RESEARCH ARTICLE

Application of Socio-Economic and Health Deprivation Indices to study the relationships between socio-economic status and disease onset and outcome in a metropolitan area subjected to aging, demographic fall and socio-economic crisis

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Keywords

Metropolitan area • Socioeconomic crisis • Deprivation indices • Mortality by cause • Diseases onset • Diseases outcomes

Summary

Aims. *Genoa is a city affected by a deep economic, demographic and social involution. The association between disease onset and outcome and socioeconomic status (SES) was assessed in the mortality by cause in two periods, using indices referred to the distribution of deprivation in the population defined in a ten-years span (2001 to 2011).*

Material and Methods. *Two Socio-Economic and Health Deprivation Indices (SEHDIs), computed at census tract level (2001 and 2011 Censuses), were applied to analyse the SMRs by cause, age (0-64 and 65+ years) and gender of the five normalised groups of deprivation individuated in the two population distribution. The associations between SES and onset of disease was described in the mortality 2008-11 using the index referred to 2001 population. The second index, referred to 2011 population, described the associations between SES and disease outcomes in the mortality 2009-13. Two ANOVAs evaluated the statistical significance ($p < 0.05$) of differences in death distribution among groups.*

Results. *The population at medium-high deprivation increased in Genoa between 2001 and 2011. The mortality by age and gender showed different trends. Not significant trends (NS) in both periods regarded only the younger (respiratory diseases in both sexes, prostate cancer, diabetes in women). Linearly positives (L↑) trends in both periods were observed only in men (all cancers and lung cancers, overall mortality and cardiovascular diseases in younger, diabetes in older). Not linear trends (NL) in both periods interested both sexes for flu and pneumonia, women for lung cancer, old women for overall mortality and respiratory diseases, old men for colorectal cancers. Instead, L↑ trends in the final phases of disease interest all cancers in the elderly (NS trend at the disease onset), all cancers and breast cancer in young women, diabetes and colorectal cancers in young men (NL trends at the disease onset). On the contrary, L↑ trends at the disease onset and NL trends in the final phases regarded cardiovascular diseases in elderly, overall mortality, respiratory diseases and prostate cancer in old men, diabetes and colorectal cancers in old women. Finally, NL trends at the disease onset regarded colorectal cancers in young women (NS trend in the final phases) and breast cancer in the older (linearly negative trend, L↓, in the final phases).*

Discussion. *Deprivation trends confirmed the literature about populations shifting towards poverty. Aging-linked social risks were revealed, reflecting the weakening of social-health care, which worsened in elderly if alone. Serious problems in younger singles or in the single-parent families arose. Cardiovascular diseases, all cancers and colorectal cancers trends confirmed the advantage of less deprived when diseases are preventable and curable. Prostate and breast cancers trends reflected the rising incidence and increasing problems in care. The need of corrective interventions in social and health policies was emerging, aimed to support in a targeted way a population in an alarming condition of socio-economic deterioration.*

Introduction

This paper describes the relationships between health and Socio-Economic Status (SES) in the population of Genoa city, in order to illustrate the simultaneous effects of aging, demographic fall and socio-economic (SE) involution in a metropolitan area. In a previous article, the changes in demographic and SE situation of Genoa since the Second World War and the capacity of two deprivation indices in describing the evolution of demographic and SE situation in the more recent period were displayed.

The distributions by deprivation clusters of overall mortality and of mortality by cause in two partially overlapping periods, 2008-11 and 2009-13, were analysed. In the two periods the residents were distributed by deprivation clusters applying two Socio-Economic and Health Deprivation Indices (SEHDI) [1, 2]: the first referring to demographic and SE situation at 2001 Census, the second to that at 2011 Census. This allowed to compare the mortality of some pathologies in a population which moved from a state of relative well-being, such that at 2001, to a situation

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of impoverishment, aging and social involution, such that at 2011.
Moreover, due to the long duration of survival of most of the considered diseases, some suggestions about the association between deprivation and disease occurrence determinants could be caught through the analyses by the first index, and some evidences about the association with disease outcomes determinants by the second, thus describing the influence of deprivation in different phases of disease course in the same population.

Materials and methods

The variables concurring to the SEHDIs 2001 and 2011 came from 2001 and 2011 Censuses, respectively [3-4]. The indices were built at Census Tract (CT) level with a methodology already published [1-2]. The CTs of Genoa were classified in five normalised groups at growing deprivation either by SEHDI 2001 and by SEHDI 2011. The choice of a normalised classification was made to respect the usual normal distribution of SE deprivation phenomena in the population [5].
The mortality data of the period 2008-2013 was derived from the ISTAT Database of mortality in Liguria. The data were geo-referred at CT level by the Liguria Region Statistics Office in collaboration with the Statistics Office of Genoa municipality.
The considered causes of death were overall mortality (ICD-10 A00-Y89), diabetes mellitus (E10-E14), cardiovascular diseases (I00-I99), respiratory diseases (J00-J99), overall cancers (C00-C43, C46-C95), colorectal cancer (C18-C21, C26.0), lung cancer (C33-C34), female breast cancer (C50), prostate cancer (C61). Flu and pneumonia (J10-J18) were added to these causes due to their interest in public health [6].
Most of the above causes are long-lasting, in fact the patient often survives on average nearly ten years. Therefore, the affected population should have been presented at both Censuses, residing mostly in the same CT either at the onset, or at the outcome of its disease. If the situation of deprivation of any CT (chosen as proxy of individual deprivation of its resident) changed between Censuses, the disease was associated to different clusters of deprivation in the two periods under analysis, even if the events were the same for three years on six (2009-2011). In this way, hints of the association of disease with deprivation under the same conditions of taken in charge was remarked, stressing the association with the deprivation status at the onset of disease in the first period, and with the outcome of disease in the second.
In a first step the standardised mortality rates (SMRs) by cause and deprivation groups were computed, using the SEHDI 2001 population distribution for the 2008-2011 period and the SEHDI 2011 population distribution for the 2009-2013.
In a second step the SMRs were calculated considering also gender and age (0-64 years and 65 years and more). In each step two ANOVAs with F-test and linear distribution test ($p < 0.05$) were performed to evaluate the statistical significance of differences in death distribution through the SE groups [7].
All the analyses were performed by the statistical software SPSS 19.0 and Stata 13.0.

Results

The changes in the population distribution by SEHDI clusters at 2001 and 2011 Censuses were wide and relevant. The clusters at medium and medium-low deprivation diminished (-7.4% and -2.1%), those at medium-high deprivation notably increased (+8.3%), while those in high deprivation and the ones at low deprivation increased imperceptibly (+0.1% and +0.2%).
Table I compares the general trends (all ages and both sexes) of each cause in the deprivation clusters defined according to SEHDI 2001 in the period 2008-2011, and those of period 2009-2013 in the deprivation clusters defined according to SEHDI 2011.
For each cause, the number of death (OBS) by deprivation group and in all population and the SMRs computed adopting the Liguria region as standard are shown. The statistically significant increase (*) and decrease (°) with respect to Liguria rates are also displayed.
The statistical significance of trend (or its not significance, NS) was calculated, stressing the linearity (L) or not linearity (NL) and the direction of trend (positive ↑, when mortality increased at deprivation growing; negative ↓, when mortality increased at deprivation decreasing).
The overall mortality trends were L↑ in both periods. In 2008-2011, the Genoa total mortality and those of groups from low to medium deprivation were significantly lower than the Liguria rates, while the more deprived groups showed mortality significantly higher.
In 2009-2013, the total mortality and that of deprived groups were significantly higher versus Liguria rates, while the one of richer groups was significantly lower.
Analogously, the trends were L↑ in both periods for diabetes, respiratory diseases and lung cancers. Instead, NL trends characterised flu and pneumonia.
Different behaviours by period were highlighted for cardiovascular diseases, all cancers and colorectal cancers, which trends were NL in the first period and L↑ in the second.
Prostate and breast cancers tendencies changed from L↓ to L↑ between periods.
The trends of mortality by cause, age groups (0-64 years and ≥ 65 years) and gender in the deprivation clusters defined by SEHDI 2001 for 2008-2011, and SEHDI 2011 for 2009-2013 are shown in Table II for the overall mortality and in Table III for the mortality by cause.
NS trends in both periods regarded the respiratory diseases in younger of both sexes, the prostate cancer in younger men, and the diabetes in younger women.
Instead, L↑ trends in both periods were observed for overall mortality and cardiovascular diseases in younger,

Tab. I. Mortality by cause and deprivation in Genoa city. Comparison of 2008-2011 and 2009-2013 trends. Number of death (OBS), Standard Mortality Ratios (SMR) and statistical significance (p).

Deprivation groups	Cause	2008-2011			2009-2013			Cause	2008-2011			2009-2013		
		OBS	SMR	p	OBS	SMR	p		OBS	SMR	p	OBS	SMR	p
High deprivation	OVERALL MORTALITY	1074	1.10	*	2327	1.99	*	ALL CANCERS	281	1.02		473	1.42	*
Medium-high deprivation		7164	1.08	*	12440	1.10	*		1822	0.98	°	3344	1.03	*
Medium deprivation		16595	0.91	°	18042	1.00			4885	0.95	°	4797	0.93	°
Medium-low deprivation		7012	0.91	°	7059	0.87	°		2001	0.92	°	1973	0.85	°
Low deprivation		569	0.92	°	601	0.77	°		164	0.96		155	0.69	°
Total		32414	0.98	°	40469	1.03	*		9153	0.99	°	10742	0.95	°
Trend:		p < 0.05 L↑			p < 0.05 L↑				p < 0.05 NL			p < 0.05 L↑		
High deprivation	DIABETES	52	1.66	*	91	2.43	*	COLORECTAL CANCERS	41	0.98		60	1.60	*
Medium-high deprivation		260	1.21	*	406	1.12	*		297	1.05	*	491	1.34	*
Medium deprivation		509	0.88	°	571	0.99			730	0.94	°	770	1.32	*
Medium-low deprivation		189	0.77	°	193	0.75	°		304	0.92	°	323	1.24	°
Low deprivation		14	0.71	°	25	1.01			21	0.80	°	24	0.95	
Total		1024	0.98	°	1286	1.02			1393	0.99		1668	1.31	*
Trend:		p < 0.05 L↑			p < 0.05 L↑				p < 0.05 NL			p < 0.05 L↑		
High deprivation	CARDIOVASCULAR DISEASES	351	0.99		869	1.99	*	LUNG CANCERS	71	1.31	*	103	1.67	*
Medium-high deprivation		2635	1.07	*	4495	1.07	*		361	0.90	°	748	1.22	*
Medium deprivation		6006	0.91	°	6495	0.97	°		1008	0.97	°	958	0.98	
Medium-low deprivation		2604	0.93	°	2543	0.85	°		386	0.94	°	390	0.88	°
Low deprivation		213	0.98		229	0.80	°		21	0.58	°	29	0.67	°
Total		11809	0.98	°	14631	1.00			1847	0.98	°	2228	1.04	*
Trend:		p < 0.05 NL			p < 0.05 L↑				p < 0.05 L↑			p < 0.05 L↑		
High deprivation	RESPIRATORY DISEASES	71	1.21	*	145	1.82	*	PROSTATE CANCER	8	0.67	°	14	1.14	
Medium-high deprivation		414	1.04	*	772	1.00			69	0.91	°	148	1.19	*
Medium deprivation		1013	0.92	°	1146	0.92	°		194	0.94	°	232	1.15	*
Medium-low deprivation		426	0.92	°	479	0.86	°		91	1.04	*	85	0.94	
Low deprivation		37	1.01		42	0.78			9	1.29	*	4	0.44	°
Total		1961	0.98	°	2584	0.96	°		371	0.99	°	483	1.10	*
Trend:		p < 0.05 L↑			p < 0.05 L↑				p < 0.05 L↓			p< 0.05 L↑		
High deprivation	FLU & PNEUMONIA	17	1.30	*	35	1.99	*	FEMALE BREAST CANCER	18	0.95	°	47	1.96	*
Medium-high deprivation		77	0.86	°	149	0.88			126	0.93	°	236	1.05	
Medium deprivation		227	0.92	°	287	1.06			356	0.95	°	388	1.09	
Medium-low deprivation		114	1.09	*	123	1.01			155	0.96	°	153	0.97	
Low deprivation		7	0.86	°	12	1.03			17	1.33	*	12	0.83	
Total		442	0.97	°	606	1.02			672	0.99	°	836	1.08	*
Trend:		p < 0.05 NL			p < 0.05 NL				p < 0.05 L↓			p < 0.05 L↑		

NOTE: Standardized Mortality Ratios on the Liguria rates. SEHDI: Socio-Economic and Health Deprivation Index (at 2001 and 2011 censuses).
p = test F, p < 0.05: * Significant increasing risk; ° Significant decreasing risk.
Trend: p < 0.05 L↑: linear positive; p < 0.05 L↓: linear negative; p < 0.05 NL: not linear; NS: not significant.

for all cancers and lung cancer in men of both ages, for the diabetes in old men.

NL trends in both periods are displayed by women for lung cancer, by old men for colorectal cancers, by old women for overall mortality and respiratory diseases.

On the contrary, the trends of all cancers in old women were NS at the disease onset but L↑ in the final phases.

NL trends at the disease onset but L↑ in the final phases characterized all cancers and breast cancer in younger women, and diabetes and colorectal cancers in younger men.

In elderly of both sexes the trends of cardiovascular diseases changed from L↑ at the disease onset to NL in the final phases.

Analogously, the total mortality, respiratory diseases and prostate cancer trends in old men, and the diabetes and colorectal cancers in old women changed.

Finally, the trends of colorectal cancers in younger women were NL at the disease onset and NS in the final phases, while the breast cancer trend in old women were NL at the disease onset and L↓ in the final phases.

Discussion

A general observation about results regarded the differences between deprivation trends of younger and older groups, because the younger showed a higher

Tab. II. Trends of overall mortality in Genoa city: comparison of 2008-2011 and 2009-2013 mortality by age, gender and deprivation groups. Number of death (OBS), Standard Mortality Ratios (SMR) and statistical significance (p).

Cause	Clusters	2008-2011 (SEHDI 2001)												2009-2013 (SEHDI 2011)											
		0-64 years - Males			0-64 years -Females			65+ years - Males			65+ years -Females			0-64 years - Males			0-64 years -Females			65+ years - Males			65+ years -Females		
		OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p
OVERALL MORTALITY	HD	148	2.27	*	74	2.46		391	1.38	*	461	1.21	*	133	2.28	*	113	3.20	*	681	1.22	*	1399	1.97	*
	MHD	524	1.31	*	330	1.53	*	2569	1.20	*	3741	1.37	*	777	1.28	*	443	1.26	*	5086	0.96	°	6131	1.03	*
	MD	1030	0.98		639	1.08	*	6709	1.00		8217	1.05	*	1096	1.07	*	698	1.19	*	7329	0.97	°	8916	1.06	*
	MLD	339	0.79	°	205	0.82	°	2841	0.93	°	3627	1.07	*	402	0.84	°	257	0.94		2837	0.95	°	3562	1.08	*
	LD	26	0.77		22	1.09		235	0.90		286	1.10		63	1.23		31	1.11		220	0.97		287	1.30	*
	Total	2067	1.04	*	1270	1.15	*	12745	1.02	*	16332	1.12	*	2471	1.12	*	1542	1.21	*	16153	0.97	°	20295	1.09	*
	Trend	p < 0.05 L↑			p < 0.05 L↑			p < 0.05 L↑			p < 0.05 NL			p < 0.05 L↑			p < 0.05 L↑			p < 0.05 NL			p < 0.05 NL		

NOTE: Standardized Mortality Ratios on the Liguria rates. SEHDI: Socio-Economic and Health Deprivation Index (at 2001 and 2011 censuses).
Clusters: HD: High Deprivation, MHD: Medium-High Deprivation, MD: Medium Deprivation, MLD: Medium-Low Deprivation, LD: Low Deprivation.
p= test F, p<0.05: *= significant increasing risk; °= significant decreasing risk.
Trend: p < 0.05 L↑: linear positive; p < 0.05 L↓: linear negative; p < 0.05 NL: not linear; NS: not significant.

number of positive trends, either in both periods and in the final phases of disease. Moreover, often old women's trends appeared to be worsened more than the men's ones.

The associations observed in the younger age group are interesting. In the latter the low frequency of competitive diseases makes easier to identify the risk determinants, also if SES linked factors.

The campaigns for prevention and early diagnosis in the past were directed more specifically towards the younger age groups and facilitated more timely diagnoses. They were associated with more efficacious treatments and less fatal outcomes, but their effects differed between the deprivation clusters.

The differences might be related to variations in intensity of exposure to the risk factors (like occupational exposure in men), or to different preventive or diagnostic-therapeutic strategies. Women, for example, are more attentive to some beneficial behaviour patterns, like health dietary habits and early prevention.

Furthermore, we must remember that the more lethal diseases, such as lung cancer, enjoy less effective preventive and therapeutic options, showing a more homogeneous distribution of survival among population groups. In fact the care options are limited in the same way for everyone, although exposure to the risk factors is not similar in all individuals. Conversely, when more preventive and therapeutic options at different costs are available, as in the case of prostatic and breast cancers, differences in timely diagnosis and survival duration increase among clusters of population at different deprivation level.

As regards overall mortality in Genoa, it is interesting to observe the change in the ratios of mortality with the Liguria rates between periods. In 2008-11, using the 2001 SEHDI distribution of population, the Genoa total mortality and those of clusters from low to medium deprivation were significantly lower than the Liguria one, while the more deprived groups showed mortalities significantly higher. This testified the welfare of the city with respect to the overall region, related to the presence of most major hospitals into the city and, likely, to the better organisation of taking in charge the patients, particularly the elderly. Moreover, in this period the number of foreigners called to provide aid and assistance at home was increasing [8].

In 2009-13, using the 2011 SEHDI distribution of population, the general mortality and that of the deprived groups resulted significantly higher versus the Liguria one, while the mortality of richer groups were significantly lower. This testified the worsening of general living conditions and of organisation of social and health system, which led to an increasing in the mortality of deprived with respect to the richer groups, the only ones able to utilise own resources to make up for the lacks of the health and welfare system.

Confirming the literature, the SMRs trends were linearly positive in both periods for a lot of diseases strongly associated with deprivation (diabetes, respiratory diseases, and lung cancers) and the worst living

Tab. III. Trends of mortality by cause in Genoa city: comparison of 2008-2011 and 2009-2013 mortality by age, gender and deprivation groups. Number of death (OBS), Standard Mortality Ratios (SMR) and statistical significance (p).

Cause	Clusters	2008-2011 (SEHDI 2001)												2009-2013 (SEHDI 2011)											
		0-64 years - Males			0-64 years -Females			65+ years - Males			65+ years -Females			0-64 years - Males			0-64 years -Females			65+ years - Males			65+ years -Females		
		OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p	OBS	SMR	p
DIABETES MELLITUS	HD	4	2.79		2	3.37		18	2.19	*	28	1.96	*	5	3.64		1	1.71		29	1.72	*	56	2.10	*
	MHD	11	1.26		4	0.94		83	1.33	*	162	1.59	*	17	1.20		10	1.71		162	1.01		217	0.97	
	MD	11	0.48	°	12	1.03		211	1.08		275	0.94		20	0.83		14	1.43		228	1.00		309	0.98	
	MLD	5	0.53	°	3	0.61		77	0.87		104	0.82	°	10	0.89		0	0.00	°	70	0.78	°	113	0.91	
	LD	0	0.00	°	0	0.00	°	6	0.79		8	0.82		0	0.00	°	0	0.00	°	8	1.17		17	2.05	*
	Total	31	0.71	°	21	0.96		395	1.09		577	1.06		52	1.00		25	1.18		497	0.99		712	1.02	
	Trend	p < 0.05 NL			NS			p < 0.05 L↑			p < 0.05 L↑			p < 0.05 L↑			NS			p < 0.05 L↑			p < 0.05 NL		
CARDIOVASCULAR DISEASES	HD	26	2.12	*	10	2.75	*	125	1.31	*	190	1.06		26	2.38	*	12	2.90	*	219	1.17	*	612	1.84	*
	MHD	86	1.15		50	1.92	*	865	1.20	*	1634	1.27	*	133	1.18		55	1.34		1708	0.96	°	2599	0.94	°
	MD	168	0.85	°	63	0.88		2289	1.01		3486	0.95	°	192	1.01		86	1.25		2508	0.99		3709	0.95	°
	MLD	57	0.70	°	27	0.89		1004	0.97		1516	0.94	°	58	0.65		24	0.75		966	0.97		1495	0.97	
	LD	4	0.63		0	0.00	°	97	1.10		112	0.91		11	1.15		2	0.61		75	0.99		141	1.37	*
	Total	341	0.92		150	1.12		4380	1.04	*	6938	1.01		420	1.01		179	1.20	*	5476	0.98		8556	0.99	
	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 NL			p < 0.05 NL		
RESPIRATORY DISEASES	HD	7	4.17	*	1	1.23		31	1.31		32	1.36		2	1.43		3	3.08		55	1.15		85	1.81	*
	MHD	12	1.17		11	1.89		216	1.20	*	175	1.04		26	1.80	*	14	1.44		416	0.91	°	316	0.81	°
	MD	19	0.70		17	1.07		552	0.98		425	0.88	°	19	0.78		14	0.86		584	0.90	°	529	0.96	
	MLD	9	0.81		7	1.03		210	0.82	°	200	0.96		5	0.44	°	9	1.19		246	0.97		219	1.01	
	LD	0	0.00	°	0	0.00	°	17	0.77		20	1.25		2	1.64		0	0.00	°	24	1.24		16	1.10	
	Total	47	0.92		36	1.20		1026	0.98		852	0.95		54	1.02		40	1.14		1325	0.93	°	1165	0.95	
	Trend	NS			NS			p < 0.05 L↑			p < 0.05 NL			NS			NS			p < 0.05 NL			p < 0.05 NL		
OVERALL CANCERS	HD	48	1.75	*	33	1.97	*	110	1.23	*	90	1.01		43	1.77	*	43	2.19	*	193	1.09		194	1.16	*
	MHD	218	1.30	*	152	1.27	*	801	1.19	*	651	1.02		292	1.16	*	232	1.19	*	1584	0.94	°	1236	0.89	°
	MD	468	1.06		352	1.07		2236	1.06	*	1829	1.00		470	1.11	*	376	1.15	*	2128	0.89	°	1823	0.93	°
	MLD	150	0.83	°	123	0.88		931	0.96		797	1.00		173	0.87	°	155	1.02		884	0.94	°	761	0.98	
	LD	10	0.70		21	1.87	*	70	0.85		63	1.03		23	1.09		16	1.04		56	0.78	°	60	1.16	
	Total	894	1.07	*	681	1.11	*	4148	1.06	*	3430	1.00		1001	1.09	*	822	1.16	*	4845	0.92	°	4074	0.94	°
	Trend:	p < 0.05 L↑			p < 0.05 NL			p < 0.05 L↑			NS			p < 0.05 L↑			p < 0.05 L↑			p < 0.05 L↑			p < 0.05 L↑		
COLORECTAL CANCERS	HD	6	2.24		3	1.74		16	1.66		16	1.38		2	0.81		3	1.50		32	1.69	*	23	1.11	
	MHD	17	1.04		21	1.70		139	1.90	*	120	1.44	*	48	1.87	*	27	1.36		213	1.18	*	203	1.17	*
	MD	63	1.46	*	52	1.54	*	301	1.31	*	314	1.32	*	66	1.52	*	50	1.50	°	340	1.33	*	314	1.28	*
	MLD	20	1.13		19	1.32		138	1.32	*	127	1.22	*	21	1.03		30	1.94	*	151	1.50	*	121	1.26	*
	LD	0	0.00	°	4	3.44		9	1.00		8	1.01		2	0.92		3	1.91		11	1.44		8	1.24	
	Total	106	1.31	*	99	1.56	*	603	1.42	*	585	1.32	*	139	1.48	*	113	1.57	*	747	1.33	*	669	1.23	*
	Trend:	p < 0.05 NL			p < 0.05 NL			p < 0.05 NL			p < 0.05 L↑			p < 0.05 L↑			NS			p < 0.05 NL			p < 0.05 NL		
LUNG CANCERS	HD	14	1.89		12	4.92	*	37	1.63	*	8	0.84		13	2.11		10	3.64	*	57	1.28		23	1.26	
	MHD	61	1.35	*	23	1.31		222	1.29	*	55	0.81		82	1.28	*	43	1.57	*	468	1.11	*	155	1.02	
	MD	133	1.12		55	1.15		616	1.14	*	204	1.05		119	1.10		46	1.00		590	0.99		203	0.94	
	MLD	37	0.76	°	19	0.94		226	0.92		104	1.23	*	49	0.97		22	1.03		227	0.96		92	1.09	
	LD	2	0.52		1	0.61		14	0.67		4	0.61		6	1.11		4	1.85		12	0.67		7	1.23	
	Total	247	1.10		110	1.23	*	1115	1.12	*	375	1.03		269	1.15	*	125	1.26	*	1354	1.03		480	1.01	
	Trend:	p < 0.05 L↑			p < 0.05 L↑			p < 0.05 L↑			p < 0.05 NL			p < 0.05 L↑			p < 0.05 NL			p < 0.05 L↑			p < 0.05 NL		
PROSTATE & FEMALE BREAST CANCERS	HD	2	3.81		1	0.26	°	6	0.84		17	1.52		0	0.00		7	1.59		14	0.97		40	1.82	*
	MHD	2	0.62		33	1.20		67	1.23		93	1.16		4	0.90		47	1.07		144	1.05		189	1.03	
	MD	10	1.18		84	1.11		184	1.08		272	1.18	*	12	1.61		93	1.27	*	220	1.13		295	1.14	*
	MLD	2	0.58		29	0.91		89	1.15		126	1.26	*	1	0.29		33	0.97		84	1.10		120	1.18	
	LD	0	0.00	°	9	3.48	*	9	1.35		8	1.04		1	2.67		2	0.58		3	0.52		10	1.47	
	Total	16	1.01		156	1.10		355	1.12	*	516	1.20	*	18	1.11		182	1.15		465	1.09		654	1.14	*
	Trend:	NS			p < 0.05 NL			p < 0.05 L↓			p < 0.05 NL			NS			p < 0.05 L↑			p < 0.05 NL			p < 0.05 L↓		

NOTE: Standardized on Liguria Region rates. SEHDI: Socio-Economic and Health Deprivation Index (at 2001 and 2011 censuses). Clusters: HD: High Deprivation; MHD: Medium-High Deprivation; MD: Medium Deprivation; MLD:Medium-Low Deprivation; LD: Low Deprivation
p = test F, p < 0.05: * Significant increasing risk; ° Significant decreasing risk.
Trend: p < 0.05 L↑: linear positive; p < 0.05 L↓: linear negative; p < 0.05 NL: not linear; NS: not significant

conditions of people affected by these diseases in any social strata are well known in literature [9-16].

Instead, for cardiovascular diseases, all cancers and colorectal cancers the different behaviours by period (trends not linear when population was distributed as in 2001 context, and linearly positive in the second

when population was distributed as in the 2011 one) confirmed the better situation of the more affluent in case of diseases preventable and curable thanks to an anticipated diagnosis or a better taken in charge [13-23]. The growing prevalence of diabetes in populations with a western lifestyle [9-12] showed robust positive associations with the SES [9]. The main risk factors, i.e. overweight or obesity and the disease inheritance, have suggested a common environment or a gene-environment interaction and a possible SE segregation. A higher level of education might partially balance these aspects, particularly in who adopted preventive lifestyles, like mostly the women. Diabetes confers increased vulnerability to particles derived from traffic and industrial or domestic combustion [10, 11]. These effects in Genoa might have affected the population differentially across SE groups, as suggested by the positive trends in elderly, stressed by the population distribution on the basis of SEHDI 2011, but which were present also with the population distribution from SEHDI 2001. Furthermore, the young showed gender differences, suggesting more attention to prevention in women [12], while in men trends are worsened, changing from NL to L positive. This suggests the high risk in the less deprived, evidenced using SEHDI 2001 distribution of population, related to the association with hyper caloric diet and more sedentary lifestyles.

The mortality for cardiovascular diseases improved in time due to the adoption of healthier life styles and the better cares (changes in smoking habits, metabolic disorders control, physical activity promotion, overweight and obesity control, pressure control and so on) [13-18]. The risk dropped with corrective actions on diet suggested by physicians and health authorities. In Italy, after these actions great effects were observed, even if SES differences still disadvantaged the most deprived [19, 20]. Worldwide a great benefit has derived from smoking cessation in young male, but this has regarded to a lesser extent the most deprived [20]. Furthermore, the association between air pollution and low SES has proven to have a large impact on mortality outcomes [21, 22]. These data characterize mostly urban areas with an industrial past, as Genoa has been. Indeed, in the youngest, robust positive trends emerged for both population distributions, while in the elderly the advantage found in the less deprived at the onset of disease disappeared in the final stages.

Most of deaths for respiratory system disease was due to the COPDs [23, 24], which affected mainly the deprived [23-26].

In Genoa, the respiratory diseases showed NS trends in the younger and NL trends in elderly women, while in elderly men trends changed from L positive to NL. As regards the elderly, the changes in smoking habits in both sexes, and the decreasing in time of the past occupational exposures at high risk in men, could explicate these trends. In fact, in men a share of deaths has related to the effects of pneumoconiosis and silicosis, occupation-related and very frequent in asbestos and silica processing workers [27]. In the past, this kind of exposures largely have involved the Genoese workers, particularly those engaged in some harbour's activities (naval building and repair), and in an industry of steel, an oil refinery and a silica factory, all activities present and active in the western part of the city since the post-war period to the end of the 90s (and after for the steel factory). The more affected pertained to the most deprived groups, either directly employed in these activities, either subjected to environmental exposure. In fact, in Genoa, houses and industries are too close, due to the limited building space available in relation to the mountainous orography.

Flu and pneumonia were not considered in the analyses by gender due to the reduced numbers of deaths, but they were taken in consideration due their consequences. In fact, the more fragile segments of populations are hit from their late complications, mostly the elderly and the homeless [25-27]. In literature, the association between this kind of diseases and deprivation is controversial, because often not linear relationships emerged, due to their connection with the differences by SES in vaccination coverage [26,27]. The results in Genoa confirm these not linear behaviours of trends in both sexes. A study on the acceptance of vaccination, carried out in nine Italian areas including Genoa [6], used the same mortality data of the second period considered in these analyses (2009-2013), verifying the vaccination coverage on the elderly population classified by deprivation with SEHDI 2011. This study proved a not linear behaviour of vaccination acceptance: in synthesis, the deprivation clusters at the extremes of distribution presented a lower coverage. This is due likely for neglection or not comprehension of the preventive messages in the deprived, and for some negative behaviour against vaccination, which are spreading in the richer classes [26, 27].

The relationship between all cancers and the deprivation is controversial in literature, because varies on the base of the specific mix of cancer sites present in the populations. In fact, cancer sites as colon-rectum, breast and prostate, whose major risk factors are the same lifestyles predisposing to diabetes and cardiovascular diseases (excessive energetic intakes associated to sedentary behaviours) are more diffused into the richer strata of population. On the contrary, unhealthier life styles, such as smoking and alcohol drinking, to which the occupational exposures at risk are added, are more frequently associated to cancer sites as lung cancer, and more often hit the poorer groups of population [28-31]. Therefore, the different combination of cancer sites and the weight of each one in the population defines the type of association with deprivation observed for all cancers. Moreover, for any cancer site, in addition to risk factors that cause the onset, it is also necessary to consider the risk factors that determine the mortality. Among them, the comorbidities, the early or late diagnosis, the effectiveness of the care (also related to the efficiency of health system), the available familial and social support, are among the major determinants [31-34].

The trends of all cancers showed a shift towards deprivation between periods in younger and older women. The behaviours observed with the SEHDI 2001 distribution of population are NL, in coherence with the literature. They referred mostly to breast cancer trends, which regarded both, either the high risks of less deprived old women, either the increase of incidence in the deprived younger ones [35]. In men, the trends were mostly related to lung cancer trends, always linearly positive at any age and in both periods, and to colorectal cancers trends mostly in the younger.

For colorectal cancers, a Swedish study demonstrated that SE differences exist in diagnostic activity and management, which may affect survival [34]. Although rectal cancer has poorer prognosis than colon cancer, it has been noted that among the highly educated peoples rectal cancer patients had better survival than colon cancer patients. In Genoa, the not linear trends in elderly seemed to underline delay in diagnoses and problems in the care path, involving in the final course of disease phase also the less deprived, in particularly women. In the younger a great difference by gender was evident. The NL trends at the onset of disease revealed contemporarily higher incidences either at the lowest or at the highest deprivation in both sexes, which could be associated to unhealthier lifestyles (as hyper caloric diet, sedentary lifestyle, and smoking). Instead, the late course of disease presented large differences by gender. This could be related with the delay in diagnosis and treatment associated with less attention to preventive aspects in younger men [36], which could have been aggravated by the delay in the screening organization (stabilized at only 44% at the end of the 2017) and the insufficient rationalization and coordination of care (previously already suspected).

For lung cancer a wide part of social gradient seen in literature probably is mediated by the distribution of smoking habits, the risk factor which account for the most of the attributable fraction [37-39], while a minor fraction can be attributed to the differences in occupational exposure [39].

In Genoa, the occurrence of lung cancer showed increasing trends to increasing deprivation in the elderly of both sexes and the younger men. The not linear trends in younger women could testify the high risks of the richest due to the smoking habit [40].

Prostate cancer showed in Italy lower incidence risks among men having low educational level [38], consistent with data from other countries [41]. This is probably related to the PSA screening diffusion, more common habit among the more educated higher social classes [41, 42], while it is presumable that the deprived experienced also some delay in diagnosis [41, 42].

In the Genoese data, considering the analyses by age groups, the NL trends seemed to testify the presence of both the effects cited in literature.

As regards the breast cancer, the risks seem to be mostly related with reproductive, hormonal and dietary factors [43-45], which are cited as more spread in the higher social classes [43-45], while the obesity, strong predictor of cancers post-menopausal [45], is capable to explain the positive trends observed, related to the increase among the less educated women. Considering the analyses by age groups, the breast cancer trends, NL at the disease onset, were coherent with the literature data. As regards the disease outcomes, displayed by the second period, the opposite trends by age (positive in the younger and negative in the older) could be due to the different frequencies across deprivation groups related to the dietary and reproductive habits at higher risk among the less deprived in the elderly, while for the younger delayed diagnoses in the more deprived were suspected.

Not considering the differences by age, the overall trends of prostate and female breast cancers changed from the linear negative trends at the onset of disease to the linear positive trends of the final course of disease. This is not in contradiction with the findings by age, because by summing the two ages the higher number of cases in the elderly is enough to show a statistically significant changing of trends.

As regards the limits and strengths of these analyses, we must return to the methodological choose to apply two SEHDI's indices in describing the distribution of population by deprivation in the two periods.

The comparison between periods could be not valid if the populations at the two censuses were largely composed of different individuals, e.g. if the number of non-residents in the first period were too high, as in the case of a large increment in foreign migrants. The latter, in fact, could have determinants of their disease onset not dependent from the situation of Genoese deprivation.

This kind of limitation is certainly to be considered, given the integration of foreigners in the population happened between 2001 and 2011. In fact, they have created territorial aggregations of foreigners in specific areas of the city over time [46].

Nevertheless, the effects of their presence in the mortality should be reduced, given their younger average age compared to the natives, and the "healthy worker" effect [47-49], related to the fact that only the healthiest can have faced the inconveniences of emigration due to their need to find a job.

Conclusion

The findings of this study further strengthen the correlation between the impoverishment of a population and the worsening of its health condition. In Genoa, most of the not oncologic diseases show linear positive trends, well known in literature for the populations slipping towards poverty. The trends of oncologic diseases show mostly problems related to delayed diagnoses in the more deprived younger and in old women, problems likely correlated to some weakness in preventive measures and organisation of care [30, 38].

The trends of the main diseases support the hypotheses

of ageing-linked social risks and reflected poor social-health care, which worsen in elderly if alone [8,50].
Nevertheless, from this work emerges that among the most affected there are also the young if single, or householder of a single-parent families, which probably are at low or no social support, and often have a precarious or low remuneration employment. In fact, on the base of observed mortality outcomes, we have reason to suspect that some of these latter gave up prevention and treatment for economic and/or cultural reasons [51-53].
This situation becomes particularly relevant when the poorness is strongly tied to the worsening of the educational level of the population, considering how much this influences how individuals cope with prevention, assume lifestyles at risk, etc. [38, 54].
Moreover, the association with a strong ageing, increasing the needs of social support and care giving, is an "explosive mix" for a public health and a social system based on resources more and more reduced [8].
The use of the SEHDIs probably constitutes a useful tool to design targeted intervention policies at contrasting the effects of impoverishment on the population health.
The contemporary use of indices referring to the situation of SES of population in the periods of onset and outcome of a long term disease contributes to guide the organisation of the take in charge of patients, highlighting the different kind of relationships that bind deprivation and disease.
These results provide evidence that SES indices related to different time periods could be used, identifying in a more specific way the subpopulations that could benefit most from the investment of resources dedicated to disease management in its different stages, from the preventive aspects and the programs of health education to the taken in charge of the final phases of life.
These analyses of Genoese social evolution advise to choose the most appropriate SES indices for more effective health policies, targeted to reduce the social inequalities in health.

Conflicts of interest

Nothing to declare.

Authors' contribution

Authors equally contributed to realize this paper.

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