Vaccine xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Socioeconomic factors influencing childhood vaccination in two northern Italian regions

Paola Anello [a], Laura Cestari [b], Tatjana Baldovin [a], Lorenzo Simonato [a], Gabriella Frasca [c], Nicola Caranci [d], Maria Grazia Pascucci [c], Francesca Valent [e,f], Cristina Canova [g,*]

[a] Department of Cardiologic, Vascular, Thoracic Sciences and Public Health of the University of Padova, Padova, Italy
[b] Sistema Epidemiologico Regione del Veneto, Padova, Italy
[c] Servizio Prevenzione Collettiva e Sanità Pubblica, Regione Emilia-Romagna, Bologna, Italy
[d] Agenzia sanitaria e sociale regionale, Regione Emilia-Romagna, Bologna, Italy
[e] Istituto di Igiene ed Epidemiologia della ex Azienda Ospedaliera-Universitaria di Udine, Udine, Italy
[f] Epidemiological Service, Health Directorate, Friuli Venezia-Giulia Region, Udine, Italy
[g] Department of Molecular Medicine of the University of Padova, Padova, Italy

ARTICLE INFO

Article history:
Received 14 March 2017
Received in revised form 16 June 2017
Accepted 18 July 2017
Available online xxxx

Keywords:
Childhood vaccination
Sociodemographic factors
Maternal education
Citizenship
Italy
Birth cohort

ABSTRACT

Background: Infant vaccination rates have been declining in Italy over the past 5–7 years. The aims of this study were to assess the trend in the proportions of children unvaccinated at 24 months old, to identify sociodemographic factors associated with non-vaccination; and to examine changes in parental attitudes to vaccination over time.

Methods: We conducted a population-based birth cohort study by combining existing electronic data sets. The study population consisted of children born from 1995 to 2010 in the Friuli-Venezia Giulia (FVG) region, and from 2007 to 2011 in part of the Emilia Romagna (ER) region, in north-eastern Italy. The immunization registers were linked with the medical birth registers, which contain sociodemographic data on both parents and the newborn. Unconditional logistic regressions were used to identify associations between vaccine uptake at 24 months and maternal sociodemographic variables.

Results: Of 145,571 babies born in FVG and 75,308 in ER, there were 4222 (1.9%) who had not been vaccinated at all, and 23,948 (11.0%) without the optional measles, mumps and rubella (MMR) vaccination. The number of unvaccinated infants increased over time. Mothers who were over 35 or under 25 years old, unmarried, with a higher formal education, and citizens of highly-developed countries were less compliant with vaccination recommendations in both the regions. A cohort effect was observed in FVG, for both educational level and citizenship: babies born between 1995 and 2000 to mothers without an Italian citizenship and with a lower formal education were more likely to refuse vaccination for their offspring, while this association was reversed between 2006 and 2010.

Conclusions: Mothers who are Italian citizens and have a good formal education have begun to refuse vaccination for their children in recent years. Future public health action in this setting should target highly educated parents.

1. Introduction

Immunization programs are effective in reducing mortality and morbidity for vaccine-preventable diseases. Vaccinations prevent an estimated two-three million deaths every year from diphtheria, tetanus, pertussis, and measles [1], but their success relies on achieving and maintaining high vaccination coverage rates.

In Italy, immunization programs are included among the health benefits provided free of charge to all citizens [2]. Immunization strategies are periodically defined in national guidelines (*Piano Nazionale Prevenzione Vaccinale*; PNPV), that each Regional Authority translates into its own regional immunization plan and schedule, implemented by its local health services. In most regions, the vaccination offer is based on a dual system, which includes both "compulsory" and recommended vaccinations. The difference

* Corresponding author at: Department of Molecular Medicine, University of Padua, via Loredan 18, 35131 Padua, Italy.
E-mail address: cristina.canova@unipd.it (C. Canova).

http://dx.doi.org/10.1016/j.vaccine.2017.07.058
0264-410X/

is merely theoretical, however, since parents who refuse to have their children vaccinated incur no sanctions. The compulsory vaccinations are against diphtheria, polio, tetanus (DT-IPV), and hepatitis B (HepB), while vaccination for pertussis (aP), measles-mumps-rubella (MMR), Haemophilus influenzae B (Hib), invasive pneumococcal disease, and *Neisseria meningitides* group C, are optional [3].

In 2015, the vaccination coverage in Italy among two-year-old children was high for diphtheria, polio, tetanus, hepatitis B, pertussis and Hib (averaging 93.4%), and lower for MMR (85.3%). Infant vaccination coverage rates have been declining in recent years, however, and none of the vaccines have reached the target 95% coverage set by the PNPV [4], frustrating several specific goals such as the preservation of a polio-free status [5], and the eradication of measles and rubella [6]. Furthermore, Italy is currently experiencing a measles epidemic with 2395 cases reported from 1 January to 14 May 2017 against the 844 cases of 2016, and the 251 cases of 2015 [7]. Identifying groups who are less likely to have their children vaccinated has become a major issue in Italy in order to address strategies to optimize vaccination coverage. Some social determinants may affect routine childhood immunization. Coverage estimates for generally recommended vaccines are lower in lower-income countries than in higher-income countries. In 2015, the coverage for the third dose of DTP and for the first dose of measles-containing vaccines was below 80% in the WHO African Region, but over 90% in the Americas, European and the Western Pacific Region. Vaccination coverage for the first dose of the measles vaccine was below the 95% target (range: 85–99%) in 11/30 countries of the European Union/European Economic Area [8].

In highly-developed countries, many sociodemographic characteristics are linked to vaccination coverage: having a single mother, a young mother, having a large number of siblings, and living in multiple households [9–16]. However, when indicators of parental socioeconomic status (SES) are considered – as the level of education, household income, employment situation -, results are inconsistent. Most studies showed that immunization coverage was most prevalent among disadvantaged children [9,10,17–24]. Other studies showed a negative trend in compliance to vaccination among parents with higher education or SES [25–27], while a few authors reported no association between parents' SES and vaccine uptake [11,28]. In Italy, there is a lack of recent studies on the issue. One study showed that children of mothers with higher education are more likely to be immunized against MMR [17], while another study found no association between maternal education level and age appropriate vaccination against mandatory vaccines [16]. A recent study found no association among parental education level and MMR uptake, but it was limited to only two vaccination centers in the Palermo area (Southern Italy) and performed on a small number of parents (almost 400) [29].

Experience in some countries also points to difficulties in reaching the children of migrants with routine vaccination services because their parents are either unaware of these services or unwilling to use them for cultural, religious or other reasons [30]. Some studies have identified a positive association between being unvaccinated and belonging to migrant or ethnic minority groups [9,10,12–14,18,27,31,32]. Almost all the above-mentioned studies were not population based, however, and they adopted a cross-sectional design, with few exceptions [9,11,20,26,28].

We therefore aimed at: (i) to assess the trend in the proportions of unvaccinated children (for both compulsory and MMR vaccination) at 24 months old; (ii) to identify sociodemographic factors associated with non-vaccination, focusing on the mother's formal education and citizenship; (iii) to determine whether sociodemographic factors influence parents' attitudes to vaccination and how this has changed over time. To do so, we used two population-based birth cohorts in two Italian regions.

2. Methods

2.1. Study population

We used a population-based birth cohort study design. The study areas were the Friuli Venezia-Giulia (FVG) region (population about 1.2 million, with 10,000 births a year), and 4 Local Health Units part of the Emilia Romagna region (ER) comprising Modena, Ravenna, Cesena and Rimini (population of about 1.5 million, with 15,000 births a year).

Since 1980, FVG has operated a centralized system that automatically collects and pools data on healthcare funded by the NHS using a unique anonymous ID regional code. Individual data on mother and father, pregnancy, labor and delivery, and the newborn are collected in a medical birth register (MBR), which is linked to other healthcare records. The region has a centralized vaccination registry that has recorded vaccine uptake on an individual level since 1995. In Emilia-Romagna, MBR data were available for all children born in Modena, Ravenna, Cesena and Rimini since 2007. Completeness of Medical Birth Register in providing data on maternal education and citizenship was almost 100% in FVG and ER. Childhood vaccination data were retrieved from the databases of the Local Health Authorities, subsequently encrypted and linked with the MBR and mortality data.

All babies born in FVG from 1995 to 2010, and in ER from 2007 to 2011, identified using the regional MBR, alive at 24 months, and resident in the study areas were enrolled in the cohorts and followed up for two years after linkage with the vaccination registries.

2.2. Definitions of outcome and determinants

The current vaccination schedule involves the administration of a hexavalent vaccine that includes the four compulsory vaccines (diphtheria, polio, tetanus, hepatitis B), plus pertussis and Hib. Primary immunization with this hexavalent vaccine consists of three doses, administered at 3, 6 and 11–13 months of age, while optional MMR immunization is a single dose scheduled at around 15 months of age. For the purpose of our analyses, children were defined as unvaccinated for compulsory vaccines if they had received no compulsory vaccination in their first 24 months of life, or vaccinated if they had received at least one dose of any of these vaccines, and MMR unvaccinated/vaccinated if they had or not received the MMR vaccination dose in their first 24 months of life.

Information was obtained from the MBR on all possible determinants, i.e. birth order, number of children, mother's age at child's birth (<25, 25–34, 35–39, 40+), marital status (married/unmarried), formal education (lower than high school, high school, university) and parental citizenship. For maternal citizenship, countries were grouped into geographical areas in: Italy, other Highly Developed Countries (not Central-Eastern Europe, North America, Oceania, Israel and Japan); Balkans and Eastern Europe (Croatia, Slovenia, Slovakia, Cyprus, Poland, Romania, Hungary, Estonia, Latvia, Lithuania), Central/South America, Africa (North Africa, Sub-Saharan Africa); and Asia (except for Israel and Japan). Maternal and paternal citizenships were then categorized in Italian/non Italian. Stateless individuals were included in the non-Italian group.

2.3. Statistical analysis

All the analyses were run separately for the two Italian regions. In the descriptive analysis, we calculated the frequency for each determinant in the two cohorts. A Chi-squared test was used to examine the difference between FVG and ER groupings (Table 1).

Please cite this article in press as: Anello P et al. Socioeconomic factors influencing childhood vaccination in two northern Italian regions. Vaccine (2017), http://dx.doi.org/10.1016/j.vaccine.2017.07.058