Original article

Analysis of influenza vaccination coverage among the elderly in Genoa (Italy) based on a deprivation index, 2009-2013

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Keywords

Influenza vaccination • Vaccine coverage • Deprivation • Elderly

Summary

Introduction. *The elderly suffer the most influenza-related complications, and 90% of deaths due to influenza occur in older subjects. Consequently, the elderly are among the main targets of influenza vaccination campaigns. The use of deprivation indexes can help to identify subgroups with lower vaccination uptake. This study analyzed influenza vaccination coverage in elderly persons living in Genoa (Italy) in relation to a local Index of Socio-Economic and Health Deprivation (SEHDI) in order to identify population subgroups needing specific intervention to improve vaccination coverage.*

Methods. *The study targeted subjects aged ≥ 65 years living in Genoa in the period 2009-2013. Information on vaccination coverage was provided by general practitioners and Local Health Units. A combination of linear regression, factor analysis and cluster analysis was used to construct the SEHDI at Census Tract (CT) level, on the basis of data from the 2011 Italian census.*

Results. *In 2011, people aged ≥ 65 years accounted for the 27.7% of the population of Genoa. Most elderly subjects were assigned to either the medium (45.3%) or medium-high (32%) deprivation groups, while the percentages in the extreme tails were low (3.6% high deprivation; 1.3% low deprivation). Significant, non-linear ($p < 0.05$ NL) relationships were observed in both sexes with regard to mortality due to all respiratory diseases (RD) and chronic obstructive pulmonary disease (COPD), with the highest Standardized Mortality Ratio (SMR) values in women in the high deprivation group of women (1.81, $p < 0.05$ RD; 1.79, $p < 0.05$ COPD). The SMRs for influenza and pneumonia showed a positive linear trend in women ($p < 0.05$) with the highest value in the high deprivation group (1.97, $p < 0.05$), while in men the trend was NL ($p < 0.05$). A positive linear trend ($p < 0.05$) was found with regard to vaccination coverage, which grew weakly as deprivation increased, up to the medium-high deprived group (from 34.6% to 44.4%). However, the high deprivation group showed the lowest value (33.3%).*

Conclusions. *The results revealed a relationship between deprivation and influenza vaccination coverage in the elderly. This finding should be taken into account in the organization of vaccination campaigns and should prompt differentiated intervention in each local area.*

Introduction

Socio-economic status (SES) is a composite concept that includes material and social deprivation [1, 2]. SES indexes are used to capture the various aspects of deprivation in a single number [3, 4] and to explore the relationships between SES and health outcomes. With regards to influenza, every year about 8% of the population is infected [5]. Among the elderly, incidence rates are low (in 2017, in Italy around 0.46 per 1,000; in Liguria 0.67 per 1,000) [6]. Although less affected by the disease, older people suffer more disease-related complications and 90% of deaths due to influenza and its complications occur in the elderly [5, 7]. For this reason, this age group is among the main targets of vaccination campaigns. As the risk of all-cause and cause-specific mortality is higher in unvaccinated elderly subjects than in those who are vaccinated [8], vaccination is strongly recommended. In 2003, the World Health Organization [9] recommended increasing influenza vaccination coverage among all high-risk subjects and attaining 75% coverage among the elderly by 2010. Subsequently the Italian National Health Plan set this target. The 2017-2019 Italian National Immunization Plan [10], in addition to the prevention and control of influenza recommendations for the 2017-2018 season [11] have set the minimum coverage target at 75% and the optimal goal at 95% [10, 11]. Nevertheless, after a peak of 74.1% in 2006-2007, coverage declined to 49.5% in 2014-15, and the subsequent increase has been scant, reaching a level of 51% [12].

The decrease in vaccination coverage has determined a significant rise in the number of cases [13] and an excess in overall mortality since December 2016 in Europe (particularly in the elderly) [14]. In Italy, from 2012 to 2015, a + 13% of excess mortality was documented in winter, largely as a result of influenza [15].

SES plays a major role in determining adherence to anti-influenza immunization programs, particularly in the elderly [16, 17]. Influenza vaccination coverage shows

local variations [18, 19] and often appears to be lower among individuals of low SES [18-20].
The measurement of SE deprivation takes into consideration the multidimensional aspects of social stratification. Therefore, the use of deprivation indexes is a useful strategy for measuring health disparities at the population level, and hence for distinguishing non-vaccinating groups [21].
The aim of this study was to identify groups of subjects aged ≥ 65 years with lower vaccination coverage in Genoa (Italy). To this end we applied a specific deprivation index based not only on the SE characteristics of the population, but also on its specific health needs, the ultimate goal being to guide specific interventions aimed at increasing influenza vaccination compliance.

Methods

The study focused on subjects aged ≥ 65 years living in Genoa from 2009 to 2013. Genoa, the regional capital of Liguria, is situated on the coast of the Ligurian sea and extends for more than 27 km. It has almost 590,000 inhabitants (2011 Census) and one of the oldest populations in Italy (65+ years old, 27.7%). As the terrain is mostly hilly, urban development on the landward side has created steep narrow streets. The central and western parts host the city's port, shipyards and steel mills, while the eastern part is residential and richer.
The numbers of observed and expected deaths due to all causes and to specific causes were obtained from the National Statistics Institute (ISTAT) through the Liguria Region Statistics Office. Collaboration between the Regional Statistics Office and the Municipal Statistics Office enabled these data to be stratified by gender and Census Tract (CT), as of the 2011 national census.
Data on influenza vaccination coverage were provided by the Liguria Regional Health Agency and the Department of Health Sciences of the University of Genoa, which collected and validated data from all general practitioners (GPs) working in the city. These data covered the influenza seasons from 2014 to 2016 and were accompanied by the street addresses of GPs' ambulatories. The addresses were geo-coded by CT, again by the Statistics Office of Genoa.
A composite Socio-Economic and Health Deprivation Index (SEHDI) was computed in accordance with a previously experimented method [22]. The unit of observation was the CT, for each of which the index was calculated on the basis of the variables recorded in the Genoa municipality during the 2011 Italian National Census of Population and Households. Mortality trends were analyzed by means of one-way analysis of variance (ANOVA) and the relationship between vaccination coverage and the deprivation index was analyzed by means of a Pearson bivariate correlation [23].

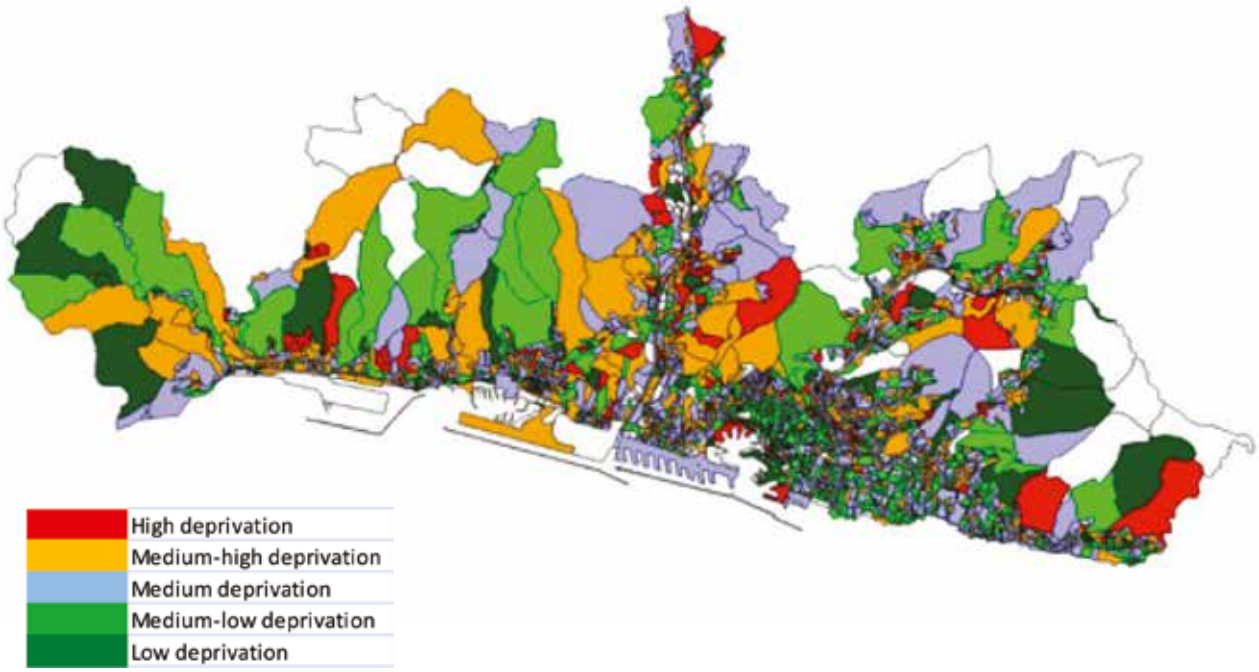
Results

According to the analysis of the factors used to construct the SEHDI, the contribution of the 1st factor (comprising the structural dependence index, the old-age index, the % of widowers/widows) to the explanation of the whole variance was 21.2%. The 2nd factor (% of single-parent families, % of single-parent families with children < 15 years) contributed 21.8%, and the 3rd factor (% of married, % of 2-members families) accounted for 16%. The 4th factor (% of rented homes, % of lower secondary school) contributed 13.8% (Tab. I).
In 2011, subjects aged 65+ years accounted for 27.7% of the population of Genoa. The percentages of the whole population and of the elderly who were in a condition of medium deprivation were similar (45.9% vs. 45.3%); medium-low deprivation was more frequent in the overall population than among the elderly (20.5% vs. 17.8%), while medium-high deprivation was more frequent in the elderly (32% vs 19.4%). At the extreme tails (both ends of the deprivation scale), the percentages were low. Only 3% of the whole population and 3.6% of elderly fell into the high deprivation group, and 2% and 1.3% belonged to the low deprivation group, respectively.
Mapping was performed in order to produce a visual depiction of the spatial distribution of SEHDI clusters in the city; the distribution of index values in the various CTs is shown in Figure 1. SES was higher in the central and eastern coastal areas than in the rest of the city. By contrast, there was a greater concentration of subjects belonging to high and medium-high deprivation groups in the two valleys, in the historical center and in the western industrial areas (Fig. 1).
Table II reports the Standardized Mortality Ratio (SMR) for all respiratory diseases, chronic obstructive pulmonary disease (COPD), influenza and pneumonia by sex, age (0-64 years and 65+ years) and SEHDI deprivation group.
In the younger subjects of both sexes, all trends were non-significant, while in the elderly statistically significant non-linear relationships [$p < 0.05$ non-linear trend (NL)] between SEHDI values and the SMRs of all res-

Tab. I. Composition of the SEHDI in Genoa, by 2011 Census variables (total explained variance 72.2%). SEHDI factors and explained variance.

Factor 1 = 21.2%	Factor 2 = 21.2%	Factor 3 = 16.0%	Factor 4 = 13.8%
Index of structural dependence	% single-parent families	% married	% rented homes
Old-age index	% single-parent families with children <15 years	% 2-members families	% lower secondary school
% widowers/windows			

Fig. 1. Map of Genoa showing the spatial distribution of SEHDI by census tract.



piratory diseases and COPD were observed in both sexes. In men, higher SMRs of all respiratory diseases were seen in the extreme tails groups, though the confidence intervals (CI) were not significant (low deprivation 1.24; high deprivation 1.15). The intermediate groups presented SMRs less than 1, which declined to a protective effect in the medium deprivation group (0.90, $p < 0.05$). Also in women, higher SMRs were found in the extreme groups, the highest value being seen in the high deprivation group (1.81, $p < 0.05$); from low deprivation to medium-high deprivation, the SMRs declined to protective values in the latter (0.81, $p < 0.05$).

A similar pattern was noticed with regard to COPD SMRs in both sexes ($p < 0.05$ NL trend). In men, higher SMRs were seen in the extreme categories (high deprivation 1.44, not significant [NS]); low deprivation 1.18, NS), while the intermediate groups presented SMRs less than 1, with a protective value in the medium deprivation group (0.88, borderline $p < 0.05$). In women, too, the higher SMRs were in the extreme tails, with the highest value in the high deprivation group (1.79, $p < 0.05$), while the intermediate groups presented SMRs less than 1, which decreased until a protective effect was reached in the medium deprivation group (0.88, $p < 0.05$).

The SMRs for influenza and pneumonia showed a linear positive trend in women ($p < 0.05$), with the highest SMR in the highly deprived (1.97, $p < 0.05$) and the lowest value in the low deprivation group (0.53, NS). In men, the trend was not linear ($p < 0.05$; low deprivation group SMR 2.46, NS; high deprivation group SMR 1.11, NS), while the other SMRs decreased from the medium-low deprivation group to the medium-high group.

Figure 2 shows the vaccination coverage (%) among the elderly in Genoa by deprivation group.

In the elderly, influenza vaccination coverage was lower at both ends of the scale (33.25% in the high deprivation group and 34.67% in the low derivation group). In the intermediate groups a positive linear trend ($p < 0.05$) was found, which grew slightly from the medium-low deprivation group (41.74%) to the medium-high deprivation group (44.36%).

Vaccination coverage decreased as the percentages of singles/unmarried and families with more than 4 members decreased; whereas it increased with the percentages of earners from labor or capital income, of 2-member families and of employees increased. Singularly, in the high deprivation cluster, vaccination coverage improved as the percentages of people belonging to the labor force, of rented homes and of 5-members families increased, but worsened as the percentage of owned homes rose. In the medium-high deprivation group, coverage rose as single-member families increased, and diminished as 3 to 5-member families and the average numbers of people per dwelling or per family grew. In the medium deprivation group, coverage rose with the increase in 3-member families and in the average number of people per dwelling, but declined as the percentage of single-member families increased. In the medium-low deprivation group, coverage improved as the percentage of single-member families and of employees rose, but decreased as the percentages of housewives and the average number of people per dwelling or per family grew. In the low deprivation group, vaccination coverage decreased with the growth of the percentages of foreigners and stateless

Tab. II. Standardized mortality ratios in Genoa for all respiratory diseases, COPD, pneumonia & influenza for the period 2009-2013.

Deprivation groups	*Respiratory 0-64 M*				*Respiratory 0-64 F*				*Respiratory 65+ M*				*Respiratory 65+ F*			
	OBS	SMR	95% CI		OBS	SMR	95% CI		OBS	SMR	95% CI		OBS	SMR	95% CI	
			Low	Up			Low	Up			Low	Up			Low	Up
High deprivation	2	1.43	0.00	3.42	3	3.08	0.00	6.56	55	1.15	0.84	1.45	85	1.81	1.43	2.20
Medium-high deprivation	26	1.80	1.11	2.50	14	1.44	0.69	2.20	416	0.91	0.82	1.00	316	0.81	0.72	0.90
Medium deprivation	19	0.78	0.43	1.13	14	0.86	0.41	1.31	584	0.90	0.83	0.98	529	0.96	0.88	1.04
Medium-low deprivation	5	0.44	0.05	0.82	9	1.19	0.41	1.97	246	0.97	0.84	1.09	219	1.01	0.87	1.14
Low deprivation	2	1.64	0.00	3.91	0	0.00	0.00	0.00	24	1.24	0.74	1.73	16	1.10	0.56	1.64
Total	**54**	**1.02**	**0.75**	**1.30**	**40**	**1.14**	**0.78**	**1.49**	**1325**	**0.93**	**0.88**	**0.98**	**1165**	**0.95**	**0.90**	**1.01**
Trend	*NS*				*NS*				*p<0.05 NL*				*p<0.05 NL*			
Deprivation groups	*COPD 0-64 M*				*COPD 0-64 F*				*COPD 65+ M*				*COPD 65+ F*			
	OBS	SMR	95% CI		OBS	SMR	95% CI		OBS	SMR	95% CI		OBS	SMR	95% CI	
			Low	Up			Low	Up			Low	Up			Low	Up
High deprivation	1	1.56	0.00	4.61	2	4.18	0.00	9.97	39	1.44	0.98	1.89	38	1.79	1.22	2.36
Medium-high deprivation	9	1.35	0.47	2.24	8	1.68	0.52	2.84	228	0.88	0.77	1.00	160	0.91	0.77	1.05
Medium deprivation	8	0.71	0.22	1.21	9	1.13	0.39	1.87	345	0.94	0.84	1.04	219	0.88	0.76	0.99
Medium-low deprivation	4	0.76	0.02	1.51	5	1.35	0.17	2.53	133	0.92	0.76	1.08	106	1.08	0.87	1.29
Low deprivation	0	0.00	0.00	0.00	0	0.00	0.00	0.00	13	1.18	0.54	1.83	10	1.52	0.58	2.47
Total	**22**	**0.90**	**0.53**	**1.28**	**24**	**1.39**	**0.83**	**1.94**	**758**	**0.94**	**0.87**	**1.01**	**533**	**0.96**	**0.88**	**1.05**
Trend	*NS*				*NS*				*p<0.05 NL*				*p<0.05 NL*			
Deprivation groups	*Influenza & pneumonia 0-64 M*				*Influenza & pneumonia 0-64 F*				*Influenza & pneumonia 65+ M*				*Influenza & pneumonia 65+ F*			
	OBS	SMR	95% CI		OBS	SMR	95% CI		OBS	SMR	95% CI		OBS	SMR	95% CI	
			Low	Up			Low	Up			Low	Up			Low	Up
High deprivation	1	3.80	0.00	11.24	0	0.00	0.00	0.00	10	1.11	0.42	1.79	24	1.97	1.18	2.76
Medium-high deprivation	7	2.57	0.67	4.47	2	1.68	0.00	4.01	77	0.90	0.70	1.10	63	0.62	0.47	0.77
Medium deprivation	5	1.09	0.13	2.04	1	0.50	0.00	1.49	115	0.94	0.77	1.12	166	1.15	0.98	1.33
Medium-low deprivation	0	0.00	0.00	0.00	0	0.00	0.00	0.00	61	1.27	0.95	1.59	62	1.10	0.82	1.37
Low deprivation	1	4.34	0.00	12.85	0	0.00	0.00	0.00	9	2.46	0.85	4.08	2	0.53	0.00	1.26
Total	**14**	**1.40**	**0.67**	**2.14**	**3**	**0.69**	**0.00**	**1.48**	**272**	**1.01**	**0.89**	**1.13**	**317**	**1.00**	**0.89**	**1.11**
Trend	*NS*				*NS*				*p<0.05 NL*				*p<0.05 L*			

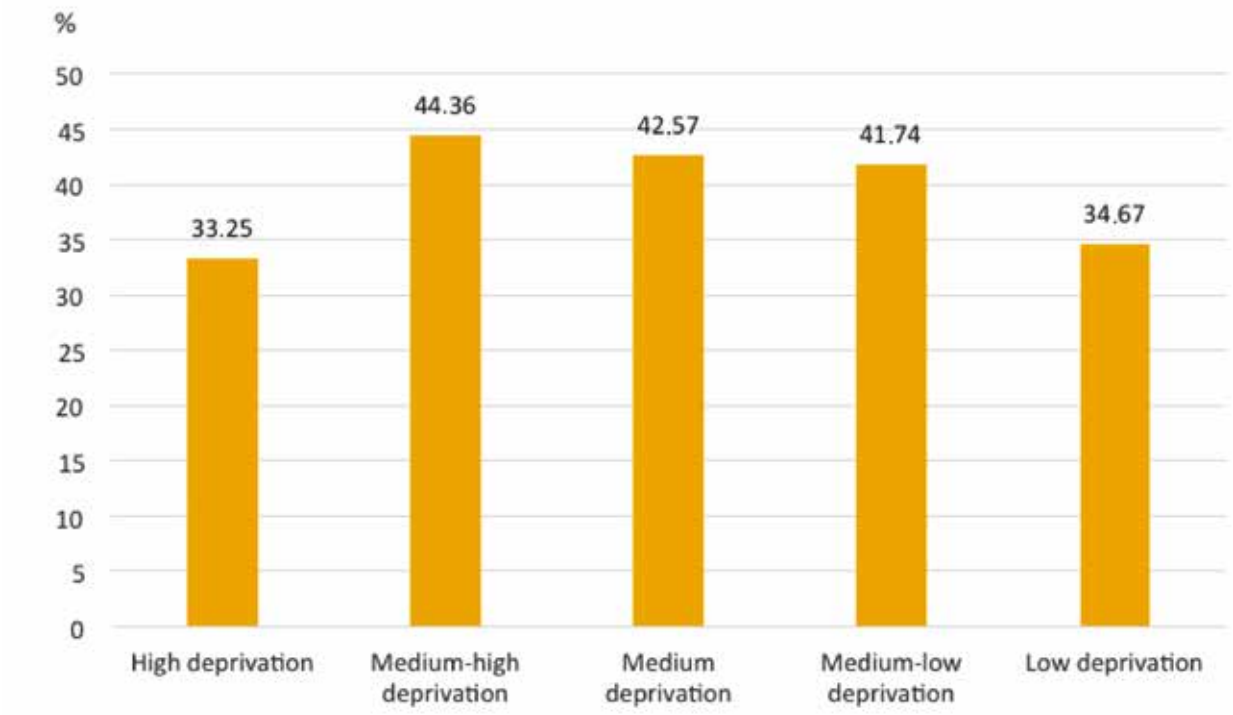
OBS: Observed death; SMR: Standardized Mortality Ratio; 95% CI: Confidence Intervals at 95% level; Low: lower interval; Upp: upper interval; L: linear trend; NL: not linear trend; NS: not significant trend.

persons residing in Italy and of single-parent families with children aged less than 15 years.

Discussion and conclusions

The population of Genoa has one of the highest aging indexes in the world, especially among women. Accordingly, the proportion of young people is declining. As a result, the population is fragile from the SE point of view. In particular, the intermediate age-class is shrinking markedly, which has substantially reduced the family support necessary to enable the elderly to cope with serious diseases and other health problems (e.g., disability) [24, 25]. Furthermore, with the decline of the city's traditional industrial and commercial activities, Genoa has tried to develop the sectors of tourism and advanced tertiary services [26]. Unfortunately, however, the SE structure still remains mainly based on savings and retirement income, rather than on the success of local business [27]. Moreover, the impervious nature of the territory creates logistical difficulties in the provision of social and health services.

Fig. 2. Vaccination coverage (%) among the elderly in Genoa by deprivation group - period 2014-2016.



In Genoa, the SEHDI was able to explain 72.2% of the total variance of the deprivation in the population. Indeed, the four component factors closely reflect the fragility of the Genoese population. The 1st factor (Tab. I), which concerns aging, loneliness and the increasing SE dependence of the elderly, summarizes this situation. The second factor brings out another type of poverty, that of the youngest families, who have little or no social support. This situation mostly involves foreigners who assist elderly Genoese residents living alone, given the low birth rate that has characterized the native population for many decades. These families (often Latin Americans) are mostly composed of unaccompanied women with dependent children, whose income does not allow family reunification and, thus, mutual family support; at times, the children of these families also have problems of social integration. This aspect is highlighted on the map by the fact that the CTs with high percentages of foreign residents coincide with the CTs with the highest SE disadvantage. The third factor reiterates the concept of the first two, emphasizing the importance of mutual support in the family. Finally, the fourth factor underlines the importance of home ownership in determining SES; at the same time, it reveals the relevance of the level of education in improving SES situation, and, from a health point of view, in understanding preventive messages and adhering preventive strategies.

With regard to the distribution of socio-health deprivation, the study showed that more than a third of the elderly population belonged to medium-high and high deprivation groups, and almost half to the medium deprivation group. This underlines the increasing socio-health problems of the city due to the high percentage of elderly persons in the population (27.7%), as already revealed by the traditional ISTAT summary indicators (old age, structural dependence, replacement indices).

The SMRs for respiratory diseases and COPD in the elderly display non-linear behaviors, with highest values in the two extreme clusters. Moreover, in women these SMRs seem to increase as deprivation increases, highlighting a worse socio-health situation. Considering the SMRs for influenza and pneumonia, the trend is not linear in men, while it is positive in women, owing to the very high value in the highly deprived. The result seen in men may be justified by the inverse relationship that was found between vaccination coverage and deprivation, with people belonging to the low deprivation group showing the lowest coverage (almost two percentage points less than in the high deprivation group). By contrast, in women, the socio-health disadvantages tend to affect the deprived more than the less deprived; thus mortality due to influenza and pneumonia increases in this group, as also does mortality due to the other respiratory diseases.

Our findings on the relationship between deprivation and mortality are in line with those from similar studies conducted in other European cities [28-30]. A study carried out in 15 European cities showed SE inequalities at the area level in concomitance with many main causes of death. Specifically, SMRs for influenza and pneumonia in women were directly associated with SE deprivation in three cities and inversely associated in one, while among men a direct association was observed in all cities [28]. Moreover, Italian studies have also found higher mortality rates in more deprived areas, with sig-

nificantly higher rates being recorded among the more deprived elderly both men and women [29, 30].

Regarding the association between vaccination coverage and deprivation, most studies conducted in the elderly have reported higher influenza vaccination uptake in the low deprivation groups [14, 15, 31]. Two studies [32-33], however, found that the less deprived elderly had lower influenza vaccination coverage than those in the lower and middle deprivation classes. We found that influenza vaccination coverage was lower at both ends of the scale. The low level seen in the low deprivation group could be the consequence of anti-vaccination campaigns [34], which have recently grown in Italy; these may have induced an exaggerated and distorted perception of potential vaccine risks [33] more frequent in the higher SE classes. The highest vaccination coverage was found in the medium-high deprivation group. In this group, it is possible that chronic and co-morbid conditions were more common, and that these subjects were therefore more likely to visit health care facilities where vaccination is encouraged and provided [32].

The present study has some limitations, the main one being that the observation unit was not the individual but the CT. This choice, while unavoidable, obliges caution in making inference about causal associations, as the ecological fallacy (namely, the error arising when the characteristics of a reference area, such as the CT, are assumed to apply to every individual in that area) cannot be ruled out [2, 3, 22]. Another limit may concern the possible under-reporting of vaccination coverage by GPs and, therefore, the incompleteness of data. On the other hand, one of the main strengths of the study lies in its use of validated administrative data, which makes the analysis transparent and repeatable. Moreover, it must be underlined that the different method of constructing the SEHDI could have given rise to differences from the literature results, as the associations observed in each individual investigation are linked to the distribution of the population into deprivation groups that are individuated by each single index. Indeed, "deductive" indexes – i.e. those based on the choice "a priori" of SE variables, each one of which is thought to be the best possible indicator of poverty – might not be the best method of constructing the best deprivation index to use for health purposes.

In conclusion, this study allowed us to describe the situation of deprivation of the elderly living in Genoa and to detect the main critical points concerning influenza vaccination. These findings should be taken into account in the organization of vaccination campaigns and should prompt differentiated actions in each local area.

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Conflict of interest statement

None declared.

Authors' contributions

RG and DP conceived and designed the study. LA, FZ, AB, LS and AM collected data. MV and RL performed statistical analysis and interpretated resultes. RL, MV, DA and DP participated in drafting the article or revising it critically for important intellectual content. All authors gave their final approval of the manuscript.

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