Knowledge and attitudes on pediatric vaccinations and intention to vaccinate in a sample of pregnant women from the City of Rome

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ABSTRACT

Background: In recent years, pediatric immunization rates in Italy have decreased well below the recommended thresholds, largely due to an increase in scepticism about the efficacy and safety of vaccines. We aimed to identify the degree of such scepticism, and the factors driving it, among a sample of pregnant women in the City of Rome.

Methods: We conducted a cross-sectional survey on a sample of pregnant women attending antenatal classes (CANs) in Rome through distribution of a self-administered questionnaire. Multiple logistic regression models were built to analyze the determinants of knowledge, attitudes and intention to vaccinate in this population.

Results: A total of 458 pregnant women attending CANs in 36 family health centers and two hospitals in Rome answered the survey. Mean age was 32.9 (±5.0) years, and over 90% of women were in their first pregnancy. More than 26% of respondents showed a good level of knowledge of the safety and efficacy of vaccines, but there were high rates of uncertainty or agreement with some of the most common anti-vaccination sentiments. Only 75% of women were sure about vaccinating their children with the hexavalent vaccine, and 64.3% with MMR. A good level of knowledge was the strongest predictor of positive attitudes towards vaccination (OR 11.61, 95% CI 6.43–20.96), which, in turn, influenced the intention to vaccinate for most vaccines with the perception of the benefit of immunization for protection against disease.

Conclusions: Scepticism about the safety, efficacy and importance of vaccines is associated to pregnant women's hesitancy to vaccinate their children, suggesting the need to develop strategies to increase vaccine acceptance in the antenatal period. The capacity of health care professionals, particularly midwives, to correctly deliver information to future parents should be strengthened in order to reduce the spread of misinformation and fear of vaccine safety.

1. Introduction

During recent decades, vaccine hesitancy, defined by the WHO Strategic Advisory Group of Experts (SAGE) on Immunization as "delay in acceptance or refusal of vaccination despite availability of vaccination services" [1], has been increasing globally, with high rates of scepticism about vaccine safety recorded in particular in European countries, including Italy [2]. Based on a review of existing literature [3] and expert opinion, an explanatory matrix of vaccine hesitancy has been developed by the SAGE, identifying three categories of determinants: contextual, individual and group, and vaccine/vaccination-specific influences [1]. Several studies have shown the role that population clusters of hesitancy and anti-vaccination sentiment may play in lowering herd immunity and contributing to disease outbreaks [2,4–6].

As a consequence of growing scepticism towards vaccination during the period 2014–2016, Italy has experienced a marked decrease in pediatric immunization rates. The coverage for polio, diphtheria, tetanus and hepatitis B had already fallen below the recommended threshold of 95% in 2014 and this downward trend was confirmed in the following years [7]. A 4% decline in coverage

for the first dose of measles-mumps-rubella (MMR) vaccination was observed between 2012 and 2015, with vaccination rates falling from 89.2% to 85.2% [7]. In 2017, Italy experienced an outbreak of measles, with 5098 cases reported up to December 2017 [8–10], 95% of which occurred among unvaccinated individuals or individuals vaccinated with only one dose; there were four deaths. To counteract the fall in vaccination coverage and the increase in vaccine-preventable disease rates, the Italian Parliament approved a law in July 2017 (no. 119/2017) obliging all preschool pupils (aged 0–6) to be immunized against 10 diseases (polio, tetanus, diphtheria, pertussis, hepatitis B, *Haemophilus influenzae* type B, measles, mumps, rubella, varicella). Compliance is necessary for admission to state-run schools, and parents who do not vaccinate children enrolled in compulsory education are fined [11]. Data on 2017 vaccination coverage suggest the new law is working: polio immunization rates show a national average of almost 95% with 11 of the 22 Regions reaching the threshold of 95%, while measles coverage has reached rates of 91.68%, representing a 4.42% increase compared to 2016 [12,13]. However, this legislative measure by itself will not be sufficient to guarantee the compliance among preschoolers, since education in this age group is not compulsory. Introduction of this law may also be counterproductive if it decreases trust in health institutions among the large group of hesitant parents, thereby worsening the polarization in opinion on vaccination [14]. A lively debate about the mandatory vaccination policy is currently ongoing in Italy, with the newly established Government discussing the possibility of revising law 119/2017. Within this context, the development of initiatives aimed at increasing the trust of Italian citizens in vaccination is of paramount importance.

We conducted a cross-sectional survey of the knowledge, attitudes and intention to vaccinate of pregnant women attending antenatal classes (corsi di accompagnamento alla nascita - CANs) organized by the family health centers of the City of Rome's Local Health Units (Aziende Sanitarie Locali- ASL). The choice of this population was driven by the observation that the antenatal period is when attitudes and beliefs about childhood vaccines first take shape [15]. The study was conducted prior to the approval of the law on compulsory vaccination in Italy and was intended to provide evidence to underpin the development of strategies aimed at increasing vaccine acceptance among the general population, in addition to restrictive policy measures. The final aim was to obtain a picture of vaccine hesitancy and its determinants in the specific population of pregnant women surveyed and to allow the design of tailored strategies to increase trust in immunization.

2. Methods

2.1. Study population

The study was coordinated by the Section of Hygiene in the Department of Public Health and Infectious Diseases of Sapienza University of Rome, with the authorization of the Directors General and Health Directors of the three Local Health Units (Aziende Sanitarie Locali; ASL) of the City of Rome (ASL Roma 1, ASL Roma 2, ASL Roma 3). A coordinating team, composed of a PhD candidate in Public Health and a senior resident physician in Hygiene and Preventive Medicine, was responsible for contacting the referents for each ASL and the midwives in charge of the CANs in each Family Health Center, and for supervising the team that administered the survey. This team was composed of resident physicians from the School of Specialization in Hygiene and Preventive Medicine of Sapienza University of Rome.

A self-administered questionnaire was distributed by team members to a sample of pregnant women attending CANs orga-

nized by the family health centers of the three ASL during the period April 2016-April 2017. One antenatal course was randomly selected for each Family Health Center. In addition, two hospitals equipped with a birthing unit, which organize CANs in Rome (one university hospital and one non-academic center), were also randomly selected, to increase the representativeness of the sample.

Participants also received an accompanying letter for informed consent, explaining the details and purposes of the study and guaranteeing participants anonymity. If a particular CAN included a class on pediatric vaccinations, the distribution of the questionnaires was scheduled before that class. One team member supervised the administration of the questionnaires in each center.

The administration of the questionnaires was interrupted when the Italian Government approved the Law 119/2017, since it was assumed that the introduction of the new legislative measure could bias the responses to the survey.

2.2. Questionnaire

Since no tool was available to assess knowledge of and attitudes towards vaccines, together with determinants of vaccine hesitancy in the population of pregnant women, a specific questionnaire was developed for this purpose, based on a review of the literature on existing tools to assess vaccine hesitancy in parents and on the determinants of vaccine hesitancy [2,15–22] (see Annex 1). A pilot phase was conducted on 49 pregnant women attending the CANs in three Family Health Centers of ASL Roma 2 in April-May 2016, with the aim of assessing clarity and appropriateness of questions, as well as the validity of the questionnaire. The results of the pilot phase showed the questionnaire to be both a reliable and valid tool for assessing the level of knowledge, attitudes and vaccine hesitancy among pregnant women [23], although one question was slightly rephrased to improve clarity. The tool was structured in six sections: personal and reported experiences of vaccine side effects (5 items); knowledge of vaccination schedule, and of the efficacy and safety of vaccines (4 sets of items); attitudes towards and perception of the efficacy, convenience and value of vaccination (3 sets of items); knowledge of and attitude towards the MMR vaccine (1 set of items); intention to vaccinate (2 sets of items); and personal information (10 items). Personal information, experiences of vaccine side effects and source of information on vaccinations were assessed by multiple-choice questions; open fields were also included to add specific information on the type of experience or to better specify some socio-demographic information. Three-point answers (*Agree, Uncertain, Disagree*; or *Yes, Uncertain, No*) were used to assess knowledge of and attitudes towards vaccines, measuring the degree of agreement with specific statements (eight statements assessing knowledge of the safety and efficacy of vaccines, and 12 exploring attitudes towards the efficacy, value and convenience of vaccinations), and also to assess the perceived benefit of vaccination for protection against infectious diseases and the future mothers' intention to vaccinate their children. The perceived quality of the information received on vaccination and of the healthcare system in Italy, and the women's perception of their own knowledge of vaccinations (which we term "self-perceived knowledge") were instead assessed through a five-point Likert scale (*Excellent, Good, Adequate, Inadequate, Poor*).

2.3. Statistical analysis

A descriptive analysis of questionnaire responses was conducted using absolute frequencies with percentages (categorical variables) and means with standard deviation (SD) (continuous variables). An analysis of determinants of knowledge, attitudes and intention to vaccinate was also conducted through the construction of multiple logistic regression models. We opted for

logistic regression since the underlying assumptions for multiple linear regression (normality, linearity, homoscedasticity) were not met. The variables "knowledge" and "attitudes", originally consisting of multiple categories, were collapsed into two levels to allow an overall assessment of the level of knowledge of and attitudes towards the safety, efficacy and delivery of vaccines. In brief, for the knowledge variable, responders were divided into those who agreed with correct responses for at least six of the eight statements included in the questionnaire versus all others, while for attitudes, pregnant women were grouped into those who showed a positive attitude towards at least eight of the 12 statements included in the questionnaire versus all others (cut-off levels were chosen based on the 75th percentile of answers). Two scores were also built to assess knowledge and attitudes (knowledge score and attitudes score), obtained by summing up the correct number of answers provided in the specific sections of the questionnaire.

Outcomes assessed were: (a) higher level of knowledge of the safety and efficacy of vaccines; (b) positive attitudes towards the safety, efficacy and supply of vaccines; (c) intention to vaccinate with hexavalent, trivalent MMR, anti-chickenpox, anti-meningococcal B, anti-meningococcal C, anti-rotavirus, anti-pneumococcal (vaccines included in the Italian national vaccination schedule, which includes both "mandatory" and "recommended" vaccines), defined as a "Yes" answer to the specific question included in the questionnaire. The following predictor variables were initially tested in the three models: socio-demographic data (age, primiparity, nationality, level of education, political orientation, marital status, smoking habits, eating preferences (e.g. omnivore vs vegetarian), preferred type of treatment (e.g. mainly homeopathy/phytotherapy vs allopathic medicine)); source of information on vaccinations; previous experiences with vaccination side-effects; and perceived quality of the NHS. All variables were dichotomized for the purpose of analysis. Knowledge was included as an additional covariate to assess its association with both attitudes and intention to vaccinate, and for the latter we also assessed the level of attitudes and the perceived ability of vaccinations to protect against the specific diseases in question.

Multiple logistic regression models were built using the strategy suggested by Hosmer and Lemeshow [24]. Each variable was examined by univariate analysis using the appropriate statistical test (Student's t-test or χ^2 test) and was included in the model when the p-value was less than 0.25. Subsequently, multivariate logistic regression with backward elimination of any variable that did not contribute to the model on the grounds of a likelihood ratio test (cut-off, p = 0.05) was performed. Variables whose exclusion altered the coefficient of the remaining variables by more than 20% were kept in the model. Interaction terms (such as the interaction between political orientation, trust in the NHS and source of information) were tested using a cut-off significance level of 0.15. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. An OR > 1 was indicative of an association with a higher knowledge and positive attitudes towards vaccinations, and with the intention to vaccinate with vaccines included in the national vaccination schedule. All statistical calculations were performed using Stata version 15.0 (Stata Corporation, College Station, TX, USA).

3. Results

The final sample constituted 458 pregnant women in their third trimester, participating in 38 CANs organized by 36 Family Health Centers (10 from ASL Roma 1, 18 from ASL Roma 2 and eight from ASL Roma 3) and two hospitals (University Hospital Policlinico Umberto 1 and Santo Spirito Hospital), with a response rate of 98.3% (458/466). Mean age of respondents was 32.9 (±5.0) years, over 90% of women were in their first pregnancy, and most of them were Italian. The main socio-demographic features of the sample are summarized in Table 1.

3.1. Personal experience of vaccination and knowledge of safety and efficacy of vaccines

The most frequently reported source of information on vaccinations was word of mouth (62.6% of the sample), followed by traditional media, such as TV and newspapers (33.6%) (Table 2). Unofficial web sources (e.g. blogs, forums, non-institutional web sites) were consulted with approximately the same frequency as

Table 1
Socio-demographic characteristics of the sample.

Variables	N	%
First pregnancy (455)[a]		
Yes	412	90.6
No	43	9.4
Place of birth (267)[a]		
Lazio Region	182	68.2
Other Italian Regions	31	11.6
Foreign country	54	20.2
Education (436)[a]		
Primary school	1	0.2
Lower secondary school	16	3.7
Professional qualification	14	3.2
Upper secondary school	146	33.5
University graduate	198	45.4
Post-graduate	61	14.0
Marital status (443)[a]		
Unmarried	234	52.9
Married	206	46.5
Separated/divorced	1	0.2
Other	2	0.4
Political orientation (387)[a]		
Right	26	6.7
Center-right	24	6.2
Center	9	2.3
Center-left	57	14.7
Left	91	23.5
Populistic movements	56	14.5
Other	14	3.6
Don't know	110	28.4
Religious orientation (427)[a]		
Practicing believer	131	30.7
Non-practicing believer	195	45.7
Atheist/agnostic	101	23.6
Smoking habits (440)[a]		
Smoker	22	5.0
Former smoker	178	40.5
Non-smoker	240	54.5
Dietary habits (420)[a]		
Omnivorous	395	94.1
Vegetarian	14	3.3
Other	11	2.6
Treatment preferences (442)[a]		
Only conventional drugs	168	38.0
Mostly conventional drugs, but also homeopathic and phytotherapic products	207	46.8
Mostly homeopathic and phytotherapic products, but also conventional drugs	58	13.1
Only homeopathic and/or phytotherapic products	9	2.0
Perceived quality of the NHS (442)[a]		
Poor	22	5.0
Inadequate	115	26.0
Adequate	198	44.8
Good	101	22.8
Excellent	6	1.4

[a] Number of women responding to the question.

Table 2
Sources of information, perceived quality of information and self-perceived knowledge of vaccines.

Variables	N	%
Source of information on vaccinations (multiple answers allowed) (4 4 1)[a]		
Word of mouth	276	62.6
General practitioner/primary care pediatrician	110	25.1
Family Health Unit	60	13.7
Gynecologist/midwife	29	6.6
Private doctor	30	6.8
Institutional websites	84	19.1
Blog/forum/non-institutional websites	93	21.1
Mass media (radio/TV/newspapers)	148	33.6
School/university	78	17.7
No-vax movements	7	1.6
Other	25	5.7
Quality of the information received by a healthcare professional (161)[a]		
Poor	12	7.4
Inadequate	22	13.7
Adequate	61	37.9
Good	58	36.0
Excellent	8	5.0
Self-perceived level of knowledge on vaccinations (440)[a]		
Poor	126	28.6
Inadequate	184	41.8
Adequate	99	22.5
Good	29	6.6
Excellent	2	0.5

[a] Number of women responding to the question.

institutional sources (21.1 vs 19.1% Almost 38% of respondents (169/441) obtained information on vaccination from a health professional, mainly from general practitioners or primary care pediatricians (25.1%), indicating a satisfactory quality of the information provided (i.e. adequate or better) in 78.9% of cases. Almost 30% of respondents rated their level of knowledge on vaccinations at least adequate (Table 2).

The average knowledge score in the sample was 3.9 ± 2.1 (calculated on a total of eight items and 421 respondents). Five point five percent (23/421) of women did not respond correctly to any of the statements included in the section on knowledge of safety and efficacy of vaccines, while 26.1% of respondents (110/421) showed a higher level of knowledge, responding correctly to ≥75% of questions (≥8/12). There was a high level of uncertainty about the proposed statements (Table 3), with rates ranging from 20.3% for *The efficacy of vaccinations against infectious diseases has been scientifically proven* to 57.7% for *In Italy, polio has disappeared thanks to improved hygiene and not through vaccination*. Quite high rates of agreement were observed with statements reflecting common anti-vaccination themes: for instance, 22.9% of respondents (101/441) disagreed that substances contained in vaccines are not dangerous to humans, and 14.0% (62/442) agreed that vaccines could cause diseases, such as autism, multiple sclerosis or cancer (Table 3).

Thirty-four point six percent of respondents (155/448) could not remember which vaccinations they had received during their

lifetime (data not shown). Six women (1.3% of respondents) reported direct experience of adverse events relating to vaccination (data not shown): in three cases fever was reported, either alone or combined with other symptoms, such as diarrhea, fatigue or nausea; in one case sleepiness lasting for several hours was reported, while one woman reported having an allergic reaction and another reported contracting rubella as a result of the vaccine. Eight-point nine percent (40/452) of women reported indirect experiences of harmful effects of vaccines (involving relatives, friends and acquaintances) (data not shown), with 32.5% (13/40) of these referring to autism caused by vaccination.

3.2. Attitudes towards the benefits, safety, efficacy and supply of vaccines

With regards to the perceived benefits of vaccination, a high proportion of women in the sample agreed that vaccination was important for protection against meningitis (90.3%, 392/434), hepatitis B (85.2%, 367/431), tuberculosis (76.1%, 318/418) and polio 75.6% (321/425). Participants recorded the highest rates of uncertainty regarding the benefit of vaccination for diphtheria (41.8%, 166/397), parotitis (38.2%, 155/406) and pertussis (33.4%, 135/404), while recording the highest negative rates for influenza and varicella immunization (respectively, 64.1% (237/370) and 33.2% (132/398) of respondents) (Fig. 1).

The average attitudes score, calculated from the rate of agreement with the 12 proposed statements on safety, efficacy and delivery of vaccines on 421 women, was 5.2 (±2.7), with 22.1% of respondents showing a positive attitude towards at least eight out of the 12 statements included in the questionnaire (Table 4). Most respondents agreed with the importance of vaccines for the prevention of potentially serious diseases (90.8%, 404/445) and for the protection of the health of the community (82.3%, 363/441); at the same time, more than half of respondents reported concern about the side effects of vaccination (53.8%, 238/443), with over 45% of women agreeing with the statement that doctors often provide biased information on the risks associated with vaccinations (45.6%, 200/439)). Respectively, 23.6% (104/440) and 38.6% (170/440) of respondents agreed with or were uncertain about the statement that vaccines are above all an economic deal for pharmaceutical companies). With regards to the delivery of vaccinations, a very high rate of women reported that they would feel more secure if their child were to undergo a physical examination to ascertain his/her health status prior to receiving the shot (80.6%, 358/444); 32.7% of respondents (145/443) agreed with the statement that receiving multiple vaccines during a single visit might represent a risk to their child's health, while more than half of participants were uncertain about this (50.8%, 225/443). Attitudes towards compulsory vaccinations were also explored: 17.8% (77/433) of women surveyed agreed that mandatory vaccinations are against the right of citizens to choose their own healthcare, while only 55.6% of the sample (245/441)

Table 3
Knowledge of the efficacy and safety of vaccines (% of respondents agreeing/disagreeing/uncertain about the proposed statements).

Statements	Disagree %	Uncertain %	Agree %
The efficacy of vaccinations against infectious diseases has been scientifically proven (443)[a]	2.9	20.3	**76.8**
Smallpox has disappeared thanks to mass vaccination (446)[a]	4.3	35.2	**60.5**
In Italy, polio has disappeared thanks to improved hygiene and not through vaccination (447)[a]	28.4	57.7	13.9
Serious side effects of vaccines are very rare (443)[a]	9.0	28.7	**62.3**
Diseases such as autism, multiple sclerosis or cancer could be caused by vaccinations (442)[a]	**46.9**	39.1	14.0
Vaccinations increase the risk of allergies (444)[a]	**37.2**	54.5	8.3
Substances contained in vaccines are not dangerous to humans (441)[a]	22.9	47.4	**29.7**
Unvaccinated children are more resistant to infections (447)[a]	**55.5**	31.5	13.0

Note: Percentages referring to correct answers are in bold.
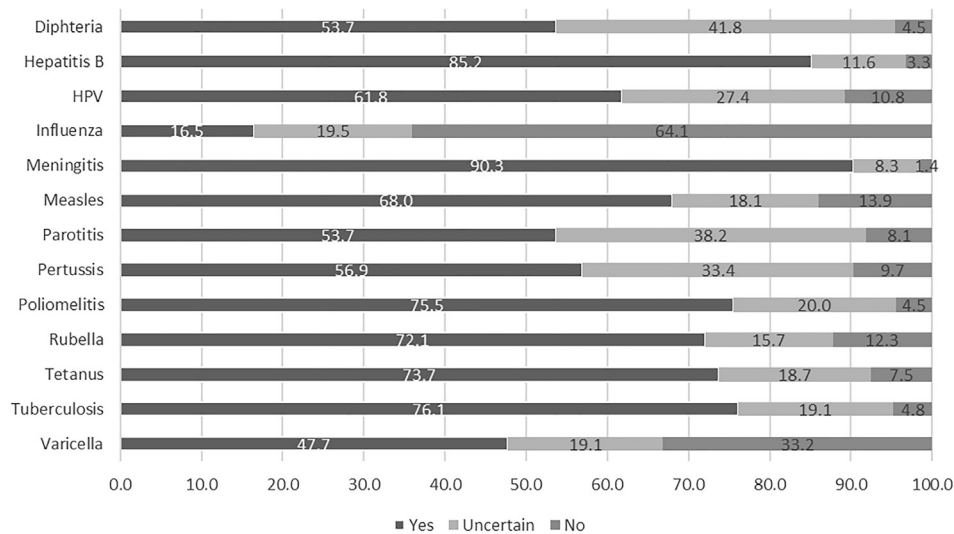[a] Number of women responding to the question.

Fig. 1. Perceived benefit of vaccinations to protect against disease. % of women agreeing/not agreeing or being uncertain about the usefulness of vaccinations to protect against the listed diseases.

Table 4
Attitudes towards the efficacy, safety and delivery of vaccines (% of respondents agreeing/disagreeing/uncertain about the proposed statements).

Statements	Disagree %	Uncertain %	Agree %
Vaccines are important for the prevention of diseases that can have very serious effects (445)[a]	2.7	6.5	**90.8**
I think the administration of multiple vaccines at the same time can be risky to my child's health (443)[a]	**16.5**	50.8	32.7
I am worried about the side effects of vaccines (443)[a]	**22.1**	24.1	53.8
Physicians often provide biased/ incomplete information on vaccine's side effects (439)[a]	**20.0**	34.4	45.6
Vaccines are above all an economic deal for pharmaceutical companies (440)[a]	**37.7**	38.6	23.6
Vaccinating my child is important to protect the health of our community (441)[a]	4.7	12.9	**82.3**
Compulsory vaccinations are against the right of citizens to the choice of care (433)[a]	**58.4**	23.8	17.8
I would vaccinate myself/my child even if the vaccinations were no longer compulsory (441)[a]	11.6	32.9	**55.6**
I am not sure about the safety of the new vaccines (e.g. anti-meningococcal B) (439)[a]	**25.7**	51.7	22.6
A check of the health status of my child just before vaccination would make me feel safer (444)[a]	**7.9**	12.4	80.6
Vaccinations should be recommended based on family lifestyle, child health and clinical tests, and not be the same for everyone (445)[a]	**44.0**	25.8	30.1

[a] Number of women responding to the question Note: Percentages referring to a positive attitude towards vaccinations are in bold.

indicated that they would vaccinate themselves or their children if the vaccinations were no longer mandatory). Rates of agreement/disagreement with the remaining statements are reported in Table 4.

3.3. Intention to vaccinate

Women were asked about their intention to immunize their child with vaccines included in the national vaccination schedule in Italy. The intention to vaccinate their children with the hexavalent vaccine was expressed by the highest proportion of respondents (76.8%, 337/439), followed by the anti-MMR vaccine (64.3%, 281/437). At the other end of the scale, 26.5% (112/422) and 11.3% (49/434) of women, respectively, indicated that they did not intend to vaccinate their children with the anti-varicella and the anti-HPV vaccines (Fig. 2). The rate of uncertainty was very high for the anti-rotavirus (66.2%, 282/426) and anti-pneumococcal vaccines (55.4%, 231/417) (Fig. 2).

3.4. Determinants of knowledge, attitudes and intention to vaccinate

Multivariate analysis showed that a higher age, having a university degree, perception of the quality of the NHS as good or excellent, and having received information on vaccinations from institutional websites or through education (e.g. school, university)

were all associated with a higher level of knowledge of the safety and efficacy of vaccines (number of correct answers ≥ 6) (Table 5). On the contrary, factors associated with a lower level of knowledge were the choice of populist movements as political orientation, preference for homeopathy or phytotherapy vs allopathic medicine, and having received information on vaccines by "word of mouth" (Table 5).

The strongest determinant of an overall positive attitude towards vaccines (attitudes score ≥ 8) was a high level of knowledge of the safety and efficacy of vaccines, along with having a good perception of the quality of the NHS (Table 5). In contrast, having had indirect experience of vaccination side effects and having received information about vaccination through the media (TV, radio, newspapers, etc) were not likely to result in a positive attitude (Table 5).

Table 6 shows the results of the multivariate analysis of determinants of the women's intention to immunize their children with the vaccines included in the Italian national schedule. Positive attitudes towards the efficacy, safety and delivery of vaccines (defined by an attitudes score ≥ 8/12) were associated with the intention to vaccinate with hexavalent, anti-MMR, anti-pnemumococcal, anti-meningococcal B, anti-rotavirus and anti-varicella vaccines. For all these vaccines, excluding anti-pneumococcal and anti-varicella, the perceived benefit of vaccinating to protect against the specific disease was also positively associated with the inten-
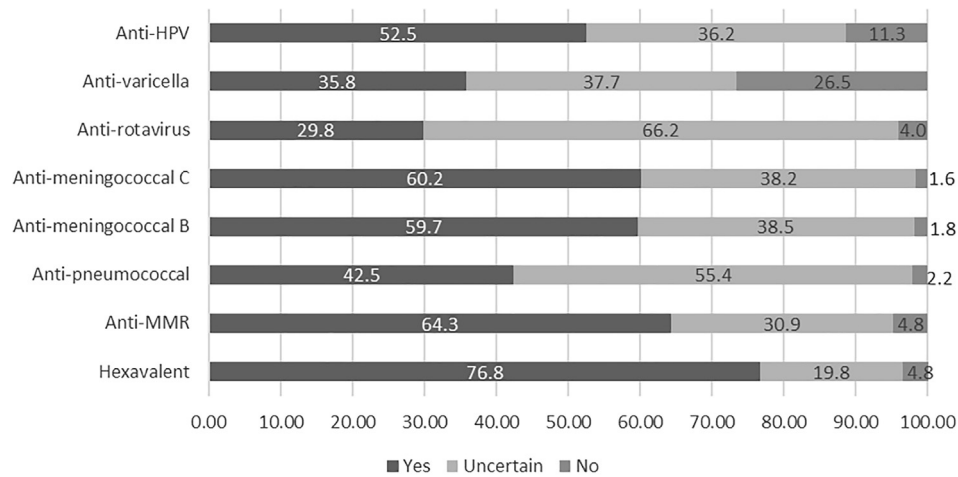
Fig. 2. Intention to vaccinate. % of women expressing their intention to vaccinate/not vaccinate or their uncertainty to vaccinate their child with the listed vaccines.

Table 5
Determinants of knowledge of and attitudes towards the efficacy, safety and delivery of vaccines.

Variables	Beta coefficient	OR	95% CI	P-value
Model 1: Higher knowledge of the efficacy and safety of vaccinations[a]				
Age	0.12	1.13	1.06–1.21	0.000
Level of education (0 = high school or lower; 1 = university graduate or higher)	0.73	2.08	1.14–3.78	0.017
Politics: populist movements (0 = no; 1 = yes)	−1.91	0.15	0.04–0.52	0.003
Preferred type of treatment (0 = allopathic medicine; 1 = homeopathy and/or phytotherapy)	−1.94	0.14	0.04–0.53	0.003
Perceived quality of the NHS (0 = very poor, poor, adequate; 1 = good, excellent)	0.65	1.92	1.04–3.57	0.039
Source of information on vaccination:				
Word of mouth	−0.61	0.54	0.31–0.94	0.029
Institutional web sites	0.91	2.48	1.28–4.81	0.007
School/university	1.23	3.44	1.78–6.63	0.000
Model 2: Positive attitudes towards the efficacy, safety and delivery of vaccinations[b]				
Indirect experience of side effects of vaccination (0 = no; 1 = yes)	−2.69	0.07	0.00–0.56	0.012
Perceived quality of the NHS (0 = very poor, poor, adequate; 1 = good, excellent)	0.83	2.29	1.22–4.27	0.010
Source of information on vaccination: media	−0.71	0.49	0.26–0.94	0.032
Knowledge of vaccination (0 = knowledge score < 6; 1 = knowledge score ≥ 6)	2.45	11.61	6.43–20.96	0.000

[a] Women were classified as those who answered correctly to six out of eight questions on the safety and efficacy of vaccines (Table 3) vs. all others.
[b] Women were divided into those who showed positive attitudes towards at least eight out of 12 statements on vaccine efficacy, safety and delivery (Table 4) vs. all others.

tion to vaccinate (Table 6). A higher level of knowledge of the safety and efficacy of vaccines (knowledge score ≥ 6) was associated with the intention to vaccinate with the anti-pnemucoccal, anti-meningococcal B and C, anti-rotavirus and anti-HPV vaccines (Table 6). Having received information on vaccines from a health professional was a determinant of the intention to vaccinate with anti-MMR, anti-meningococcal B and anti-varicella vaccines. Other significant determinants of the intention to vaccinate were a preference for conventional medicines, multiparity, and a higher level of education (Table 6).

4. Discussion

Our sample of pregnant women in the City of Rome showed a high degree of uncertainty about both the safety and efficacy of vaccines and their intention to vaccinate their children. A significant proportion of women agreed with some of the most common "anti-vaccination" theses, confirming the spread of misinformation about immunization in the population. These results are in line with those of a large study conducted in 2016 in 67 countries, aimed at measuring attitudes towards vaccination worldwide [2], in which Italy was among the European countries with the highest rate of scepticism about the efficacy (19.3%) and safety (22.7%) of vaccines [2]. Our results are also consistent with those of two

recently published studies on vaccine hesitancy in Italian parents, which recorded high rates of hesitancy [25] and misinformation regarding vaccine safety [26].

One of our main findings is that relatively few of the women surveyed understand the risks that are associated with vaccine-preventable diseases, with high rates of participants expressing uncertainty about the usefulness of vaccines for the prevention of diseases such as diphtheria, mumps and pertussis. Approximately 14% and 12% of women, respectively, indicated that they do not consider measles and rubella vaccination useful, percentages that perfectly reflect the vaccination coverage recorded in Italy for these diseases in recent years [7]. These results are in line with those of the international survey conducted within the "Vaccine confidence project" [2], which detected a high level of scepticism in Italy about the importance of vaccines in preventing diseases. Together, these data suggest the need to develop intervention strategies aimed at increasing awareness of the importance of available vaccinations.

Our results also show that attitudes towards vaccination cannot be easily categorized into "pro-vax" and "anti-vax": despite the perception that some infectious diseases represented a low risk to their child, most women participating in the survey were, in fact, positive about the importance of vaccination, both for the prevention of diseases that can have very serious effects and for the pro-

Table 6
Determinants of the intention to vaccinate.

Variables	beta coefficient	OR	95% CI	P-value
Hexavalent[a]				
Preferred type of treatment (0 = allopathic medicine; 1 = homeopathy and/or phytotherapy)	−1.08	0.34	0.17–0.67	0.002
Perceived benefit of vaccination against poliomyelitis (0 = no/I don't know; 1 = yes)	0.93	2.54	1.36–4.76	0.003
Perceived benefit of vaccination against pertussis (0 = no/I don't know; 1 = yes)	1.05	2.85	1.58–5.16	0.001
Perceived benefit of vaccination against tetanus (0 = no/I don't know; 1 = yes)	0.72	2.21	1.93–4.98	0.012
Attitudes towards vaccination (0 = attitudes score < 8; 1 = attitudes score ≥ 8)	1.17	3.23	1.19–8.76	0.022
Anti-MMR[a]				
Source of information on vaccination: health care professionals (0 = no; 1 = yes)	0.76	2.14	1.15–3.98	0.017
Preferred type of treatment (0 = allopathic medicine; 1 = homeopathy and/or phytotherapy)	−0.86	0.42	0.20–0.01	0.027
Perceived benefit of vaccination against measles (0 = no/I don't know; 1 = yes)	1.74	5.71	3.00–10.84	0.000
Perceived benefit of vaccination against rubella (0 = no/I don't know; 1 = yes)	1.59	4.90	2.52–9.52	0.000
Attitudes towards vaccination (0 = attitudes score < 8; 1 = attitudes score ≥ 8)	1.58	4.85	1.89–12.47	0.001
Anti-pneumococcal[a]				
Multiparity (no = 0, yes = 1)	1.24	3.45	1.50–7.93	0.003
Knowledge of vaccination (0 = knowledge score < 6; 1 = knowledge score ≥ 6)	0.88	2.41	1.39–4.18	0.002
Attitudes towards vaccination (0 = attitudes score < 8; 1 = attitudes score ≥ 8)	0.65	1.91	1.07–3.41	0.029
Anti-meningococcal B[a]				
Knowledge of vaccination (0 = knowledge score < 6; 1 = knowledge score ≥ 6)	1.02	2.77	1.62–4.73	0.000
Source of information on vaccination: health care professionals (0 = no; 1 = yes)	0.57	1.77	1.19–2.79	0.015
Perceived benefit of vaccination against meningitis (0 = no/I don't know; 1 = yes)	1.64	5.17	2.29–11.66	0.000
Anti-meningococcal C[a]				
Multiparity (no = 0, yes = 1)	1.55	4.72	1.60–13.86	0.005
Knowledge of vaccination (0 = knowledge score < 6; 1 = knowledge score ≥ 6)	1.19	3.30	1.93–5.63	0.000
Anti-rotavirus[a]				
Knowledge of vaccination (0 = knowledge score < 6; 1 = knowledge score ≥ 6)	0.73	2.07	1.18–3.63	0.011
Level of education (0 = high school or lower; 1 = university graduate or higher)	−0.51	0.60	0.37–0.98	0.039
Attitudes towards vaccination (0 = attitudes score < 8, 1 = attitudes score ≥ 8)	1.00	2.71	1.51–4.86	0.001
Anti-varicella[a]				
Source of information on vaccination: health care professionals (0 = no, 1 = yes)	0.58	1.78	1.01–3.17	0.049
Perceived benefit of vaccination against measles (0 = no/I don't know, 1 = yes)	3.18	24.07	12.86–45.04	0.000
Attitudes towards vaccination (0 = attitudes score < 8, 1 = attitudes score ≥ 8)	0.96	2.62	1.33–5.18	0.006
Anti-HPV[a]				
Knowledge of vaccination (0 = knowledge score < 6, 1 = knowledge score ≥ 6)	0.83	2.29	1.44–3.64	0.000

[a] Women were classified as those who expressed their intention to vaccinate their children with vaccines included in the national schedule vs all others.

tection of community health. At the same time, almost 80% of women declared themselves worried or uncertain about the side effects of vaccines and about the risks associated with the simultaneous administration of multiple vaccines. The same percentage of women agreed with or were uncertain about the (incorrect) statement that doctors provide biased or incomplete information on vaccine safety. The proportion of women who believe that vaccination is mainly in the economic interests of pharmaceutical companies was also high. Therefore, it would seem that women generally accept the concept of immunization as a "social norm" (as outlined in the model of determinants of vaccine hesitancy developed by the WHO SAGE Working Group [3]), but at the same time there is a low level of trust of available vaccines, both regarding their safety and efficacy, and the reliability of the vaccination information provided. There is also a low level of understanding of the severity of diseases for which vaccinations are currently available, thus leading to a negative risk/benefit relationship. An effort should therefore be made to improve the availability of data on the safety and efficacy of vaccines, including by non-industry-sponsored and unbiased sources [27,28], and to strengthen reporting and pharmacovigilance systems [13].

Multivariate analysis demonstrated that a higher level of knowledge of vaccination was the strongest predictor of positive attitudes, and, in turn, attitudes were shown (in most cases) to influence the intention to vaccinate, along with the perception of the benefit of vaccination for protection against disease. In our models, among the significant determinants of knowledge of and attitudes towards vaccination, we also identified trust in the NHS and the preferred choice of treatment (conventional vs.

unconventional treatments, such as homeopathy or phytotherapy). This finding is in line with both a theoretical construct of the vaccine hesitancy matrix of determinants, which also identifies, among individual and group influences, trust in the health system [3], and with the three C model, where trust in the health system is one of the key factors determining vaccine choices [15]. The perception that the risks associated with infectious diseases are low was also identified in other studies as one of the main factors influencing the choice of vaccination in parents [29] and pregnant women [30]. Concerns about vaccine safety were also identified as one of the main causes of vaccine rejection in several studies [25,26,31,32]. Finally, some systematic reviews have identified among the most frequently reported causes for global vaccination hesitancy a perception that high risks are associated with vaccination [33] and a lack of confidence in the information provided by institutions, with the fear that vaccine provision is partially or wholly dictated by economic interests [34]. All these results are consistent with our findings and confirm the need to improve communication with citizens on vaccines and, more generally, to work to increase trust in health institutions.

In this study, socio-demographic factors were not significant in determining the intention to vaccinate with two exceptions: (a) multiparity (significantly associated with the intention to vaccinate against pneumococcal and meningococcus C). This contradicts two studies conducted at national level in Italy and in the Veneto Region, where vaccine hesitancy was greater in parents with two or more children [20,26], but is consistent with another Italian study on parent hesitancy [25] and with a recently published survey conducted in Australia on vaccine hesitancy in the antenatal

period [31]; and (b) level of education (significantly associated with the intention to vaccinate against meningococcus C), which is consistent with the determinants of vaccine hesitancy found in a sample of pregnant women in a study conducted in Texas [35]. These data suggest that vaccine hesitancy is currently widespread in different segments of the population, and that there might be a need to target messages according to different educational and literacy levels.

We found that the intention to vaccinate was influenced not only by a positive attitude towards vaccination, but also by a higher level of relevant knowledge and by having received information on vaccination from health professionals. This confirms the importance of the involvement of health professionals in educating parents, which has been highlighted in other studies [26,33,35]. However, in contrast to some other reports [26,30], health professionals did not represent the main source of information on vaccination in our study: we confirmed the importance played by the media and by "word of mouth" in spreading misinformation about vaccine safety and efficacy, a trend also recorded by the NAVIDAD study conducted on pregnant women in different cities in Italy [36]. In this regard, other Italian research groups have previously highlighted the importance of involving Italian institutions and scientific societies in the fight against the anti-vaccine content present in the Italian media [9,20,26,37].

The results of our study are particularly relevant in view of the ongoing political debate on whether to revise the recent law on compulsory vaccination in Italy, the introduction of which led to an important increase in vaccination rates during 2017. The improvement in immunization coverage achieved last year through enforcement will need to be sustained by other kinds of intervention, focused on increasing the trust of citizens in vaccination. In this respect, our study provided useful insights for the development of interventions aimed at reducing vaccine hesitancy, specifically among pregnant women. Pregnancy has often been regarded as a strategic "teachable moment" for health promotion and behavior change [38–42], and the antenatal period is a time when attitudes towards vaccination are usually being explored and consolidated for the first time [15,23,32,33]. As already stated by other authors, pregnant women may therefore represent the ideal population for conducting specific interventions aimed at increasing awareness of and trust in vaccination [15,32,33]. Data on the effectiveness of interventions intended to counter vaccine hesitancy are currently limited [43,44], but according to the WHO SAGE Working Group, multi-component and dialogue-based interventions would be the most effective strategies [45]. These include the training of health workers to provide them with the ability to effectively manage vaccine hesitancy in parents, but also with the aim of counteracting hesitant behavior within health workers themselves [34,44]. In the context addressed by our study, midwives, gynecologists, and to a lesser extent pediatricians and nurses, would represent the ideal target for this kind of intervention. Available evidence on knowledge and attitudes relating to vaccination among midwives suggests that while the majority support vaccination, there are a wide range of beliefs and concerns, particularly regarding the safety and usefulness of vaccines [43]. In this respect, we are currently conducting a survey aimed at exploring the knowledge and attitudes of midwives belonging to the Board of Midwives of Rome Province, whose results, together with those emerging from the present study, will allow the development of context-specific education and communication interventions.

Despite the increasing attention paid recently to vaccine hesitancy in pregnancy in the scientific literature [30,31,35,36], evidence on this topic is still limited and our study is one of the few conducted so far to explore the features and determinants of hesitancy in this specific population. In Italy, several studies have explored vaccine hesitancy, but most of them had a different population target [20,26,47–49]. The only two studies published so far that focus on pregnant women explored the knowledge of and attitudes towards vaccination of the women themselves during pregnancy [50] and attitudes towards compulsory vaccination [36].

Our research has some limitations. Our results are not entirely generalizable to the population of pregnant women because of the high educational level of participants (almost 60% were graduates) and because of the over-representation of first-time pregnant woman (only 9.4% already had a child); these are both typical features of women attending CANs in Italy [46]. Therefore, there is little information available on women belonging to the most disadvantaged social groups and on foreign women, who are often those with the greatest difficulty in accessing health information. However, in our sampling we achieved an excellent distribution of CAN participants in the territory of the City of Rome, providing a significant picture of the relevant knowledge and attitudes of this population of women, which can inform the development of specific interventions. From the methodological point of view, the decision to analyze knowledge and attitudes through the construction of specific scores did not allow a detailed analysis of the knowledge and attitudes that most impact on the intention to vaccinate. This will, however, be the subject of further analyses. Furthermore, despite the positive results of our pilot study, our ad hoc questionnaire may have missed some relevant information to assess all determinants of the intention to vaccinate (e.g. knowledge on vaccines' mode of action, impact of the frequency of access to healthcare, etc). Finally, the intention to vaccinate was considered as a proxy for the vaccination behavior of the study population. However, vaccination coverage in Rome in 2017 is higher than the rates reflected by the intention to vaccinate in our study, suggesting there are factors we did not consider (not least, the recent law on compulsory vaccination) that intervene to convince a significant proportion of uncertain women to opt for vaccination after the birth of their children.

In conclusion, the high level of uncertainty among pregnant women of the safety and efficacy of vaccines and the effect of this uncertainty on the intention to vaccinate suggest the need to develop targeted strategies to increase vaccine acceptance in the antenatal period. These strategies should be dialogue based and focus on strengthening the capacity of health care professionals, particularly midwives, and on a proper involvement of media to deliver information correctly to future parents and thereby reduce the spread of misinformation and fear about vaccine safety, with the ultimate aim of contributing to the maintenance of high levels of vaccination coverage.

Competing interests

The authors declare that they have no competing interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2019.02.049.

References

[1] MacDonald NE. the SAGE working group on vaccine hesitancy. Vaccine hesitancy: definition, scope and determinants. Vaccine 2015;33:4161–4. https://doi.org/10.1016/j.vaccine.2015.04.036.

[2] Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The state of vaccine confidence 2016: global insights through a 67-country survey. EBioMedicine 2016;12:295–301. https://doi.org/10.1016/j.ebiom.2016.08.042.

[3] Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. Vaccine 2014;32:2150–9. https://doi.org/10.1016/j.vaccine.2014.01.081.

[4] Raude J, Fressard L, Gautier A, Pulcini C, Peretti-Watel P, Verger P. Opening the "Vaccine Hesitancy" black box: how trust in institutions affects French GPs' vaccination practices. Expert Rev Vaccine 2016;15:937–48. https://doi.org/10.1080/14760584.2016.1184092.

[5] Liu F, Enanoria WTA, Zipprich J, Blumberg S, Harriman K, Ackley SF, et al. The role of vaccination coverage, individual behaviors, and the public health response in the control of measles epidemics: an agent-based simulation for California. BMC Public Health 2015;15:447. https://doi.org/10.1186/s12889-015-1766-6.

[6] Phadke VK, Bednarczyk RA, Salmon DA, Omer SB. Association between vaccine refusal and vaccine-preventable diseases in the United States: a review of measles and pertussis. JAMA 2016;315:1149–58. https://doi.org/10.1001/jama.2016.1353.

[7] Istituto Superiore di Sanità (National Health Institute). Copertura vaccinale in Italia (Vaccination coverage in Italy). Available from: <http://www.epicentro.iss.it/temi/vaccinazioni/dati_Ita.asp> [last access: 23/01/2019].

[8] European Centre for Disease Prevention and Control. Measles and Rubella Surveillance-2017. Stockholm; ECDC; 2018. Available from: <https://ecdc.europa.eu/sites/portal/files/documents/Measles-and-Rubella-Surveillance-2017-final_0.pdf> [last access: 23/01/2019].

[9] Adamo G, Sturabotti G, De Soccio P, Prencipe GP, Sciarra I, Baccolini V, et al. The elimination of measles and rubella in Italy. Ig Sanita Pubbl 2017;73:429–42.

[10] Adamo G, Baccolini V, Marzuillo C, Sturabotti G, Villari P. Slow progress in measles and rubella elimination in Italy. Epidemiol Biostat Public 2016;13:e120751–52. https://doi.org/10.2427/12075.

[11] Legge 31 luglio 2017, n. 119. Conversione in legge, con modificazioni, del decreto-legge 7 giugno 2017, n. 73, recante disposizioni urgenti in materia di prevenzione vaccinale. G.U. Serie Generale, n.182; 5 Agosto; 2017. Available from: <http://www.gazzettaufficiale.it/eli/gu/2017/08/05/182/sg/pdf> [last access: 23/01/2019].

[12] D'Ancona F, D'Amario C, Maraglino F, Rezza G, Ricciardi W, Iannazzo S. Introduction of new and reinforcement of existing compulsory vaccinations in Italy: first evaluation of the impact on vaccination coverage in 2017. Eurosurveillance 2018;23:1800238. https://doi.org/10.2807/1560-7917.ES.2018.23.22.1800238.

[13] Adamo G, Sturabotti G, Baccolini V, de Soccio P, Prencipe GP, Bella A, et al. Regional reports for the subnational monitoring of measles elimination in Italy and the identification of local barriers to the attainment of the elimination goal. PLoS One 2018;13(10):e0205147. https://doi.org/10.1371/journal.pone.0205147. 24.

[14] Ward JK, Colgrove J, Verger P. Why France is making eight new vaccines mandatory. Vaccine 2018;36:1801–3. https://doi.org/10.1016/j.vaccine.2018.02.095.

[15] Salmon DA, Dudley MZ, Glanz JM, Omer SB. Vaccine hesitancy: causes, consequences, and a call to action. Am J Prev Med 2015;49:S391–8. https://doi.org/10.1016/j.vaccine.2015.09.035.

[16] Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. Lancet 2011;378:526–35. https://doi.org/10.1016/S0140-6736(11)60678-8.

[17] Jarrett C, Wilson R, O'Leary M, Eckersberger E, Larson HJ, Eskola J, et al. Strategies for addressing vaccine hesitancy – a systematic review. Vaccine 2015;33:4180–90. https://doi.org/10.1016/j.vaccine.2015.04.040.

[18] Opel DJ, Mangione-Smith R, Taylor JA, Korfiatis C, Wiese C, Catz S, et al. Development of a survey to identify vaccine-hesitant parents: the parent attitudes about childhood vaccines survey. Hum Vaccin 2011;7:419–25. https://doi.org/10.4161/hv.7.4.14120.

[19] Opel DJ, Taylor JA, Mangione-Smith R, Solomon C, Zhao C, Catz S, et al. Validity and reliability of a survey to identify vaccine-hesitant parents. Vaccine 2011;29:6598–605. https://doi.org/10.1016/j.vaccine.2011.06.115.

[20] Regione Veneto, ASL Verona. Indagine sui determinanti del rifiuto dell'offerta vaccinale in Regione Veneto (Study on the determinants of the vaccination offer refusal in Veneto Region); 2011. Available from: <http://www.epicentro.iss.it/vaccini/pdf/Ulss20Verona_04-2012ReportDeterminantiRifiutoVaccinale.pdf> [last access: 23/01/19].

[21] Dempsey AF, Schaffer S, Singer D, Butchart A, Davis M, Freed GL. Alternative vaccination schedule preferences among parents of young children. Pediatrics 2011;128:848–56. https://doi.org/10.1542/peds.2011-0400.

[22] Heininger U. An internet-based survey on parental attitudes towards immunization. Vaccine 2006;24(37–39):6351–5. https://doi.org/10.1016/j.vaccine.2006.05.029.

[23] Massimi A, Rosso A, Marzuillo C, Prencipe GP, De Soccio P, Adamo G, et al. Childhood vaccinations : a pilot study on knowledge, attitudes and vaccine hesitancy in pregnant women. Epidemiol Biostat Public Heal 2017;14:e126251–55. https://doi.org/10.2427/12625.

[24] Hosmer DW, Lemeshow S. Applied logistic regression. 2nd ed. New York: Wiley; 2000.

[25] Napolitano F, D'Alessandro A, Angelillo IF. Investigating Italian parents' vaccine hesitancy: a cross-sectional survey. Hum Vaccin Immunother 2018:1–8. https://doi.org/10.1080/21645515.2018.

[26] Giambi C, Fabiani M, D'Ancona F, Ferrara L, Fiacchini D, Gallo T, et al. Parental vaccine hesitancy in Italy – results from a national survey. Vaccine 2018;36:779–87. https://doi.org/10.1016/j.vaccine.2017.12.074.

[27] Manzoli L, Flacco ME, D'Addario M, Capasso L, De Vito C, Marzuillo C, et al. Non-publication and delayed publication of randomized trials on vaccines: survey. BMJ 2014;348:g3058. https://doi.org/10.1136/bmj.g3058.

[28] De Vito C, Manzoli L, Marzuillo C, Anastasi D, Boccia A, Villari P. A systematic review evaluating the potential for bias and the methodological quality of meta-analyses in vaccinology. Vaccine 2007;25:8794–806. https://doi.org/10.1016/j.vaccine.2007.10.034.

[29] Brown KF, Kroll JS, Hudson MJ, Ramsay M, Green J, Long SJ, et al. Factors underlying parental decisions about combination childhood vaccinations including MMR: a systematic review. Vaccine 2010;28:4235–48. https://doi.org/10.1016/j.vaccine.2010.04.052.

[30] Danchin MH, Costa-Pinto J, Atwell K, Willaby H, Wiley K, Hoq M, et al. Vaccine decision-making begins in pregnancy: Correlation between vaccine concerns, intentions and maternal vaccination with subsequent childhood vaccine uptake. Vaccine 2017:1–7. https://doi.org/10.1016/j.vaccine.2017.08.003.

[31] Corben P, Leask J. Vaccination hesitancy in the antenatal period: a cross-sectional survey. BMC Public Health 2018;18:566. https://doi.org/10.1186/s12889-018-5389-6.

[32] Dubé E, Gagnon D, Ouakki M, Bettinger JA, Witteman HO, MacDonald S, et al. Measuring vaccine acceptance among Canadian parents: a survey of the Canadian Immunization Research Network. Vaccine 2018;36:545–52. https://doi.org/10.1016/j.vaccine.2017.12.005.

[33] Marti M, de Cola M, MacDonald NE, Dumolard L, Duclos P. Assessments of global drivers of vaccine hesitancy in 2014—looking beyond safety concerns. PLoS One 2017;1(12):e0172310. https://doi.org/10.1371/journal.pone.0172310.

[34] Yaqub O, Castle-Clarke S, Sevdalis N, Chataway J. Attitudes to vaccination: a critical review. Soc Sci Med 2014;112:1–11. https://doi.org/10.1016/j.socscimed.2014.04.018.

[35] Cunningham RM, Minard CG, Guffey D, Swaim LS, Opel DJ, Boom JA. Prevalence of vaccine hesitancy among expectant mothers in Houston, Texas. Acad Pediatr 2017:1–7. https://doi.org/10.1016/j.acap.2017.08.003.

[36] Gualano MR, Bert F, Voglino G, Buttinelli E, D'Errico MM, De Waure C, et al. Attitudes towards compulsory vaccination in Italy: results from the NAVIDAD multicentre study. Vaccine 2018;36:3368–74. https://doi.org/10.1016/j.vaccine.2018.04.029.

[37] Aquino F, Donzelli G, De Franco E, Privitera G, Lopalco PL, Carducci A. The web and public confidence in MMR vaccination in Italy. Vaccine 2017:4494–8. https://doi.org/10.1016/j.vaccine.2017.07.029.

[38] Olander EK, Darwin ZJ, Atkinson L, Smith DM, Gardner B. Beyond the 'teachable moment' – a conceptual analysis of women's perinatal behaviour change. Women Birth 2016;29:e67–71. https://doi.org/10.1016/j.wombi.2015.11.005.

[39] Atkinson L, Shaw RL, French DP. Is pregnancy a teachable moment for diet and physical activity behaviour change? An interpretative phenomenological analysis of the experiences of women during their first pregnancy. Br J Health Psychol 2016;21:842–58. https://doi.org/10.1111/bjhp.12200.

[40] Phelan S. Pregnancy: a "teachable moment" for weight control and obesity prevention. Am J Obstet Gynecol 2010;202:135.e1–8. https://doi.org/10.1016/j.ajog.2009.06.008.

[41] Williams SE. What are the factors that contribute to parental vaccine-hesitancy and what can we do about it? Hum Vaccin Immunother 2014;10:2584–96. https://doi.org/10.4161/hv.28596.

[42] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine 2013;31:4293–304. https://doi.org/10.1016/j.vaccine.2013.07.013.

[43] Dubé E, Gagnon D, MacDonald NE, Eskola J, Liang X, Chaudhuri M, et al. Strategies intended to address vaccine hesitancy: review of published reviews. Vaccine 2015;33:4191–203. https://doi.org/10.1016/j.vaccine.2015.04.041.

[44] European Centre for Disease Prevention and Control. Vaccine hesitancy among healthcareworkers and their patients in Europe – A qualitative study.

Stockholm: ECDC; 2015. Available from <https://ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/vaccine-hesitancy-among-healthcare-workers.pdf> [last access: 23/01/19].

[45] Attwell K, Wiley KE, Waddington C, Leask J, Snelling T. Midwives' attitudes, beliefs and concerns about childhood vaccination: a review of the global literature. Vaccine 2018. https://doi.org/10.1016/j.vaccine.2018.02.028.

[46] Spinelli A, Baglio G, Donati S, Grandolfo ME, Osborn J. Do antenatal classes benefit the mother and her baby? J Matern Neonatal Med 2003;13:94–101. https://doi.org/10.1080/jmf.13.2.94.101.

[47] Pelullo CP, Di Giuseppe G. Vaccinations among Italian adolescents: knowledge, attitude and behavior. Hum Vaccin Immunother. 2018;5:1–7. https://doi.org/10.1080/21645515.2017.1421877.

[48] Napolitano F, Napolitano P, Liguori G, Angelillo IF. Human papillomavirus infection and vaccination: knowledge and attitudes among young males in Italy. Hum Vaccin Immunother 2016;12:1504–10. https://doi.org/10.1080/21645515.2016.1156271.

[49] Morrone T, Napolitano F, Albano L, Di Giuseppe G. Meningococcal serogroup B vaccine: knowledge and acceptability among parents in Italy. Hum Vaccin Immunother 2017;13:1921–7. https://doi.org/10.1080/21645515.2017.1313940.

[50] D'Alessandro A, Napolitano F, D'Ambrosio A, Angelillo IF. Vaccination knowledge and acceptability among pregnant women in Italy. Hum Vaccin Immunother. 2018;14:1573–9. https://doi.org/10.1080/21645515.2018.1483809.