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Measuring Progress in Health through Deprivation Indexes[7]

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Abstract: Progress in health is usually measured by means of indicators of health status such as premature mortality ratio or life expectancy. There is evidence that in more developed countries, despite general health improvement, inequalities in health among individuals are worsening. Most of these inequalities, however, could be avoided because they are due to socioeconomic conditions, depending on the relation between socioeconomic conditions and health largely proved in literature.

The main conclusion is that measuring progress in health should not be limited to health status, but should also consider health inequalities. The suggested method to quantify them is to follow the deprivation index approach. The analysis is applied to a case study where the comparison between health statuses of two Census periods is completed by estimating also the variability in health inequalities, proxied by the gradients in Standard Mortality Ratios [SMRs] among small areas with different socioeconomic conditions. The latter are quantified by an index of material deprivation previously developed based on 1991 and 2001 Census data.

JEL Classifications: I10, C40, C81
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1. Background

The particular point of view of this paper is that progress in health means not only improving the average health status of the population but also avoiding health inequalities within the population itself. This is especially relevant in industrialized countries where, despite generally good health status, significant inequalities still exist among people and gradients in mortality rates between groups differentiated by a range of socioeconomic conditions can be documented. This is also true for Italy, where health inequalities do not depend on different health care delivery conditions, because each citizen is automatically enrolled in the National Health Service and anyone in need of health care can openly have access to it.

Health status, however, depends not only on resources devoted to health care delivery but also,

[7] All the paper is common, however, sections 1, 4, 5 are to be attributed to Angela Testi and sections 2, 3, are to be attributed to Enrico Ivaldi.

and much more strongly (about 7-8 times), on resources devoted to education and lifestyle, on socioeconomic conditions in general. The existence of an inverse association between socio- economic status and the incidence of most diseases is well-established in literature, both from an economic [1-2], as well as an epidemiological [3-4] and public health[5-6] point of view. Health inequalities, therefore, arise due to the different circumstances in which people grow, work, and age. The conditions in which people live and die are, in turn, shaped by political, social, and economic forces. As a consequence, most of the detected health inequalities could be avoided by employing active social policies, as literature points out [7-9]. From a policy point of view this means that in developed countries, improving health does not require to increase financing in the healthcare sector but, instead, in the social and educational ones. Progress in health in fact should not be limited to the increase of health status indicators, but should also eliminate health inequalities due to socioeconomic conditions.

The relationship between socioeconomic factors and health inequality is proven at the individual level [10], or geographical area [11]. In this paper, we follow the second branch of the literature, i.e. studies on deprivation relating the state of disadvantage suffered by an individual with the living conditions of the area where the individual resides. Deprivation indexes are quite simple, inexpensive tools because they are generally made up of census indicators, which are easily available, combined using different types of statistical analysis[5]. For these reasons, deprivation indexes after being developed in the United Kingdom with the seminal works of Jarman[11], Townsend[12] and Carstairs[3], were widely used in epidemiological and public health studies[13], spreading across many other countries in the world, such as Scotland[14], Spain[15], Ireland [16], Netherlands [17], New Zealand [18] and Italy [19].

Deprivation indexes are somewhat different as to the choice of the variables taken into consideration, the statistical methods of treating the variables and the way of building the index. While they are usually aimed at defining criteria to allocate resources[20-22] among areas, in this paper we utilize them to quantify health inequalities trends and, thereby, possible progress in health. The suggested method is applied to a case study, which is progress in health in an Italian city, Genoa, between two Census periods.

2. Methods

Measuring health progress by avoidable health inequalities requires facing three methodological aspects. The first is how to measure socioeconomic conditions. The second to quantify their impact on health inequalities and the third how can inter-temporal comparison be made in order to detect whether health inequalities increase or lower.

Socioeconomic conditions are generally very difficult to be measured at an individual level[10]. Consequently, we proxy the unknown individual characteristics with an index of deprivation of the area where the individual lives to identify an "environmental" component underlying social differences among individuals. Measuring deprivation on geographic areas rather than on individual conditions means to assume, implicitly, that all people living in the same area are equal. Therefore, special attention must be paid to appropriately interpreting the results since "not all deprived people live in deprived wards, just as not everybody in a ward ranked as deprived are deprived themselves" [22]. However, recurring to deprivation indexes, i.e. pointing out the close, existing relationship between deprivation and territory[23] may be, questionable for different reasons. Some Authors, maintain that the environmental effect is not so important and in all cases many other variables are necessary to quantify it and not only the census ones[24]. Other Authors, warn against the risk of ecological fallacy[25], that is an error in the interpretation of statistical data when inferences about the characteristics of individuals are based solely upon aggregate statistics collected for the group to which those individuals belong.

The validity of the environmental effect is usually assumed[5] for territories defined as "small areas"[3, 11, 12, 26, 27], but this definition can be interpreted in different ways[28, 29]: in UK, where deprivation indexes were born and more extensively utilized, small areas are commonly identified using electoral wards, consisting of about 2000 households, but there are also proposals to use enumeration districts, i.e. the smallest geographical unit of the census, which would encompass about 200 households[30]. In the present case study the smallest area where census data are available is larger than in UK: they are the so-called Urban Units (UUs), into which the city of Genoa is divided. At the moment UUs represent the smallest areas able to satisfy the need for population homogeneity and data availability at the same time. There are 71 UUs in the city of Genoa (about 610.000 inhabitants): each Unit has an average population of about 8.600 individuals.

Socioeconomic conditions of each UU are measured by an index of deprivation previously developed by Testi et Ivaldi[31] - Genoa Index of Deprivation (GDI). The Index requires four census variables chosen after explorative factorial analysis[8, 32]: “unemployment”, “overcrowding”, “ housing ownership”, “low education”.

Unemployment represents a state of economical insecurity and lack of resources; housing ownership could be intended as a proxy for wealth, while overcrowding has been inserted for its potential capacity to synthesize living conditions. The fourth variable, “low education level”, is used as a proxy to represent social position and indirectly gives information about current income. Data were drawn from the Census Data (Statistical and studies Department - Municipality of Genova).

Our deprivation index is, therefore, made up of the following variables:

X_1 = % of unemployed people compared to active;

X_2 = average number of people per room;

X_3 = % of households living in rented houses;

X_4 = % of people with secondary education (8 years) or lower.

Due to the non-normality of original distributions (with the exception of unemployment), the use of a transformation capable of achieving an approximate normal distribution for each variable is required[4,29]. The Box Cox method[33] was used to find an appropriate transformation. This method relies on a family of power transformations given by

$$x(\lambda) = \frac{(x^{\lambda} - 1)}{\lambda} \qquad \lambda \neq 0$$

$$x(\lambda) = \ln(x) \qquad \lambda = 0$$

and it plans, in order to select the value of the parameter λ, to use that value which, given an observations vector $\mathrm{x} = x_1, x_2, \ldots, x_n$, maximizes the logarithm of the likelihood function.

$$f(x, \lambda) = -\frac{n}{2}\ln(\sigma^2_{X(\lambda)}) + (\lambda - 1)\sum_{i=1}^{n}\ln(x_i)$$

Successively, z-scores were calculated for each observation, obtained by subtracting the mean of Genoa from the observed, transformed value and dividing the result by the standard deviation of Genoa.

The final deprivation index GDI is an un-weighted combination of four standardized variables:

$$\text{GDI} = \sum_{i=1}^{4} z_i$$

Where

$$z_1 = \frac{x_1 - \mu_{X_1}}{s_{X_1}},\ z_2 = \frac{x_2 - \mu_{X_2}}{s_{X_2}},\ z_3 = \frac{x_3 - \mu_{X_3}}{s_{X_3}} \text{ and } z_4 = \frac{x_4 - \mu_{X_4}}{s_{X_4}}$$

with μ_{X_i} $(i = 1,\ldots,4)$ and s_{X_i} $(i = 1,\ldots,4)$ respectively represent the means and the standard deviations for the city of Genova.

Note that the value of GDI may be either negative or positive, going from the most deprived areas (larger positive values) to the most affluent ones (larger negative values).

For reporting gradients in health outcome, deprivation scores are commonly grouped into deciles of the range. Other methods of determining the boundaries of classes such as using characteristics of the distribution would not affect substantial changes in the general patterns observed[29] .

So Category 1 identifies less deprived UUs – larger negative values of GDI - and on the contrary, Category 10 contains UUs characterized by strong deprivation – larger positive values of GDI). The deprivation index in each class is the weighted average for the population resident in each category.

The second methodological issue was to quantify the impact of socioeconomic conditions on health inequalities. This is an important step aimed at validating the deprivation index itself, even if in some papers this aspect seem to be lacking. It is, however, a crucial aspect because each situation requires its particular index, as factors affecting health may be different depending on the particular context[3,9] .

The index validation requires to choose how to measure health, both health status and health inequalities. Health status was evaluated as the risk of premature death (<65 years) proxied by the Standardized Mortality Ratios (SMRs) for all causes. SMRs are computed as the ratio between the observed deaths and the expected ones, i.e. the deaths that would have happened if each area had the same risk condition of the whole town. Death records analyzed in this paper are collected from the Mortality Registry of Genoa (http://registri.istge.it/). In each case, a three-year average was carried out. Pearson Correlation index between GDI and SMR, - that measures the percentage of health condition variation due to socioeconomic conditions - is used to determine how much socioeconomic conditions, as proxied by GDI, affect health status.

Health inequalities can be quantified as the difference between premature mortality risk in the most affluent areas of the city and the same risk in the most deprived ones. This means computing SMR for each large category of deprivation. We expect that SMR is >1 for most deprived ones and <1 for the most affluent, as SMR=1 means that the deprivation category does not influence the premature mortality risk.

The third point is how to detect variability in time, assessing the relationship between premature mortality and deprivation over time (the inter-censal period 1991-2001). The novelty of our solution with respect to the existing literature[34] is to implement a further standardization, because, even if the two series of indexes are the sum of standardized variables, they are not themselves standardized variables. We have obtained two new indexes, respectively GDI 1991(s) and GDI 2001(s) that can be compared across the period.

3. Results

In Table 1 data on health status in the city of Genoa are presented with reference to premature deaths for the two census years 1991 and 2001.

Table 1: Health status in Genoa 1991, 2001

Premature death per 100,000 inhabitants	**1991**	**2001**
Number of death under 65 years	1,590	1,147
Population under 65 years	528,369	460,074
ratio/100,000 inhabitants	300.93	249.31

GDI(s) for the two Census periods and for all small areas (UUs) of the city of Genoa are depicted in Figure 1. On the x-axis UUs are ranked from the more affluent to the more deprived one. The regular line shows the corresponding values of GDI(s) in 1991. The other, more irregular points, represent the GDI(s) values in 2001 for the same UU. There are, however, some differences. In particular, improvement in socioeconomic conditions is detected by a shift downwards remember that negative GDI(s) measure affluent conditions), whereas an upwards shift denotes that socioeconomic conditions are worsening. Variation is measure by the Spearman Rho Coefficient amounting at 0.959 (Figure 1).

In Table 2 the Pearson Correlation between GDI(s) and SMR is reported to measure how much of the premature death risk is due to socioeconomic conditions.

Table 2: Correlation between GDI(s) and SMR, in 1991 and 2001

	GDI(s) 1991	GDI(s) 2001
Pearson Correlation	0.514	0.622

In Table 3, the GDI(s) are reported for ten deprivation categories. Note that each category contains the same number of people. In the same Table, SMRs for each category is also reported.

Table 3: GDI(s) and SMRs for deprivation categories (population deciles)

Deprivation categories	1	2	3	4	5	6	7	8	9	10
GDI 1991(s)	-1.66	-1.03	-0.59	-0.21	-0.13	0.14	0.34	0.55	0.83	1.51
GDI 2001(s)	-1.66	-1.04	-0.54	-0.30	-0.11	0.15	0.39	0.50	0.76	1.64
SMR 1991-93	0.79	0.91	0.9	1.03	1.03	0.93	0.97	1.07	1.12	1.25
SMR 2001-03	0.79	0.86	0.79	1.01	0.99	0.96	1.00	1.13	1.07	1.38

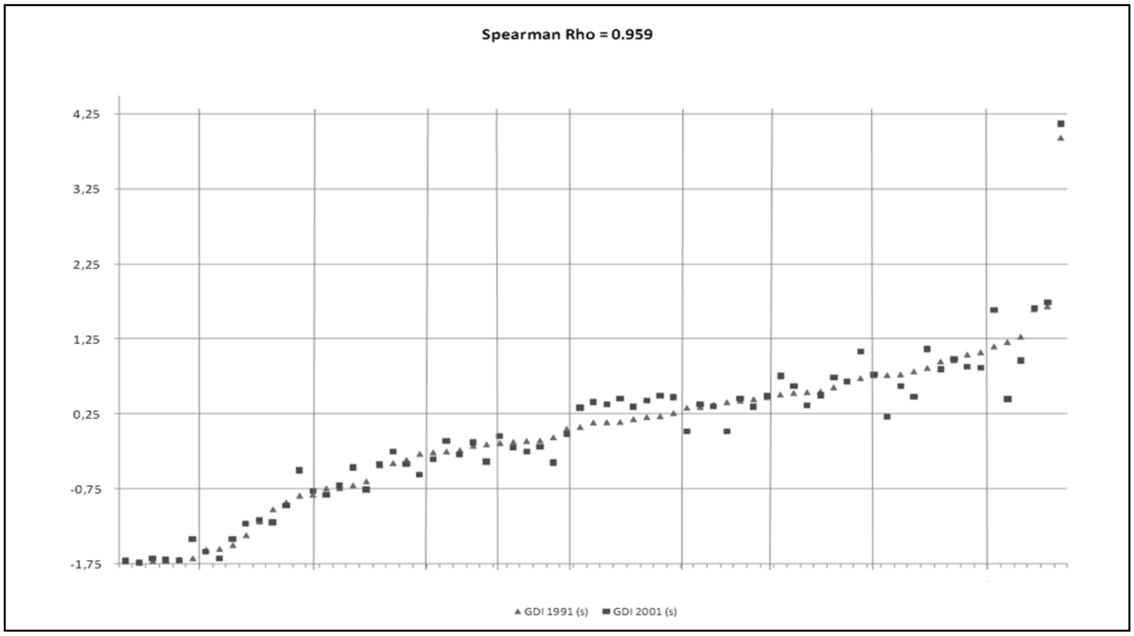

Figure 1: GDI(s) during 1991-2001 (UUs City of Genoa)

4. Discussion

Our case study confirms the literature results that socioeconomic conditions affect health status deeply[34]. In fact, GDI (s) indexes are strongly related to SMRs showing that more than 50% of premature deaths in 1991 and more than 60% in 2001 are due to socioeconomic conditions *coeteris paribus* (Table 2).

It is not easy to conclude if deprivation has worsened or improved in the same period (Figure 1). What we can say is that it is probably the same, on the whole, because the ranking of the GDI(s) is quite similar, as stated by the value of the Spearman Rho 0.959 (Figure 1). This means that only very few UUs change their relative position.

In the same period, however, correlation between health and deprivation has become stronger: health inequalities are explained for the 62% (instead that for the 51%) by socioeconomic conditions that remained approximately the same (Table 2), thus giving even more importance to the socioeconomic determinants of health.

In the same period if we refer only to the absolute number of premature deaths it seems that health status is better (Table 1): the number of premature deaths per 100,000 inhabitants <65 has decreased for the whole city of Genoa in the period 1991-2001 from 300 to 249 per 100,000 inhabitants (http://registri.istge.it/).

This is, however, only an apparent improvement, because health inequalities in two Census years (1991 and 2001) have worsened and in particular, for the most deprived categories the risk of premature death has increased dramatically even in a medium-sized city such as Genoa, where economic conditions are quite good and national health system is quite equitable giving access freely to everyone who needs health care. From Table 3 it is possible to compute that in 1991 the difference in SMR between the most deprived category and the most affluent was about 46% and that this difference increased to 59% in 2001. This means that health inequalities due to socioeconomic conditions had increased by more than 50% (from 42 to 64%) in ten years.

5. Conclusions

In this paper we demonstrate how deprivation indexes can be useful not only for epidemiological studies or resources allocation purposes, but also for evaluating progress in health. In particular, we use an index of deprivation previously developed by the Authors [31] - Genoa Index of Deprivation.

Focusing on health inequalities may upset the optimistic conclusions that can be drawn merely from absolute mortality ratio. It seems, therefore, that measuring progress in health should not be limited to quantifying absolute change in health, but to checking for avoidable health inequalities, i.e. inequalities due to different socioeconomic conditions.

The case study refers to an Italian city, Genoa, where in ten years health status has apparently improved but health inequalities have deepened. The main conclusion is, therefore, that the usual indicators reporting the health status are not appropriate to measure progress in health. A measure of health inequalities should be preferred, that be related with inequalities in socioeconomic conditions. Our results confirm that health inequalities still exist even in good economic conditions and this should be taken into consideration when evaluating progress in society.

It seems, therefore, particularly appropriate the suggestion of the World Health Organization[35], that social justice is not only an ethical issue. It is, however, also an economic one because it affects the way people live as well as their consequent chance of risk of premature death. Social and economic policies have a determining impact on whether human capital can develop its full potential. So, in a certain sense, the natures of the health problems that rich and poor countries have to solve are converging. The development of a society, rich or poor, can be judged by the quality of its population's health and how fairly health is distributed across the social spectrum.

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