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BRIEF REPORT

Health inequalities and historically persistent socioeconomic differences in Venice

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Introduction

Tourists visiting Venice, nearly thirteen million every year, may regard it as a single multi-facet jewel from the past: they would probably never suspect that when boarding a "vaporetto" (the local public transport boat) they would stop at different areas where material health inequalities affect today's resident population.

The municipality of Venice (population 271,073, including 66 homeless, in 2001 Census) is composed of two rather distinct entities, an inland metropolitan area, next to large industrial facilities, where the majority of the population resides (175,124), and the lagoon area, inhabited since the ninth century, where 95,883 islanders live mostly in the historical town and in the larger islands.

Since 2001 an integrated epidemiological system (IES) has been activated in Venice with the main goal of monitoring spatial and time patterns of the health profiles in the community. The IES operates through two steps: (a) summarisation—deterministic record-linkage is performed between the geo-referenced population file and the electronic health archives available on health events (hospital discharge records, mortality records, pathology records, drugs prescriptions, etc.); and (b) consolidation—disease-specific algorithms have been developed and applied to the data to identify the subjects affected by a given disease (Simonato et al. 2008).

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Methods

Individual information on socio-economic variables, in particular educational level, has been obtained by cross-linking to the 2001 population census file. The territory was subdivided into 17 units representing the 6 districts of the inland metropolitan area plus and the 11 original ancient "Sestieri" of the historical town and the islands. From the approximately 11 millions of electronic health records available in the IES during the study period (2002–2006) a total of 50 mortality, incidence and prevalence health outcomes have been computed concerning the majority of diseases affecting the general population resident in the 17 units of the Venice municipality. All the outcomes included in the analyses are reported in an online Table (eTable 1). We present here as a selection from the full body of the results the all causes mortality, the prevalence of diabetes type II, a disease of increasing importance in public health, and the incidence of acute myocardial infarction (AMI). Diabetes prevalent cases were identified using three data sources (hospitals discharges, drug prescription and exemption from copayment of drugs, syringes, and glucose blood level tests) as described in detail previously (Gnavi et al. 2008). Acute myocardial infarction incident cases were identified through record linkage between population file and hospitalization and causes of death database (Barchielli et al. 2008).

Standardised Mortality, Incidence and Prevalence ratios (SMR, SIR, SPR) with 95 % confidence intervals were computed comparing Observed to Expected events based on the total population rates by gender and 5-year age groups. Further standardization by socio-economic status (SES) was carried out, using as proxy the percentage of subjects with no formal education subdivided into quartiles, assigning to each territorial unit a SES score from 1 to 4. The standardized diseases ratios were also used to calculate scores (−2: SMR/SIR/SPR <0.61; −1: $0.61 \leq$ SMR/SIR/SPR < 0.81; 0:$0.81 \leq$ SMR/SIR/SPR < 1.21; 1:$1.21 \leq$ SMR/SIR/SPR < 1.61; 2:SMR/SIR/SPR ≥ 1.61) assigned to each area for each of the 28 investigated outcomes (eTable 1). The scores were summed up to produce a new cumulative, integrated index of the health profile in each Venice sestiere or district.

Computations were implemented using SAS System, version 9.1. and Rapid Inquiry Facility version 3.1, an automatic procedure based on ARCGIS platform, a tool able to produce risk analysis and disease mapping, developed by the Epidemiological and small area unit of the Imperial College of London (Beale et al. 2008).

Results

Table 1 shows the distribution of the three socio-economic indicators available in the census in the 17 districts/sestieri: percentage of subjects with no formal education, percentage of unemployed and the average years of schooling. The island areas of Burano and Pellestrina showed more than 10 % of people without primary school licence. The percentage of subjects with no formal education and the average years of schooling were highly correlated ($p < 0.01$). The proportion of unemployed follows similar pattern with the highest percentages in the islands population.

Results concerning the all causes mortality analysis, diabetes type II prevalence, acute myocardial infarction incidence and the health integrated score are presented in Table 2. A clear all-cause mortality pattern emerges when the territory is subdivided into the 6 districts of inland metropolitan area and the 11 original “Sestieri” of the historical town with islands. A total of 7,352 deaths were recorded during 2002–2006 in these 17 units for males and 7,888 for females. As shown in Table 2, mortality for both genders combined is significantly increased in the districts of Giudecca and Castello, the island of Pellestrina and the inland modern neighbour of Marghera. This pattern was confirmed for some of the major causes of death: for diseases of the circulatory system SMRs (both genders combined) were, respectively, 1.12 (0.96–1.31), 1.18 (1.09–1.28), 1.29 (1.08–1.54) in Giudecca, Castello and Pellestrina, while a significantly increased SMR of 1.14 (1.05–1.24) for neoplasms was found in Marghera (data not shown). Adjustment for socio-economic status (educational level) appreciably reduced the all deaths SMRs from 1.14 to 1.02 in Giudecca and from 1.25 to 1.14 in Pellestrina. On the other end the SMR of 1.08 in Marghera and 1.14 in Castello were unmodified.

Table 1 Distribution of the socio-economic indicators in the 17 districts/sestieri of Venice, Italy, 2002–2006

Inland/historical town	Sestiere/district	% with no formal education[a]	% unemployeds[b]	Average years of schooling[c]
Historical town	San Marco	0.94	1.85	11.66
	Cannaregio	2.64	2.51	9.66
	San Polo	1.58	2.27	10.95
	Dorsoduro	1.91	2.34	10.63
	Santa Croce	1.75	1.79	10.69
	Giudecca	6.19	4.24	7.73
	Lido	1.83	2.37	10.01
	Pellestrina	12.13	3.05	6.48
	Murano	6.92	2.27	7.21
	Burano	13.94	4.04	6.17
	Castello	3.77	2.30	9.05
Inland area	Favaro	5.05	2.76	8.05
	Carpenedo	3.08	2.24	9.20
	Terraglio	2.78	2.17	9.94
	Cipressina	4.16	2.29	8.40
	Chirignago	4.30	1.98	8.52
	Marghera	4.85	2.69	7.94
	Totale	3.81	2.40	9.07

[a] ≥11 years

[b] ≥15 years

[c] ≥25 years

In some areas of the historical town (like S. Marco, Cannaregio, S.Polo, Dorsoduro, Santa Croce) the unadjusted SPRs for diabetes were significantly lower than the whole Venice area, while in Giudecca, Pellestrina, Murano, Burano and Marghera the SPRs were significantly higher. As for mortality, in most of the island areas these excesses disappeared after the adjustment for the SES covariate, except for Castello (adjusted SPR: 1.05; 95 % CI 1.02–1.09) and Marghera (adjusted SPR: 1.07; 95 % CI: 1.05–1.10) (Table 2). Concerning AMI, the areas of Pellestrina and Marghera resulted with a significantly incidence excess (adjusted SIR Pellestrina 1.47; 95 % CI 1.12–1.91; adjusted SIR Marghera 1.14; 95 % CI 1.01–1.28).

The integrated index, which measures the cumulative weight of all the mortality, incidence and prevalence outcomes, detected the highest burden of diseases in the population living in the island of Pellestrina, followed by Giudecca, Castello, Cannaregio and Marghera. In Pellestrina

Table 2 Standardized mortality ratios for all causes of death, standardized prevalence ratios for diabetes and standardized incident ratios for acute myocardial infarction (and 95 % confidence limits) and the cumulative health index—both sexes, Venice, Italy, 2002–2006

Inland/historical town	Sestiere/district	SMR (95 % CI)	SMRcov (95 % CI)	SPR (95 % CI)	SPRcov (95 % CI)	SIR (95 % CI)	SIR Cov (95 % CI)	Cumulative health index[a]	Cumulative health index Cov[a]
Historical town	San Marco	1.02 (0.90–1.15)	1.07 (0.95–1.20)	0.65 (0.60–0.70)	0.82 (0.76–0.88)	0.88 (0.62–1.21)	0.94 (0.66–1.3)	−7	−5
	Cannaregio	1.04 (0.98–1.10)	1.04 (0.98–1.10)	0.88 (0.85–0.91)	0.94 (0.91–0.97)	0.96 (0.82–1.11)	0.95 (0.82–1.11)	4	3
	San Polo	1.02 (0.91–1.14)	1.07 (0.96–1.19)	0.79 (0.74–0.84)	0.99 (0.93–1.06)	1.17 (0.89–1.51)	1.25 (0.95–1.62)	−1	1
	Dorsoduro	0.91 (0.83–1.00)	0.95 (0.87–1.05)	0.81 (0.77–0.85)	1.01 (0.96–1.07)	0.98 (0.78–1.23)	1.05 (0.83–1.32)	3	4
	Santa Croce	0.95 (0.85–1.05)	0.99 (0.89–1.11)	0.76 (0.71–0.81)	0.95 (0.9–1.02)	1.00 (0.75–1.3)	1.08 (0.81–1.4)	−5	−4
	Giudecca	**1.14** (1.03–1.25)	1.02 (0.92–1.13)	1.28 (1.22–1.34)	1 (0.96–1.05)	0.93 (0.7–1.22)	0.84 (0.63–1.1)	9	3
	Lido	0.94 (0.89–1.00)	0.99 (0.93–1.05)	0.84 (0.81–0.87)	1.05 (1.02–1.09)	0.84 (0.71–0.98)	0.90 (0.76–1.05)	−5	−1
	Pellestrina	**1.25** (1.11–1.41)	**1.14** (1.01–1.28)	1.33 (1.25–1.4)	1.04 (0.98–1.11)	**1.60** (1.21–2.07)	**1.47** (1.12–1.91)	10	2
	Murano	1.01 (0.90–1.12)	0.91 (0.82–1.01)	1.3 (1.24–1.36)	1.02 (0.97–1.07)	1.05 (0.79–1.37)	0.94 (0.71–1.22)	2	−4
	Burano	1.06 (0.92–1.21)	0.96 (0.84–1.10)	1.17 (1.1–1.24)	0.92 (0.87–0.98)	1.00 (0.69–1.4)	0.88 (0.61–1.24)	0	−6
	Castello	**1.14** (1.08–1.20)	**1.13** (1.07–1.19)	0.99 (0.96–1.02)	1.05 (1.02–1.09)	1.08 (0.93–1.25)	1.08 (0.93–1.24)	7	5
Inland area	Favaro	0.97 (0.92–1.04)	0.97 (0.91–1.04)	1.08 (1.05–1.11)	0.96 (0.93–0.98)	1.04 (0.9–1.21)	1.03 (0.89–1.2)	−1	0
	Carpenedo	0.94 (0.90–0.98)	0.94 (0.90–0.98)	0.97 (0.95–0.99)	1.03 (1.01–1.05)	0.95 (0.85–1.06)	0.95 (0.85–1.06)	−4	−3
	Mestre Centro	0.98 (0.95–1.02)	0.98 (0.94–1.01)	0.92 (0.91–0.94)	0.98 (0.96–1)	1.03 (0.94–1.12)	1.03 (0.94–1.12)	−1	0
	Cipressina	0.96 (0.89–1.03)	0.96 (0.89–1.04)	1.07 (1.03–1.1)	0.94 (0.91–0.98)	0.92 (0.76–1.12)	0.91 (0.75–1.1)	−7	−6
	Chirignago	0.94 (0.88–1.00)	0.94 (0.88–1.00)	1.11 (1.08–1.14)	0.99 (0.96–1.01)	0.85 (0.72–1.00)	0.84 (0.72–0.99)	−3	−3
	Marghera	**1.08** (1.02–1.13)	**1.08** (1.03–1.14)	1.22 (1.19–1.24)	1.07 (1.05–1.1)	**1.14** (1.02–1.29)	**1.14** (1.01–1.28)	3	3

Cov analysis adjusted for socio-economic covariate (population quartiles no formal education). Bold values are statistically significant at 0.05 level

SMR standardized mortality ratio, *SPR* standardized prevalence ratio, *SIR* standardized incidence ratio

[a] Based on 28 studied outcomes (eTable 1)

and Giudecca islands the adjustment for the socio-economic variable strongly reduced the cumulative index while in the inland district of Marghera the cumulative index was not modified by controlling for SES.

Discussion

We reported large health inequalities within the Municipality of Venice, with the small population living in the venetian lagoon affected by the worst health profile. The situation reported is likely the result of the life conditions during the past 40–60 years and appears to be influenced by SES based on education. The fact that even a crude adjustment for socio-economic status (using quartiles of the percentage of people with no formal education as the adjusting variable) did largely reduce the SMR's suggests that the observed health inequalities between the Giudecca and Pellestrina islands and the other districts of the Venetian lagoon are influenced by socio-economic life conditions. The unmodified SMR in inland Marghera, mostly reflecting an increased mortality from neoplasms in males, is more likely related to occupational hazards in this massively industrialized area. An interesting finding concerning Giudecca and Pellestrina comes from the 1,810 census carried out during the Austro-Hungarian domination showing a socio-economic status distribution consistent over time, when compared to the present one, with a central area holding the top socio-economic conditions like S.Marco, where the noble and richest families were and still are located, and the peripheral islands such as Giudecca and Pellestrina inhabited by boatmen, fishermen and other low-level occupational activities (Rossi 2009). Among the latter populations the proportion of people without primary school diploma reaches 12−13 % as compared to 0.94 % among residents in S.Marco. The secular persistence of social inequalities in some parts of Venice confirms what Mackenbach and Dreier recently called the "stubbornness" of this major determinant of health over time (Mackenbach and Dreier 2012). The relevant role of SES in influencing the health profile of European populations has been recently stressed by a report issued by the Regional Office of WHO (WHO 2013) and is implementing actions in some European countries like UK in which this phenomenon was first studied (Marmot Review Team 2010).

The major strength of our study lies in the possibility, offered for the first time in this area through a multistep systematic record linkage of the census population, electronic health archives and digital map, of producing a complete health profile of a large, clearly defined population at microarea levels characterized by heterogeneous origins. Population-based longitudinal studies based on record linkage between electronic databases are of increasing interest in the field of public health aiming at life-long monitoring of health profiles within the National Health Services (Richter and Blane 2013). On the other hand, our data based on record-linkage between administrative health archives still suffer from limited experience, lack of validation and, furthermore, do not provide any information on possible confounders as smoking, diet or other life style factors.

This Venice example stresses, however, the usefulness of establishing life-long longitudinal studies exploiting electronic health data archives, now available in most European countries, to draw detailed pictures, even at microarea levels, of population health profiles and to relate them to the evolution and reciprocal influences of major diseases over time (Grmek 1969) as well as to determinants like socio-economic characteristic (Rose 1992) status well rooted back in the history of the populations.

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