

# Identifying Ferrara's elderly people with low influenza immunization rates: the contribution of a local socio-economic deprivation index

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## Keywords

Elderly • Influenza • Immunization • Deprivation index

## Summary

*Influenza immunization coverage rates remain far below the optimal value recommended by the World Health Organization, even in groups considered at high risk, such as the elderly. A possible explanation for this suboptimal vaccination uptake may be deprivation. A specifically developed local deprivation index was proposed for the classification of residents in the municipality of Ferrara in order to evaluate the characteristics of subjects over 65 years of age who accepted/refused influenza immunization (2010-2015). The variables building this deprivation index were primarily related to demographic*

*aspects, such as age, widow/widower status, education, family composition and housing characteristics. Influenza immunization coverage rates were unsatisfactory in all categories of deprivation. A statistically significant decreasing trend in coverage rates was observed with decreasing deprivation in the general population and in males, but not in females. In addition to factors composing the local deprivation index, being separated, living in a family of three members and independent contractor were features that hindered immunization among very deprived elderly.*

## Introduction

Influenza is a major public health burden. Complications, including deaths, are more common in the elderly and in children younger than one year of age [1]. Vaccination against influenza is safe and effective, and large cohort studies have shown that it can prevent morbidity and mortality in those population groups that suffer the main complications of the disease [2]. The World Health Organization (WHO) has set a vaccination coverage target of at least 75% in the elderly population and among risk groups. However, although the vast majority of countries recommend vaccination of the elderly population, coverage of this group is still low, both worldwide and in European countries [3].

Situated in the east of the Emilia-Romagna Region, in north-eastern Italy, the Province of Ferrara had 353,481 residents at the time of the 2011 census (23.7% over 65 years old). The area of the province corresponds to that of the Local Health Unit. There are three hospitals and one university hospital. Healthcare services are also provided by six "Case della Salute" – which are facilities that provide social and healthcare services for the population of the catchment area (municipalities or large areas inside a municipality) – and about 250 General Practitioners (GPs). The main city is Ferrara (132,545 residents in 2011, about 27.4% over 65 years old). As observed at the national level, influenza immunization coverage rates among elderly people are far below the

recommended target of 75%, and suffered a sharp decrease in recent years, from 66.9% in the 2010-2011 season to 53.6% in the 2014-2015 season [4].

In the period 2015-2017, a national project (sponsored by the Italian Center for Disease Prevention and Control) was implemented, in order to determine whether, and how, socio-economic inequalities can influence compliance with flu vaccination in subjects aged  $\geq 65$  years in Italy. In this framework, we investigated the characteristics that were able to promote or to hinder influenza immunization among subjects over 65 years old living in the municipality of Ferrara. To this end, we measured levels of deprivation by means of a specifically developed local deprivation index.

## Methods

The study was part of a national project funded by the Italian Center for Disease Prevention and Control (CCM); it involved 10 cities/areas in Italy, and was conducted under the supervision of the Department of Health Sciences of the University of Genoa.

## ETHICAL ASPECT

The research was approved by the Ethics Committee of the Liguria Region in May 2016 and, later, by the Ethics Committee of Ferrara Province in September 2016, in

order to ensure compliance with current regulations on the protection of personal data.

**POPULATION**

The study population comprised the entire population resident in the territory of the Municipality of Ferrara. As the local Socio-Economic and Health Deprivation Index (SEHDI) was calculated on the basis of variables recorded in the last census (2011), persons resident in the period 2010-2015 were considered. Each individual was assigned to his/her own census unit by geo-referencing the address and street number. The population was stratified according to gender and age (0-64 and ≥ 65 years old).

**MORTALITY DATA COLLECTION**

Selected causes of death, as recorded in the deaths register of the Local Health Unit (LHU) of Ferrara in the period 2010-2015, were investigated. The list, according to ICD-10, was as follows: all causes (A00-Y89), diseases of the circulatory system (I00-I99), diseases of the respiratory system (J00-J99), influenza and pneumonia (J10-J18), chronic obstructive pulmonary disease (J40-J47), diseases of the digestive system (K00-K93), diabetes (E10-E14), neoplasms (C00-C43, C46-C95), malignant neoplasms of the lip, oral cavity and pharynx (C00-C15), malignant neoplasms of the stomach (C16), malignant neoplasms of the colon (C18-C21, C26), malignant neoplasms of the trachea, bronchus and lung (C33-C34), malignant neoplasms of the breast (C50), and malignant neoplasms of the prostate (C61). A separate database for each cause of death was set up according to the 1,875 census units of the Ferrara municipality. Data on observed mortality were acquired by means of a record link between the LHU deaths register and the census unit. Expected mortality was calculated by multiplying Emilia-Romagna Region's mortality rates by the number of individuals living in each census unit, thereby obtaining the number of expected deaths in 2010-2015.

**ASSESSMENT OF THE LOCAL DEPRIVATION INDEX**

The local socio-economic and health deprivation index (SEHDI) of the Municipality of Ferrara was calculated for each census unit according to the method described in Lillini et al. [5]. Variables resulting from the 2011 ISTAT census were considered. The population of the

Ferrara municipality was divided into five groups according to the level of deprivation: from high to low. The deprivation index underwent socio-economic validation and healthcare validation by analysis of variance (ANOVA) with F-test and linearity test. Statistical significance was set at  $p < 0.05$ . Variables evaluated for socio-economic validation were: dependency ratio, old-age dependency ratio, turnover of active population, employment and unemployment rates. For the healthcare validation, data on all-cause mortality and on the above-mentioned selected causes of death were evaluated.

**INFLUENZA IMMUNIZATION COVERAGE**

Data on influenza immunization in subjects over 65 years old in the period 2010-2015 were collected from the LHU's vaccination register, which records all vaccinations carried out in Public Health clinics, and from a regional information database (SOLE), which stores records of vaccinations carried out by General Practitioners. Each subject immunized was assigned to the corresponding census unit by geo-referencing his/her address and street number.

**STATISTICAL ANALYSIS**

Influenza immunization coverage rates in the various groups of deprivation were analyzed by means of ANOVA with F-test and linearity test (statistical significance at  $p < 0.05$ ). The correlation between immunization coverage rates and single variables within groups of deprivation was investigated by means of Pearson bivariate correlation (statistical significance at  $p < 0.05$ ). Statistical analysis was performed by means of SPSS 19.0 and Stata 13.0.

**Results**

The variables contributing to the SEHDI in the Ferrara municipality are reported in Table I. The factors involved were able to explain 62.3% of the total variance, and were primarily related to demographic aspects, such as age, widowhood, education, family composition and housing characteristics. The deprivation index underwent socio-economic and healthcare validation, showing a significant correlation both with demographic variables, such as old-age dependency ratio, and standard

Tab. I. Variables contributing to Ferrara's local deprivation index (organized into factors by analyzing the main components).

Factor 1	Factor 2	Factor 3
% earners from labor or capital income	% 2-member families	% residential buildings in mediocre state of conservation
% widower/widow		% residences with kitchenette
index of structural dependence		
Old-age index		
% single-member families 65+		
% primary school diploma		
<b>Total variance explained=62.3%</b>		

Fig. 1. Composition of Ferrara municipality's population according to local deprivation index.

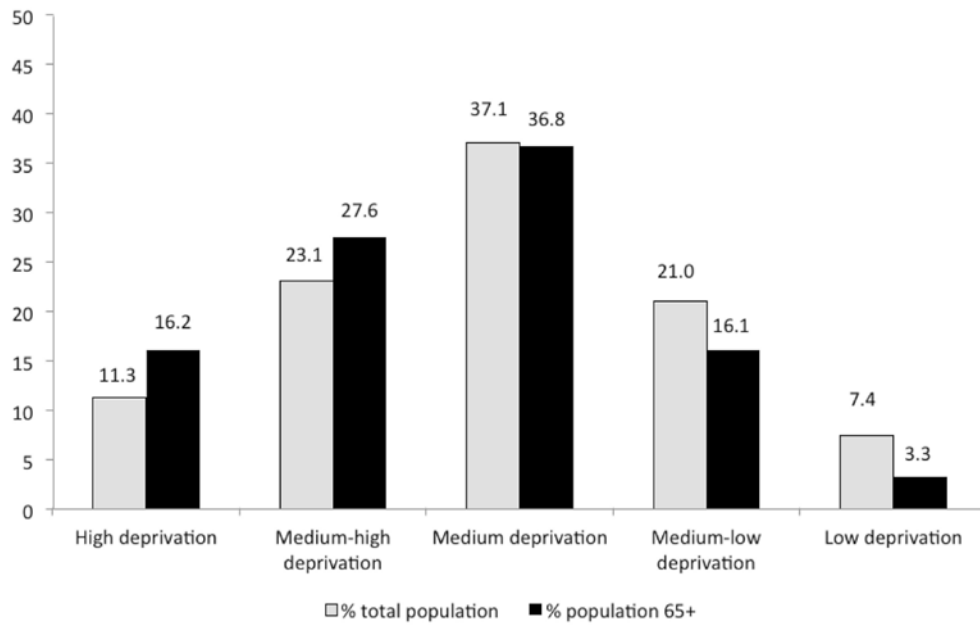
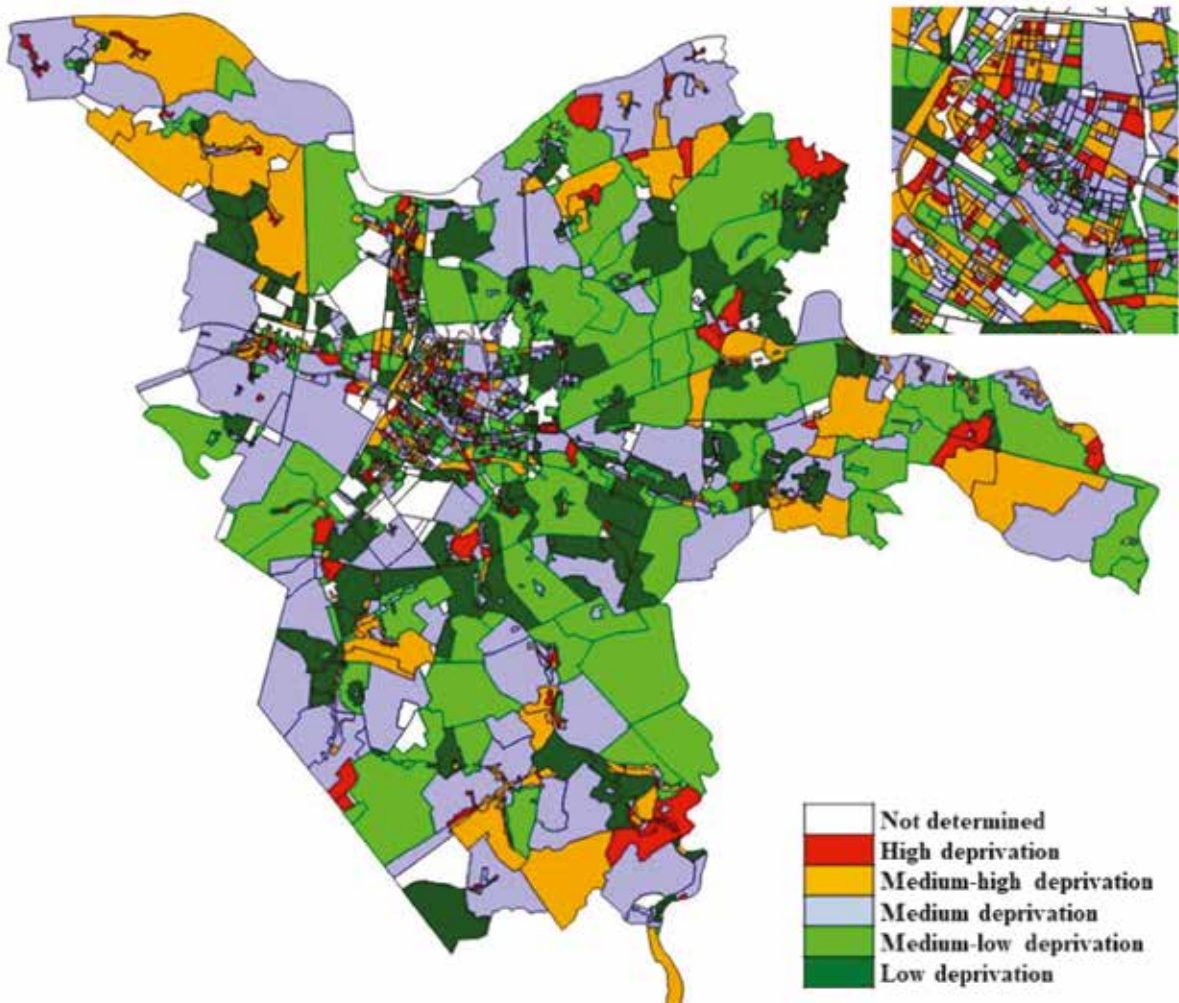


Fig. 2. Map of the municipality of Ferrara according to local deprivation index. On the top right, a focus on the center of the city.



mortality ratio; this revealed that the standard mortality ratio increased as deprivation increased.

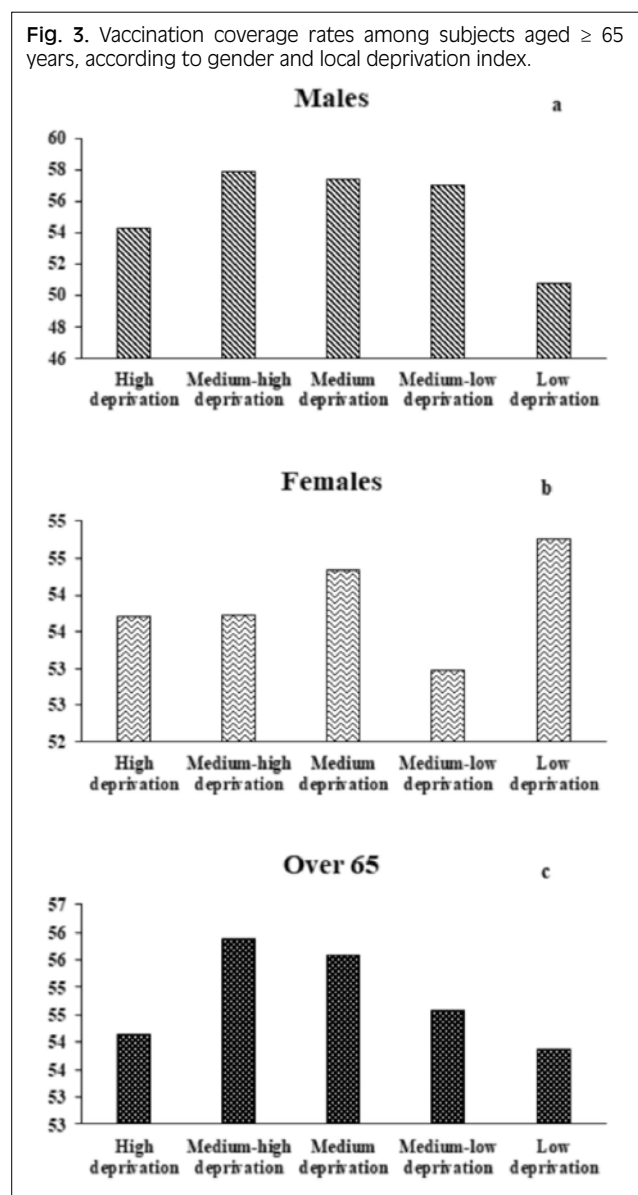
Figure 1 shows the classification of the population into five groups according to the SEHDI. As expected, the distribution of the general population approached a normal distribution, with the majority of inhabitants displaying medium deprivation (the middle group) and only a small percentage of individuals in the groups of high or low deprivation. A normal distribution was also observed when only subjects over 65 years of age were considered, with almost 44% in the two highest deprivation groups.

Figure 2 shows a map of the municipality of Ferrara: census units are shown in different colors, according to the degree of deprivation. White areas were not classified, as they corresponded to unpopulated, open spaces. The majority of the territory consisted of large areas of medium-low and low deprivation, especially in the eastern part of the municipality. Zones of medium-high deprivation were located at the edge of the municipal area, while small areas of high deprivation were located both in the outer sectors of the municipality (rural areas) and in the city centre, inside the ancient walls.

The average influenza immunization coverage rate among the over-65s living in the municipality of Ferrara in the period 2010-2015 was 55.7%. Coverage rates according to deprivation showed unsatisfactory levels in all categories of deprivation (Fig. 3). The lowest coverage rates were recorded among low-deprivation males (50.7%) and medium-low-deprivation females (53.0%), while the highest values were observed in low-deprivation females (54.8%) and medium-high-deprivation males (57.9%). In the general population, and in males but not in females, a statistically significant decreasing trend in coverage rates was observed as deprivation decreased.

In addition to the factors composing the deprivation index, socio-economic variables able to favor or to hinder influenza immunization were assessed according to gender (Tab. II). In males, being unmarried, having a high school diploma and being a foreign resident were factors hindering immunization, while widowhood and being a salaried worker were factors promoting vaccination. Among females, poor education (illiteracy and primary school diploma), unemployment, living in a family with four members and being a house-owner were variables that hindered immunization, whereas being a foreign resident, being a salaried worker, and living in a single-parent family with children under 15 years of age favored compliance with influenza vaccination.

The SEHDI was applied in order to identify specific features favouring or hindering influenza immunization (Tab. III). In the highly deprived group, only factors hindering the vaccination were observed: being separated, living in a family with three members and working as independent contractor. Being unmarried seemed to favor adherence to vaccination, while being married or widowed were factors that hindered immunization among subjects in the medium-high, medium and medium-low categories of deprivation. Among the least deprived,



owning one's home impacted negatively on immunization, while being a salaried worker had a positive effect.

## Discussion

The socio-economic inequalities underlying health differences in Ferrara are mainly due to the age composition of the population, the family structure and the living conditions (more specifically, the characteristics of the building).

Indeed, the first factor composing the index is almost totally defined by variables which stress the role of age and of an aging population. This aspect underlines the need for support and specific means of ensuring good health conditions for the elderly population.

The second factor is completely defined by only one variable, which concerns the family structure: the percentage of 2-member families. This factor reveals that, in

**Tab. II.** Socio-economic variables influencing immunization rates among subjects aged  $\geq 65$  years, according to gender.

Socio-economic variables with Pearson coefficient (p value)					
Males		Females		General population	
% unmarried	-0.071 (0.005)	% primary school diploma	-0.069 (0.006)	% unmarried	0.047 (0.041)
% widower/widow	0.063 (0.014)	% illiterate	-0.063 (0.013)	% married	-0.047 (0.048)
% upper secondary school diploma	-0.058 (0.023)	% not belonging to the labor force	-0.047 (0.045)	% upper secondary school diploma	-0.046 (0.061)
% foreigners and stateless persons residing in Italy	-0.055 (0.033)	% foreigners and stateless persons residing in Italy	0.076 (0.003)	% owned homes	-0.067 (0.007)
% employees	0.055 (0.033)	% owned homes	-0.074 (0.003)	% 4-member families	-0.067 (0.007)
		% 4-member families	-0.084 (0.001)	% 5-member families	-0.057 (0.023)
		% employees	0.136 (< 0.0001)	% employees	0.124 (< 0.0001)
		% entrepreneurs	-0.057 (0.025)	% single-parent families	0.073 (0.003)
		% single-parent families	0.052 (0.039)		
		% single-parent families with children < 15 yrs.	0.047 (0.044)		

**Tab. III.** Socio-economic variables influencing immunization rates among subjects aged  $\geq 65$  years, according to clusters of deprivation (p value).

Socio-economic variables with Pearson coefficient (p value)									
High deprivation		Medium-high deprivation		Medium deprivation		Medium-low deprivation		Low deprivation	
% separated	-0.177 (0.008)	% unmarried	0.161 (0.003)	% unmarried	0.082 (0.071)	% unmarried	0.122 (0.026)	% employees	0.279 (< 0.001)
% 3-member families	-0.141 (0.035)	% married	-0.135 (0.012)	% married	-0.089 (0.051)	% widower/widow	-0.108 (0.050)	% owned homes	-0.157 (0.018)
% self-employed	-0.127 (0.048)	% graduated	0.156 (0.004)	% 2-member families	-0.109 (0.016)	% lower secondary school diploma	0.146 (0.008)		
		% upper secondary school diploma	-0.107 (0.046)	% 4-member families	0.107 (0.019)	% belonging to labor force	0.156 (0.004)		
		% housewives	0.123 (0.023)	% employees	0.116 (0.010)	% employed	0.169 (0.002)		
		% owned homes	-0.102 (0.059)	% single-parent families	0.099 (0.029)	% not belonging to labor force	-0.206 (< 0.001)		
		% 2-member families	0.192 (< 0.001)			% foreigners and stateless persons residing in Italy	0.106 (0.045)		
		% 4-member families	-0.331 (0.001)			% self-employed	0.170 (0.002)		
		% self-employed	-0.136 (0.012)						
% single-parent families	0.182 (0.001)								

the context of an aging population, a family made up of (only) two members can give rise to health inequalities, probably owing to difficulties in providing social support (on the role of social and family support in reducing health inequalities, see also Lillini et al. [5], Vercelli et al. [6], Casanova et al. [7, 8]).

Finally, the third factor introduces the material element of socio-economic inequalities, as reflected by housing conditions. In Ferrara, old, run-down buildings and small dwellings (those with only a kitchenette) identify an economic condition that could lead to health problems and inequalities.

Overall, in Ferrara the SEHDI revealed that old age, small families and poor housing were the main predictors of health problems and inequalities. This is not an uncommon situation in areas with an aged population but quite a solid economic background, and underlines the specific need for social support in order to improve health prevention and to take care of people when a disease breaks out [7, 9-11].

Most findings showed that, even when the potential effect of clinical confounding factors is taken into account, a socio-economic gradient exists in vaccination coverage among the elderly; specifically, the lower the social position of the individual (as measured by several different

indicators), the lower is the likelihood of being immunized against seasonal flu [12]. In the literature, studies conducted in the US, UK, Canada, Germany and Spain have confirmed that higher income, education and better housing conditions are predictors of vaccination against influenza [13-18]. In contrast, we recorded generally lower coverage rates in medium-low and low deprivation classes. Indeed, Italy has already proved to be an exception, in that the available evidence suggests that in Italy, unlike other countries, the lower socio-economic classes are more likely to receive influenza vaccination [19-20]. Our data indicated that living in a large family (more than 4 members) reduced the likelihood of vaccination uptake. By contrast, a recent review [20] revealed a higher uptake among individuals who did not live alone, while a survey conducted in France [21] reported that the number of individuals in the household had no statistically significant impact on seasonal influenza immunization.

The influence of being in employment on vaccination uptake seems to differ according to the degree of professional autonomy. In high and medium-high deprivation categories, being self-employed reduced uptake, whereas being an employee proved to be a factor that increased uptake. Employment is a variable not often considered in studies that examine socio-economic determinants of influenza immunization coverage rates. However, income, which can be considered a proxy, albeit not completely adequate, has not been unequivocally associated with either reduced or increased influenza immunization [22]. The influenza immunization uptake among the elderly living in the Ferrara municipality in the years 2010-2015 was inadequate, being far from the goal of 75% fixed by the WHO and also adopted by the 2017-2019 Italian National Immunization Plan [23]. Nevertheless, having evaluated several social and demographic aspects of the elderly population, the present study suggests that compliance with common prevention practices in general, and with vaccination in particular, varies to some degree among different categories of people.

## Conclusions

Detailed analysis of the social and demographic features of population subgroups who do not adhere to preventive practices, as highlighted by the deprivation index, can contribute to establishing targeted interventions aimed at involving these subjects through specific strategies of communion and organization.

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sono contribuire a migliorare le coperture vaccinali e di conseguenza a ridurre l'accesso al Dipartimento Ospedaliero d'Emergenza e Accettazione (DEA) e i ricoveri correlati all'influenza". The authors are grateful to G. Cosenza, A. De Togni, A. Califano and S. Nola of the Local Health Unit of Ferrara.

## Conflict of interest statement

The authors declare no conflict of interest of this project.

## Authors' contributions

AS, RL, SF and GG conceived and designed the study; GM, PP, GM and FB collected the data; RL, AS, SL and SF analysed and interpreted the data; AS and SL drafted the article; RL, SF and GG revised it critically; all authors gave final approval of the version to be submitted and any revised version.

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