The impact of a school-based multicomponent intervention for promoting vaccine uptake in Italian adolescents: a retrospective cohort study

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Abstract

Background. In Italy, the National Immunization Prevention Plan recommends for adolescents between ages 11 and 18 several vaccines, however their adherence is below the expected coverage. School-based delivery strategies might represent an alternative to primary care settings. This study aims to evaluate the impact of a school-based intervention aimed to increase the vaccination uptake among Italian secondary class students.

Methods. One of the four schools in which a school-based multicomponent intervention was previously carried out has been matched with a control school in the same geographical area. Students' coverage for mandatory and recommended vaccinations was assessed before and after an 8 months period using the Local Health Authority Immunization Register.

Results. Seven hundred and fifty-five resident students in the RM Local Health Authority were included: 265 from the intervention school, 490 from the control school. At baseline, the two schools were comparable for grades and sex distribution; the intervention school had significant higher immunization rates for Meningococcal B, but lower ones for the 4th dose of dTap. After eight months, higher percentage of students received the HPV (30.5% vs 13.8% of females; p = 0.003) Meningococcal C (6.0% vs 2.0%; p = 0.005) and Meningococcal B (14.7% vs 0.3%; p < 0.001) vaccines in the intervention school compared with control. The pre-post differences between the two schools in the immunization rates were significantly higher in the intervention school for the HPV, Meningococcal C and B vaccines.

Conclusions. This study demonstrates that a school-based health promotion project was effective in improving the recommended vaccines uptake among adolescents with potential interesting implication for the national target attainment. Considering the importance of informing and educating, innovative school-based health promotion programs could represent an excellent opportunity for the Local Health Authorities to get in touch with a hard-to-reach target. Performance in offering the vaccination in school facilities should be evaluated.

INTRODUCTION

Vaccines are universally recognized as one of the most effective instruments for the primary prevention of infectious diseases, but in recent years vaccination delay or refusal is putting at risk the high level of immunization rates achieved in the past. This phenomenon, namely vaccine hesitancy, could be due to multiple levels of factors that influence parental vaccine confidence

Key words

- immunization
- schooladolescents
- students
- vaccine uptake

and acceptance [1]. Apart from the risk perception of the diseases and the confidence on vaccines, the WHO SAGE Working Group on Vaccine Hesitancy pointed out "convenience" as a possible explanation related to the ease of access to immunization in terms of location and time [2]. Immunizing adolescents represent globally a struggle despite national routine recommendations. In Italy, the National Immunization Prevention Plan recommends for adolescents between 11 and 18 years the following vaccines: diphtheria, tetanus, and acellular pertussis (dTpa), catch-up strategies for measles, mumps and rubella (MMR); Meningococcal C conjugate in subjects not vaccinated during childhood, two/ three-dose schedule against HPV (only for females); a two-dose schedule against varicella in subjects unvaccinated or with negative history for the disease [3]. Regardless, respectively 52.9%, 53.9%, 74.9%, 75.0% and 16.0% of 16 years old adolescents received the fifth dose of dTap, the second dose of MMR, the first dose of rubella and mumps and one dose of Meningococcal C [4]. HPV vaccine coverage rates ranged from 72.1% for the 1999 birth cohort to 52.4% for the 2002 birth cohort (even if the latter is not still definitive) [5]. The coverage for the remaining available vaccines is lower than 10%, in particular 2.4% for varicella [4].

With the availability of newer vaccines and greater attention to providing booster doses of routine vaccines to older children, schools are becoming a more widely used platform for immunization [6]. In several countries, school-based health centres represent an alternative to primary care settings and have been shown to minimize common obstacles, such as parents missing work, therefore increasing immunization rates [7-10].

Despite the relevant success of the extraordinary measles catch-up campaign in several Regions, which include also the MMR vaccine delivery in elementary and middle schools, [11], Italy does not have a wellstructured school-based immunization program. Furthermore, with the gradual shelving of the scholastic preventive medicine [12], Italian students are losing several opportunities to receive trustworthy information regarding vaccination and, consequently, protection against vaccine preventable diseases. This kind of activity has been delegated to the paediatricians, which usually visit their older patients only if they have health issues. Eventually, the Local Health Authority, in respect of its own autonomous organization, could implement voluntarily, but no more mandatory, school-based health promotion campaign, which are usually target to contrast non-communicable diseases, to promote healthy lifestyle and to fight dependencies.

For all these reasons, the Public Health Institute of the Università Cattolica del Sacro Cuore of Rome decided to design a project called "VacciniAmo le Scuole" (Let's school get vaccinated), which proposes to evaluate and enhance parents' and students' knowledge and attitudes of prevention regarding vaccine-preventable diseases in collaboration with the Italian Ministry of Education and the Local Health Authorities. Preliminary results provided further evidence about school-based health promotion programs as an effective strategy for improving knowledge and attitudes about this issue [13]. Since the original study design did not consider a control group, definitive conclusions about the project impact on the general vaccine coverage among the target population couldn't be carried out. The present study aimed to overcome this limitation evaluating the impact of a school-based multicomponent intervention on the adherence of Italian secondary school students to adolescent recommended vaccination. In this study, we hypothesized that the school involved in the VaccinAmo le Scuole project reported significantly higher rates of immunization of recommended vaccinations for adolescents compared with a school who did not receive the health promotion intervention (the control group).

METHODS

The intervention: VacciniAmo le Scuole project

The VacciniAmo le Scuole project was conducted in 2015 in four secondary schools in three Italian Regions (Lazio, Basilicata and Sicily), with the support of the local health authorities (ASL Roma A (now ASL Roma 1), ASL Roma B (now ASL Roma 2), ASM Matera and ASP Palermo). Each class received a 90 minutes health promotion intervention, which includes a theoretical introduction and a second part more interactive using the role-play technique, and a pre-post questionnaire [14]. Students' parents received at home a similar questionnaire, which includes a section requesting their informed consent and invitation to a meeting with the project team. All the health promotion activities have been carried out in deep collaboration with each representative of the local health authorities. After the school interventions, each Local Health Authority arranged to receive students and parents at least one day in their surgery to carry out the recommended vaccinations for adolescents. Detailed information regarding the project and its results are under submission separately. The VacciniAmo Le Scuole project was approved by the Ethical Committee of the Local Health Authorities "Roma 1" (Ref. n. 513 CE Lazio1 - Rome, 02/03/2017).

Study design and schools recruitment

The impact of the school-based multicomponent intervention VacciniAmo le Scuole was tested using a retrospective cohort design, comparing the aggregated immunization coverage in one of the schools in which the VacciniAmo le Scuole has been performed (intervention school) to a matched school from the same geographical area.

The intervention school was selected from the four schools participating in the VacciniAmo le Scuole according to the number of students involved in the project and the availability of a comparison school in the same geographical area. Only the school in the ASL ROMA1 respected these inclusion criteria. Consequently, its referent recruited a control school from the same administrative area, according to geographic vicinity and with similar socio-demographic characteristics. In this way the control school could be considered similar both in terms of the attending students (including from a socio-demographic point of view), both in terms of its relationship with the ASL. As a matter of fact, apart from the VacciniAmo le Scuole intervention, for every registered student of both the schools received yearly a personalized letter, which informs each one regarding his own immunization status.

The intervention school has 413 registered students, but only 284 participated in the VacciniAmo le Scuole project and have been included in this study. All the 517 students registered in the control school have been included in this study.

The main outcomes were the proportion of students receiving each vaccination mandatory/recommended for adolescent, namely the 5th dose of dTap, the 2nd dose of MMR, a dose of HPV (among girls), one dose of Meningococcal C (in subjects not vaccinated during childhood). Furthermore, because in 2015 the ASL ROMA1 was pursuing also the Meningococcal B vaccine, the proportions of students who received at least one dose of this vaccine were investigated as a secondary outcome. Finally, also the proportion of students receiving at least one among the above-mentioned vaccines has been evaluated as a secondary outcome because it represents a proxy of the opportunity to meet experts from the local health authority which can provide students with the best knowledge on vaccine preventable diseases for them. Because of the shifting from three to two doses schedule (only for the new cohorts of 12 years old girls whom initiated the HPV vaccination in 2015), the outcome regarding the HPV vaccine was considered as the initiation or the completion of a 2-dose HPV series. The vaccination against varicella was excluded because of the impossibility to assess the negative history for the disease in the students. It should be underlined that in people aged 11 to 18 years the above-mentioned mandatory/recommended vaccinations are free of charge, while the Meningococcal B vaccination are offered under a discounted payment because in 2015 it is not yet included in the National Immunization Plan.

All the outcomes were evaluated in both intervention and control schools just before and at 8 months since the implementation of the VacciniAmo le Scuole project.

Data sources

The head of the two schools provided the student list with information on their school grade. Students' coverage for mandatory and recommended vaccinations was assessed using the Local Health Authority Immunization Register, which routinely collected data deriving from the national Immunization Program for residents within their administrative boundaries. Students were not counted in the analysis if they were resident in another local health authority, because lack of information regarding immunization history and administration. That's led to the exclusion of 46 non-resident students in the ASL ROMA1 (19 students in the intervention school and 27 in the control school, p = 0.393).

The two above-mentioned data sets were merged using the student's tax code as key and the observations were made anonymous assigning a casual numerical code.

Students' vaccination history was ascertained before the program started in the intervention school (February, the 15th) and again after 8 months (from February, the 16th until October, 15th). Eight months have been considered as the follow-up period until the end of the scholastic year, giving two additional months to take into account that during the summer holidays parents could postpone the decision to vaccinate their children.

Students were considered to be already immunized if they had at baseline the appropriate number of doses for each immunization recommended in the National Immunization Plan (4 or 5 doses of dTap, 2 doses of MMR, at least 2 doses of HPV only for girls, at least 1 dose of Meningococcal C or B). For the dTap the information regarding the immunization status was calculated for a 4th dose, which should be completed at the age of 5-6 years old, and for the 5th dose, which should be administered every 10 years after the 4th dose (so around 15-16 years), but that is usually co-administered during the first access to the immunization center after 11 years old to make the vaccination schedule easier.

Among the students who were not already fully immunized, the ones who received the expected doses were recorded and a comparison between pre and post intervention coverage was done. For the dTap the 5th dose was considered the expected one and students that have already received it were considered fully immunized.

Statistical analysis

Descriptive data were summarized through absolute and relative frequencies for categorical variables and through means and Standard Deviations (SD) for continuous variables.

Chi Square was used to compare differences between variables of interest at baseline. Overall and stratified vaccine uptake rates between the two schools were compared using two sample tests of proportions. Furthermore, to take into account the baseline immunization coverage, the same statistical test was used to compare within and between differences in the vaccine specific pre-post immunization rates.

Statistical significance was set for p value <0.05 and all statistical tests were two-sided. Statistical analysis was performed using Intercooled Stata 12 for Macintosh (Stata Corporation Lakeway, USA, 2007).

RESULTS

755 resident students in the ASL ROMA1 were included in this study, 265 from the intervention school, 490 from the control school. Their mean age was 12.3 (\pm 1.0) years and 48.1% of them were girls. The school grades and sex distribution did not differ between the two schools. At baseline, the intervention school had significant higher immunization rates for Meningococcal B, but lower ones for the 4th dose of dTap. Among the 755 students, 40.4% needed 1 or more vaccines, significantly more in the intervention school (46.0%) than in the control one (37.3%). Characteristics of the schools as well as baseline immunization rates are shown in *Table 1*.

Table 2 reports the results of the intervention under study after eight months. A higher proportion of girls not already fully immunized for HPV received the HPV vaccine in the intervention group (30.5% vs 13.8%; p

Table 1

Characteristics and baseline immunizazion rates of the two schools included in the study

		Sch	School		
		VacciniAmo	Control	(chi2)	
Residents (N = 755)		265	490	0.393	
Sex (% of Females)		130 (49.4%)	(240) 48.9%	0.906	
School Grade	I	93 (35.9%)	163 (33.3%)	0.359	
	II	94 (35.9%)	158 (32.2%)		
	III	78 (28.2%)	169 (34.5%)		
Immunization status (Students Already Immunized)	dTap (4 doses)	210 (79.3%)	429 (87.6%)	0.003	
	dTap (5 doses)	18 (6.8%)	38 (7.8%)	0.498	
	MMR (2 doses)	202 (76.2%)	398 (81.2%)	0.105	
	HPV (at least 2 doses - females)	49 (37.7%)	110 (45.8%)	0.131	
	Men C (at least 1 dose)	98 (43.2%)	177 (36.1%)	< 0.071	
	Men B (at least 1 dose)	15 (5.7%)	0 (0.0%)	<0.001*	
	Already Immunized for all the above	143 (54.0%)	307 (62.7%)	0.020	

* Fisher' exact test.

= 0.003). Similarly, a higher proportion of students received Meningococcal C (6.0% vs 2.0%; p = 0.005) and B (14.7% vs 0.3%; p <0.001) vaccines (*Table 2*) in the intervention group respect to the control. Although not statistically significant, a higher proportion of students received at least one of the mandatory/recommended vaccines in the intervention respect to the control school (41.2% vs 33.9%; p = 0.149).

The sex and the school grade of the students not already fully immunized that received individual vaccines are shown in *Figure 1*. Only one male student of the 3^{rd} year received the second dose of MMR (not shown in *Figure 1*). Excluding HPV vaccines, usually males receive more vaccinations than females (57%, 75% and 64%, respectively for dTap, MenC and MenB). DTap uptake is higher in 3rd year students, while HPV and MenB is higher in the first class students (*Figure 1*).

Lastly, we compared the immunization coverage rates before and after the intervention under study. Results reported in *Table 3* are consistent with those reported in

Table 2

Results of the intervention VacciniAmo le Scuole as proportion of students undergoing vaccination among those not already fully immunized *

Individual vaccines	VacciniAmo N (%)	Control N (%)	р
DTP	28 (11.3)	54 (11.9)	0.796
MMR	1 (1.6)	0 (0.0)	0.406**
HPV (females)	25 (30.5)	18 (13.8)	0.003
MenC	19 (14.7)	1 (0.3)	<0.001**
MenB	15 (6.0)	10 (2.0)	0.005
At least One (DTP, MMR, HPV, MenC, MenB)	61 (41.2)	79 (33.9)	0.149

* The denominator of each cell is represented by the difference between the included students and the students already immunized with the specific vaccination (showed in *Table 1*). ** Fisher' exact test.

Table 2. The intervention school reported a significant increase in the HPV, Meningococcal C and B immunization rates (+11% (p = 0.002); +8.1% (p = <0.001) and +3.7% (p = 0.008), respectively. In particular, girls in the intervention school had lower HPV coverage at baseline (37.7% vs 45.8%), but they reached higher immunization rates at 8 months after the project implementation (56.2% vs 53.3%).

DISCUSSION

Currently, most countries in the world deliver nationally recommended vaccines to adolescents primarily through school-based vaccination centers. This approach has largely overcome missed opportunities for vaccinating adolescents in traditional healthcare settings allowing higher coverage for most of the available vaccination than in delivering systems based on the community sector or private practice [15]. Other Authors highlighted that school based educational intervention helped improve vaccination coverage among adolescents regardless of the venue of vaccination [16].

In Italy, despite this growing evidence and the large public offer of vaccinations, there is no national program in place to promote vaccine uptake on a school level that remains globally underused with a consequent inadequate access to preventive health care for adolescents. Nevertheless, the unexpected decrease in national immunization rates and the newly adopted National Vaccination Plan could enhance Regional and Local Autonomy to reinforce their efforts in this field, requiring country specific information regarding feasibility and efficacy of tailored school programs.

VacciniAmo le scuole is an innovative multicomponent health promotion program that as been shown effective in improve knowledge and attitudes towards vaccine preventable diseases among young Italian adolescents with an overall high acceptance among teachers and students [13], which is in agreement with previously published papers [17]. However, no evidence was



Figure 1

Students not already fully immunized receiving individual vaccines, stratified according school grades (first column: black = 1st year; grey = 2nd year; light grey = 3rd year) and sex (second column: vertical red line = Females; horizontal light blue line = Males).

available regarding its efficacy in improving the vaccine uptake among program participants that is evaluated in this retrospective cohort study in comparison to a standard-of-care approach.

Eight months since its implementation, vaccination coverage for most of the recommended vaccinations was higher in intervention school than in the control one. That's particularly true for HPV vaccination among girls, but also for Meningococcal C and B vaccines. For all these vaccines, as already shown by different authors, the higher uptake has been recorded in younger students [15, 18]. Furthermore, we recorded a higher uptake of Meningococcal C and B vaccines among males, which has been suggested due to the more vaccinations required for females [19].

The 5th dose of TdaP has been required by a small proportion of students, mostly in the third school grade and without differences between the two schools, presumably because parents and students was waiting for the proper schedule, which is usually administered a couple of year later. Similarly, the 2nd dose of MMR vaccine is required only by one student in the intervention school, with unsuccessful coverage, which remained around 80% in both schools, quite far from the 95% target identified in the national plan for eliminating measles and congenital rubella syndrome [20]. In this study we do not have information regarding the students history nor the specific serum antibodies, and it should not be excluded that the wild disease has already affected most of these students.

Additionally, despite the higher rate of students receiving at least 1 vaccine in the intervention school (41.2% vs 33.9%) that exceeded the control school in the overall coverage for all the investigated vaccines, it should be said that both the schools remain far from the national targets. Even if we have no insight into why necessary vaccines were missed, one possible reason relies on the fact that the vaccinations have been administered in a different location than in the ambulatory of the school. This reason should be taken into strong consideration when implementing a schoolbased health promotion program while the opportunity

Table 3

Within and between schools differences in the immunization coverage pre and post the intervention VacciniAmo le Scuole

	Post intervention immunization coverage (within-schools pre-post difference)			Between-schools pre-post differences		
	VacciniAmo	Р	Control	Р	VacciniAmo - Control	Р
dTap (5th dose)	17.0% (+10.2%)	<0.001	18.8% (+11.0%)	<0.001	-0.8%	0.725
MMR (2nd dose)	76.6% (+0.4%)	0.919	81.2% (+0.0%)	1.000	+0.4%	0.174
HPV (females)	56.2% (+18.5%)	0.003	53.3% (+7.5%)	0.100	+11.0%	0.002
MenC	51.5% (+8.3%)	0.074	36.3% (+0.2%)	0.947	+8.1%	<0.001
MenB	11.3% (+5.7%)	0.019	2.0% (+2.0%)	0.002	+3.7%	0.008

to receive the health intervention is delayed in space and time [21, 23].

The success in increasingthe actual vaccination rates could be attributed to several factors. First, the health promotion intervention has been carried out using innovative and interactive approach, namely the role play, which has been very appreciated by the schools [14]. Secondly, the intervention has been developed in deep collaboration with the local health authority. For this reason, it is tailored according to the local needs and all the project team has been available to address students, parents and teachers' concerns regarding vaccination along the project period. Finally, while most of the school-based programs have been focused on a specific vaccine (usually the HPV), this project has been developed to increase the awareness and the coverage of all the recommended vaccination for adolescent.

This study has several limitations. Generalization should be done with caution because the setting is limited to a couple of urban schools and a small number of adolescents. Student's randomization is not possible due to the specific school setting. Additionally, the control school has been matched as much as possible for socio demographic characteristics and the two groups did not show significant difference at baseline for sex and school grade. Also the immunization status at baseline is quite balanced between the two schools, with some vaccine coverage higher in the intervention school (Meningococcal C and B), but others higher in the control one (dTap, MMR and HPV). Finally, even if the immunization registry is a high reliable source of information, it is limited to vaccination administered within the local health authority boundaries. For this reason we had to limit our sample to the residents within the local health authority and we cannot exclude, even if it is unlikely, we lose some information on students who decided to be vaccinated outside the ALS Roma 1.

This study demonstrates that the school-based multicomponent health promotion project VacciniAmo le Scuole was effective in improving the recommended vaccines among adolescents with potential interesting implication for the national targets attainment. Larger and multi-centric studies may help to understand the real advantages when a school-based model of immunization delivery is implemented in Italy. Even thought Italy has recently passed a law to make mandatory 10 vaccinations and to make vaccination a school requirements for children under the age of 16, multicomponent school based immunization campaigns could be helpful to overcome several well-known barriers to adolescent immunization, such as the need for parents to miss work or the opportunity for the ASL to get in touch with a hard-to-reach target, as well as to increase the

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population confidence in the health institutions [24].

CONCLUSIONS

Our results suggest that innovative school-based health promotion intervention could increase adolescent specific vaccination uptakes and coverage. The Local Health Authorities should implement and evaluate similar school-based interventions to give Italian students trustworthy information regarding vaccination and, consequently, being protected against vaccine preventable diseases. Better results could be reach offering the vaccination in school facilities.

Author's contribution statement

All authors have made substantial contributions to the analysis and interpretation of data and have approved the final version of the manuscript. Andrea Poscia and Antonietta Spadea has been involved in the conception and design of the study and in the data acquisition, Andrea Poscia and Roberta Pastorino analyzed the data and drafted the article and Antonietta Spadea, Stefania Boccia and Walter Ricciardi revising it critically for important intellectual content.

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Conflict of interest statement

The Authors declare they have no potential conflicts of interest to disclose.

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