        | Medium-high deprivation | 168228 | 28.7 |        | Medium-high deprivation | 49180 | 22.7 |
|        | Medium deprivation | 268861 | 45.9 |        | Medium deprivation | 99721 | 46.1 |
|        | Medium-low deprivation | 120169 | 20.5 |        | Medium-low deprivation | 34428 | 15.9 |
|        | Low deprivation | 11542 | 2.0 |        | Low deprivation | 14072 | 6.5 |
|        | Total | 586180 | 100.0 |        | Total | 216417 | 100.0 |
tion yielded by this method, it must be borne in mind that the concept of deprivation extends to social and health aspects, and does not only concern mere material deprivation [4, 7-9]. This implies that the interpretation must consider aspects linked to the social support and cultural resources that people can count on in order to understand messages, specifically prevention messages, to adopt good practices and correct lifestyles, early therapeutic actions in charge etc.

Bearing in mind these two limitations can improve the role of these local indices in guiding interventions and using resources more efficiently.

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Conflict of interest statement

None declared.

Authors’ contributions

RL developed method, data organization, quality check and analyses. MV performed text revision and references. Both the authors contributed to the text writing.

References

[1] Townsend P. Deprivation. Journal of Social Policy 1987;16:125-46.
[2] Nolan BT, Whelan CT. Resources, deprivation and poverty. Oxford: Oxford University Press 1996.
[3] Caranci N, Biggeri A, Grisotto L, Pacelli B, Spadea T, Costa G. The Italian deprivation index at census block level: definition, description and association with general mortality. Epidemiol Prev 2010;34:167-76.
[4] Lillini R, Quaglia A, Vercelli M. Liguria Region Mortality Registry. Building of a local deprivation index to measure the health status in the Liguria Region. Epidemiol Prev 2012;36:180-7.
[5] Woods LM, Rachet B, Coleman MP. Choice of geographic unit influences socioeconomic inequalities in breast cancer survival. Br J Cancer 2005;92:1279-82.
[6] Cadum E, Costa G, Biggeri A, Martuzzi M. Deprivation and mortality: a deprivation index suitable for geographical analysis of inequalities. Epidemiol Prev 1999;23:175-87.
[7] Quaglia A, Lillini R, Casella C, Giachero G, Izzotti A, Vercelli M. Liguria Region Cancer Registry. The combined effect of age and socioeconomic status on breast cancer survival. Crit Rev Oncol Hematol 2011;77:210-20.
[8] Vercelli M, Lillini R, Quaglia A. Methods to study the deprivation and its relationships with cancer incidence in a local area. CancerStat Umbria 2014;5:621-37.
[9] Vercelli M, Lillini R, Quaglia A. Deprivation and cancer incidence in a de-industrialised and highly ageing area. CancerStat Umbria 2014;5:638-61.
[10] ISTAT. Basi territoriali e variabili censuarie. 2014. www. istat.it/it/archivio/104317 (last checked 09/10/2018).
[11] Tabachnick BG, Fidell LS. Using multivariate statistics. Boston, MA: Allyn and Bacon 2001.
[12] Noble M, Wright G, Smith G, Dibben C. Measuring multiple deprivation at the small-area level. Environment and Planning A: Economy and Space 2006;38:169-85.
[13] Morgan O, Baker A. Measuring deprivation in England and Wales using 2001 Carstairs scores. Health Stat Q 2006;31:28-33.
[14] Agnelli JP, Cadeiras M, Tabak EG, Turner CV, Vanden-Ejinden E. Clustering and classification through normalizing flows in feature space. Multiscale Model Simul 2010;8:1784-802.
[15] López-Cerdá E, Carmona-Torres JM, Rodríguez-Borrego MA. Social support for elderly people over 65 years in Spain. Int Nurs Rev 2018 [Epub ahead of print].
[16] Andrew MK, Dupuis-Blanchard S, Maxwell C, Giguere A, Keefe J, Rockwood K, St John P. Social and societal implications of frailty, including impact on Canadian healthcare systems. J Frailty Aging 2018;7:217-23.
[17] Yang L, Nan H, Liang J, Chan YH, Chan L, Sum RW, Kwan YM, Zhou F, Meng H, Suen LK. Influenza vaccination in older people with diabetes and their household contacts. Vaccine 2017;35:889-96.

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