



Contents lists available at ScienceDirect

Vaccine

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

Review

The benefit of the doubt or doubts over benefits? A systematic literature review of perceived risks of vaccines in European populations

Emilie Karafillakis^a, Heidi J. Larson^{a,b,*}, On behalf of the ADVANCE consortium

^a Vaccine Confidence Project, London School of Hygiene & Tropical medicine, London, United Kingdom

^b Department of Global Health, University of Washington, Seattle, USA

ARTICLE INFO

Article history:

Received 2 May 2017

Received in revised form 18 July 2017

Accepted 19 July 2017

Available online xxx

Keywords:

Vaccine

Immunisation

Hesitancy

Confidence

Risk perception

Risk-benefit

ABSTRACT

Objectives: The success of vaccination strategies depends in part on population perceptions of benefits and risks of vaccines and related confidence in vaccination. Better knowledge of public concerns about vaccines and what is driving them is needed to inform vaccination strategies and communications. This literature reviewer examined studies on vaccine and vaccination risk perceptions and concerns across European populations.

Methods: A systematic literature review was conducted to identify studies published between 2004 and 2014 in Europe. A descriptive analysis was performed.

Findings: A total of 145 articles were selected, most of which were conducted in the UK, the Netherlands and France and studied seasonal influenza, HPV and pandemic influenza vaccination. Across all countries and vaccines, the primary area of concern was vaccine safety, followed by perceptions of low likelihood of contracting vaccine-preventable diseases (VPDs), perceived low severity of VPDs, beliefs that vaccines do not work, and overall lack of information. Concerns were found to be vaccine-, country- and population-specific.

Conclusion: In addition to identifying concerns about vaccination in Europe, this study confirmed the notion that individuals have many safety concerns about vaccination and often believe that the risks of vaccination outweigh their benefits. More research needs to be conducted to explore the impact of different types of communication strategies, which would frame the benefits of vaccination as well as risks of not vaccinating. Strategies to better inform public perceptions of vaccines should include the provision of unbiased, comprehensive information tailored to population information needs, and delivered using multiple and new communication technologies such as social media.

© 2017 Published by Elsevier Ltd.

Contents

1. Introduction	00
2. Methods	00
3. Results	00
3.1. Seasonal influenza vaccines	00
3.2. Pandemic influenza vaccines	00
3.3. HPV vaccines	00
3.4. MMR vaccines	00
3.5. Childhood vaccination	00
4. Discussion	00
4.1. Limitations	00
Acknowledgements	00
Funding	00
Disclaimer	00

* Corresponding author at: Keppel Street, London WC1E 7HT, United Kingdom.

E-mail address: heidi.larson@lshtm.ac.uk (H.J. Larson).

Contributors	00
Conflict of interest	00
References	00

1. Introduction

Ever since the development of the first vaccines, individuals have raised concerns about the risks of vaccination [1]. Studies have tried to explain refusals or delays in vaccination as a consequence of imbalance between perception of the risks and benefits of vaccination: individuals weighing risks of vaccination higher than its benefits will tend to refuse or delay some or all vaccines [2–4].

As risks and benefits lack a common unit of assessment, they cannot easily be compared [5]. Furthermore, individuals have been shown to assess vaccination risks compared to other risks (i.e. diseases) differently than experts. Rather than mathematically weighing risks and benefits at the population level, individuals often rely on information consisting of individual stories and narratives which influence fear and uncertainties [6]. Parents will, for instance, think about the risks of vaccinating their children against risks of suffering from vaccine preventable diseases (VPDs) and will make a decision in favour of what they perceive as the “least risky option”.

Risk perception has been defined as the “*perceived vulnerability or likelihood of harm if no action is taken and perceived severity or seriousness of the consequences if harm was to occur*” [7]. Concerns about the risks of vaccination are known to be vaccine-specific and have been shown to vary across countries and population groups [8]. Responses to address these concerns should therefore take into account a comprehensive understanding of perceived vaccination risks as well as scientifically calculated ones. Previous systematic reviews have studied determinants of vaccine hesitancy, and reasons for refusing vaccinating, but few have focused on risk perceptions in relation to the benefits of vaccination and individual assessment of the risk-benefit balance. The aim of this study is to review all available research published between 2004 and 2014 on vaccination risk perceptions across Europe.

This study is part of the “Accelerated development of vaccine benefit-risk collaboration in Europe” (ADVANCE) project, which aims to establish a system that rapidly provides best available scientific evidence on vaccines benefits and risks.

2. Methods

The search strategy for the systematic literature review was developed in the OVID Medline database by multiple reviewers (Table 1). Keywords were selected in an effort to capture perceptions of risks, as well as confidence and/or hesitancy in vaccination. The search aimed to identify studies published in English, French, or Spanish from January 2004 to November 2014, from any of the 28 countries of the European Union as well as Norway, Iceland, Liechtenstein, and Switzerland. It was performed in November 2014, across OVID Medline, Embase, and Global Health, as well as Scopus, Web of Science, and Open Grey.

Articles were imported into Endnote X7 (Thomson Reuters) to remove duplicates, screen, and sort articles. Exclusion and inclusion criteria were developed by multiple reviewers to facilitate consistent screening of articles by titles and abstracts, done by a single reviewer. Articles were included if they studied vaccine risk perceptions or concerns, vaccine confidence and/or hesitancy, public trust in vaccines, and general attitudes or beliefs about vaccination. There were no restrictions on study populations and types of vaccines (apart from animal vaccines or vaccines not yet available). The following were excluded: experimental studies, serologic investigations, efficacy and safety trials, immunogenicity studies, pre-clinical trials, cost-effectiveness or cost-benefit studies, editorials, commentaries, conference abstracts, letters, and literature or systematic reviews. Finally, articles focusing only on participants’ knowledge, reasons for getting vaccinated, socio-economic determinants (i.e. age, level of income, education level), or interventions to increase vaccination coverage were excluded if they did not include results about risks, perceptions, beliefs, hesitancy, confidence, or trust in vaccines.

No meta-analysis was performed due to the substantial heterogeneity of studies. Data (study population, country, setting, vaccines, year of publication, method, and concerns) was extracted into a Microsoft Excel spreadsheet and a descriptive analysis of concerns, beliefs and perceptions about vaccines was undertaken instead. In order to combine and compare results across quantitative and qualitative studies, the frequency of concerns

Table 1
Search strategy developed on Medline OVID.

1	((vaccin\$ or immunis\$ or immuniz\$) adj5 (anxiety or attitude\$ or awareness or behavio?r or belief\$ or criticis\$ or doubt\$ or distrust or dropout\$ or exemption\$ or fear\$ or hesitanc\$ or trust or mistrust or perception\$ or refus\$5 or rejection or rumo?r\$ or intent\$5 or controvers\$ or misconception\$ or misinformation or opposition or delay or dilemma\$ or objector\$ or resist\$ or sceptic\$)).ti,ab
2	((vaccin\$ or immunis\$ or immuniz\$) adj3 (uptake or barrier\$ or choice\$ or mandatory or compulsory or concern\$ or accepta\$ or knowledge or parent\$ con\$)).ti,ab
3	((vaccin\$ or immunis\$ or immuniz\$) adj5 confidence) not confidence interval).ti,ab
4	((vaccin\$ or immunis\$ or immuniz\$) adj5 decision making).ti,ab
5	((vaccin\$ or immunis\$ or immuniz\$) and (anti-vaccin\$ or antivaccin\$)).ti,ab
6	1 or 2 or 3 or 4 or 5
7	exp vaccination/ or Vaccines/ or Mass Vaccination/ or Immunization/ or exp Immunization Programmes/
8	Public Opinion/ or Attitude to Health/ or Attitude/ or Health Knowledge, Attitudes, Practice/ or “Patient acceptance of health care”/ or Treatment Refusal/ or Parental Consent/ or Decision Making/ or Prejudice/ or Internet/
9	7 and 8
10	6 or 9
11	limit 10 to humans
12	europa/ or exp austria/ or exp belgium/ or exp estonia/ or exp latvia/ or exp lithuania/ or exp bulgaria/ or exp croatia/ or exp czech republic/ or exp hungary/ or exp poland/ or exp romania/ or exp slovakia/ or exp slovenia/ or exp finland/ or exp france/ or exp germany/ or exp greece/ or exp iceland/ or exp ireland/ or exp italy/ or exp liechtenstein/ or exp luxembourg/ or exp cyprus/ or exp malta/ or exp portugal/ or exp denmark/ or exp norway/ or exp sweden/ or exp spain/ or exp switzerland/ or exp great Britain/ or mediterranean region/ or mediterranean islands/ or netherlands/ or scandinavia/ or exp European Union/
13	11 and 12

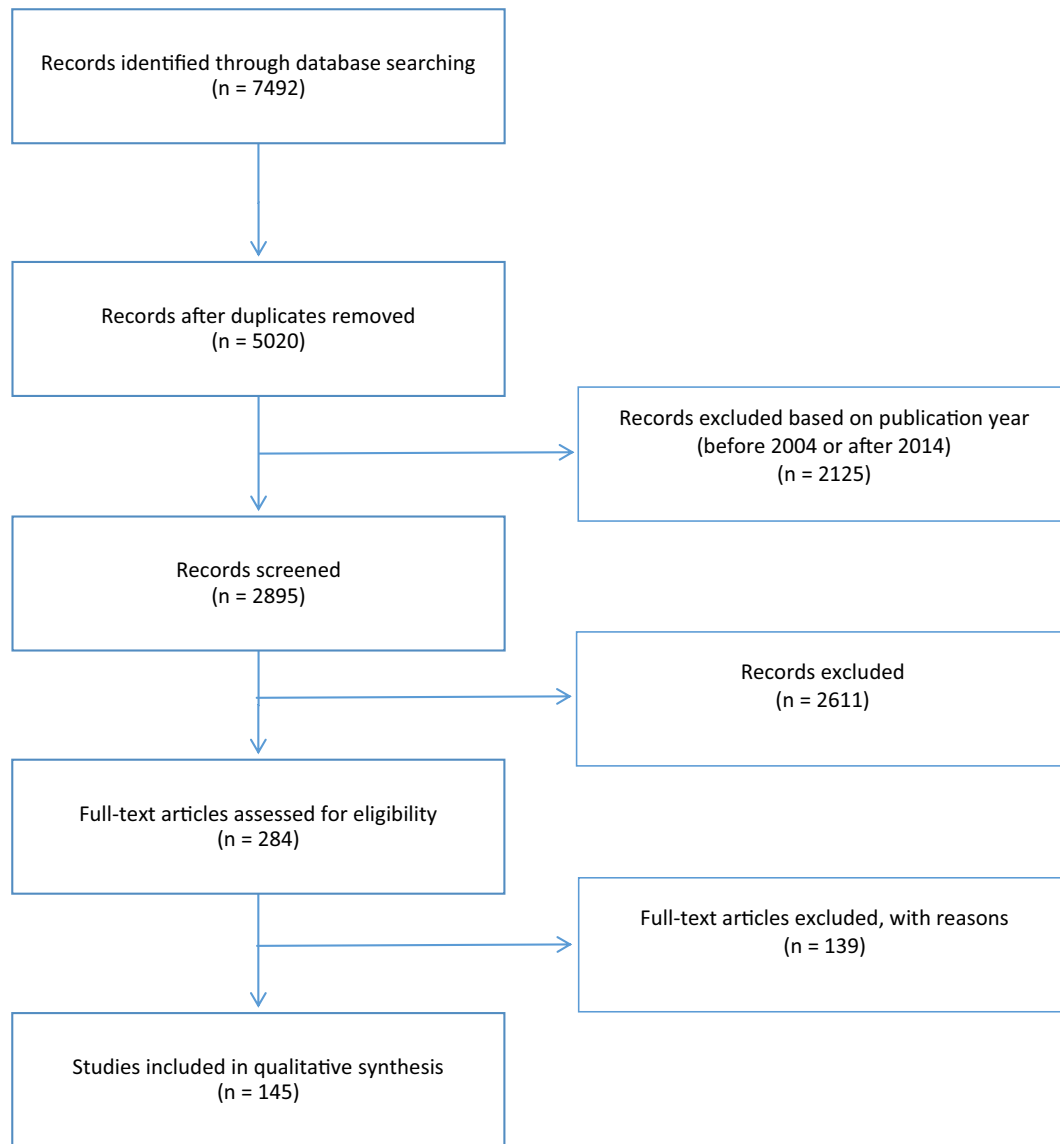


Fig. 1. Selection of articles (PRISMA chart).

was calculated by adding the number of qualitative studies where specific concerns were mentioned to the number of quantitative studies where more than 20% of participants selected those concerns. Although no theoretical framework was used to analyse the results, the SAGE model of determinants of vaccine hesitancy was used to guide the design of the search strategy, inclusion and exclusion criteria, and data extraction and analysis [8].

3. Results

The search generated 2895 unique articles, from which 145 were selected for analysis (Fig. 1). Table 2 provides an overview of articles included by country, population, and vaccine(s) studied. The majority of articles included were from the United Kingdom (35.2%), the Netherlands (11.7%), France (11.7%), Germany (8.3%), Greece (7.6%), and Sweden (6.2%). They mostly studied vaccines against seasonal influenza, human papillomavirus (HPV), pandemic influenza, measles-mumps-rubella (MMR) and childhood VPDs in general. Finally, articles commonly studied healthcare workers (HCWs), parents, adults, and individuals at high risk of VPDs, including the elderly and patients with chronic illnesses such as inflammatory bowel disease or systemic sclerosis.

Across all articles, the most common beliefs related to balancing risks of vaccination to non-vaccination were about vaccine safety ($n = 107/145$ articles) and the perceived low risk of contracting VPDs ($n = 51/145$). Other important perceptions included beliefs that VPDs are not dangerous ($n = 36/145$), vaccines do not work ($n = 32/145$), vaccines are not needed ($n = 24/145$), adults or children were healthy enough not to need vaccination ($n = 20/145$), not enough evidence or adequate testing of vaccines ($n = 21/145$), no recommendation to take the vaccine ($n = 20/145$) or a lack of information about vaccines and/or VPDs ($n = 31/145$). All concerns are listed in Fig. 2 and Figs. 3–5 provide an overview of the number of studies with the five most important concerns by country, population groups and vaccines. Concerns were analysed in more depth for specific vaccines. Articles looking at different vaccines without providing data on each vaccine separately [9–16] and vaccines for which there were only a handful of articles available [17–26] were excluded from the in depth analysis.

3.1. Seasonal influenza vaccines

The majority of studies ($n = 50$) investigated beliefs about the seasonal influenza vaccine [27–76] and reported fears of adverse

Table 2
Characteristics of included studies.

Countries		Studied populations		Vaccines		Study method	
Country	#	Population	#	Vaccine	#	Method	#
United Kingdom	51	HCWs	37	Seasonal influenza	50	Structured questionnaires (mailed, online, telephone or face to face)	98
The Netherlands	17	Parents	30	Pandemic influenza	34	Qualitative interviews	23
France	17	Adults	17	HPV	29	Focus groups	10
Germany	12	High risk groups	17	MMR	12	Focus groups and qualitative interviews	6
Multiple countries	13	Multiple populations	10	Childhood	11	Mixed methods: qualitative interviews/focus groups and structured questionnaires	5
Greece	11	Medical students	7	Hepatitis B	2	Web monitoring	2
Sweden	9	Young women	5	Anthrax	2	National statistics	1
Spain	3	Children & teenagers	6	Varicella	1		
Italy	3	Pregnant women	5	DTaP/IPV/Hib	1		
Romania	2	Religious communities	3	Pertussis	1		
Denmark	1	Anthroposophical communities	2	Pneumococcal	1		
Austria	1	Internet users	2	All vaccines in general	1		
Hungary	1	Armed forces	2				
Ireland	1	Households	2				
Poland	1						
Slovenia	1						
Switzerland	1						

reactions [27,29,33–37,41,43,45–49,57,59–63,71,73,74], and more specifically, that vaccination causes influenza or flu-like symptoms [34,35,44,71,74]. The second most common perception described was that there was a low risk of contracting influenza [29,33,35,40,51,53,54,67,70,71,76] – many studies mentioned feelings of strength and being healthy enough to fight influenza [34,35,39,44,50,55,64,76], which was often described by study participants as a mild illness [27,33,52,56–58,61,62,74,75]. Some studies also reported feelings of protection linked to not having had flu in the past [30,34,59,65], or because of regular exposure to the virus [28,38]. Many studies reported that participants also believed they did not qualify for the vaccine as they were not part of a high risk group [28,37,38,44,51,52,54,55,61,64,71,72,76], while others explained they had not been offered the vaccine [27,51,52,54,61,63,66,68,69,71,74]. On the other hand, other studies reported beliefs that seasonal influenza vaccination is not effective in preventing infection [50,60,63,67], that vaccination is not a priority [30,34,44,47,47,52,54,64,66,71], or not necessary [31,35,42,43,65,69].

General mistrust was reported around influenza vaccination, with some studies showing individuals refusing all vaccines [37,56,67,69,72], and others describing conspiracy theories [75] and mistrust of health authorities [49,75], of the seasonal influenza vaccines [69,75], or of pharmaceutical companies [75]. Some studies reported a perceived lack of information [35,75], misunderstandings [48,74], beliefs that the vaccine is developed too quickly every year [49], and negative information about vaccine safety in the media [69,71]. Perceptions were reported to be influenced by a negative previous experience with the vaccine [34,68], and advice from others against vaccination [62,68]. Finally, some studies discussed the balance (or imbalance) of risk perceptions over perceived benefits of vaccination [61,74], fear of injections [34], adjuvants [73], and/or a preference for homeopathy [37].

3.2. Pandemic influenza vaccines

Out of 34 articles on pandemic influenza vaccination, one studied the H5N1 [77] and 33 the AH1N1 [27–32,65,72,78–103] pandemic influenza vaccines. The most frequent concern cited across studies was the opinion that these vaccines could have dangerous adverse reactions [27–31,77–79,81–90,92,94–103]. This was often explained by study participants as a perception that these new vaccines were developed too quickly [80,100], resulting in insufficient

testing and evidence [31,80,85,86,93,94,98,100,102] and information about long term adverse reactions [82,83,93,95,96]. Studies reported that concerns about inadequate testing also resulted in perceptions of low vaccine effectiveness [32,79,81,86,89,96,98].

The second most important reason for hesitating to vaccinate was the belief that pandemic influenza is not a threatening illness and is comparable to a mild flu [27,72,78,80,81,86,89,96,98,99,101–103]. Many studies also discussed a perceived low risk of contracting pandemic influenza [31,65,77,84,86,88,89,91,94,97,101] because of protection from a strong immune system [27,31,86] or previous exposure to the virus [28]. Some studies mentioned that healthcare workers were not part of at risk groups or they did not come into contact with patients [28,72,80].

Other studies discussed participants being influenced by negative media reports [82,86] and contradictory messages [98] about vaccines; while some believed the media overstated the seriousness of AH1N1 [103]. Mistrust was reported towards vaccines [100,103], national and international health authorities [86], and pharmaceutical companies [86]. Other studies reported a preference for natural prevention methods [78,86,97,100], a lack of health care provider recommendation [97], previous negative experiences with vaccination [27], the belief that the vaccine could cause flu [78], doubts about the risk-benefit balance [93], the belief that infection strengthens the immune system and that individuals should be brave and face diseases [86], notions of fatalism [86], and fear of injections [86].

3.3. HPV vaccines

In the 29 articles that studied HPV vaccination [104–132], the most common concerns identified were about safety, and particularly unknown adverse reactions that might develop long after vaccination [104–110,112,113,115–120,123–127,129–132]. These concerns often came with discussion around the newness of the vaccine [104,107,112,113,117,126,129], and claims that it has not been tested long enough [104,105,107,115,122,129–131]. Many articles reported concerns about a lack of clear information around HPV infection and vaccination, and individuals feeling that they have insufficient knowledge to make an informed decision [104,108,109,112,116,118–121,127,128,132]. Some also mentioned that participants believed insufficient testing of the vaccine meant there were too many uncertainties around long-term effectiveness of the vaccine [107,109,112,113,119,131].

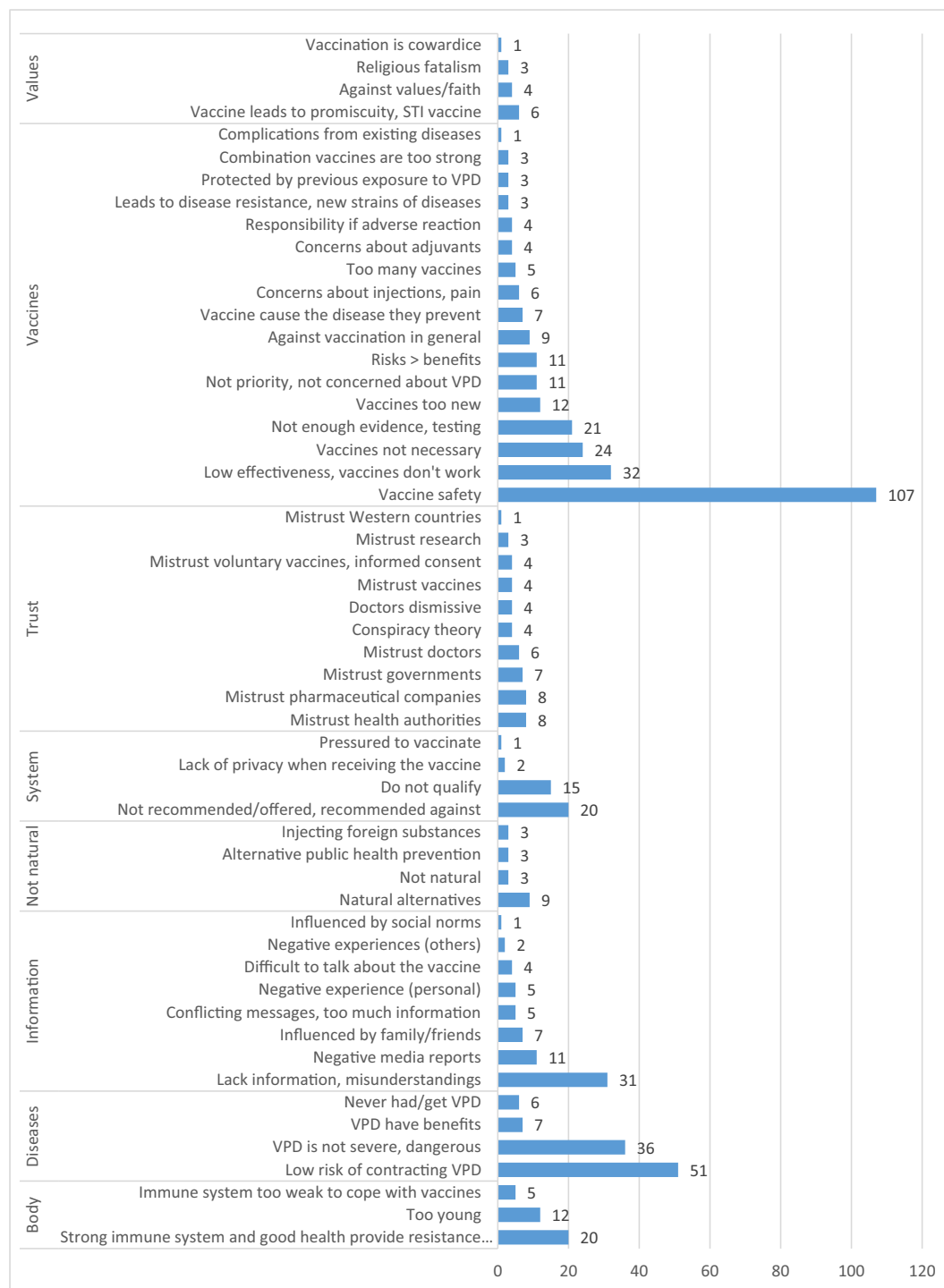


Fig. 2. Most common concerns about risks and benefits of vaccination in Europe.

Some studies reported beliefs that children are too young to receive the HPV vaccine [104,107,118,119,121,122,126], and fears of a “sexually transmitted infection vaccine” leading to unsafe sexual behaviours and increased promiscuity [107,110,117,121,124,125,130]. Some also discussed personal values or faith issues [104,110,122], and others the difficulty of talking about a “sex vaccine” [110,112,117,132]. Another important belief was that there is no risk of contracting HPV [112,114,122,129,130] and therefore no need for vaccination [105,112,115,122,130]. The perception that

the risks of vaccination are higher than benefits were more common than for other vaccines [106,107,118,130] and one study mentioned the perception that HPV infection is not a serious illness [129].

Mistrust was common, especially of pharmaceutical companies [105,106,118,130], government [104,109,123], research [112,130], and health authorities [118,130]. Two studies reported conspiracy theories about vaccines causing sterilisation [118,130] and others expressed concerns about the vaccine not being natural

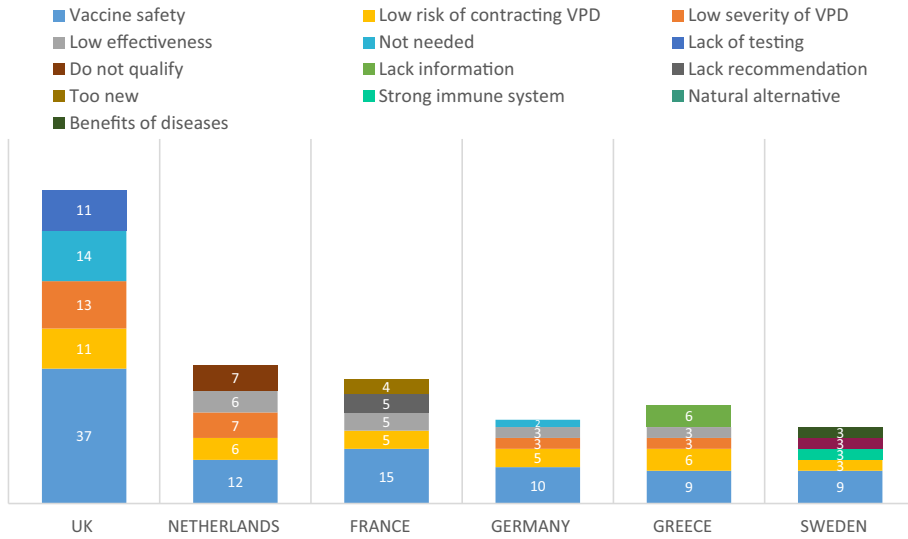


Fig. 3. Five most common concerns about risks and benefits of vaccination in Europe by country (n = number of studies).

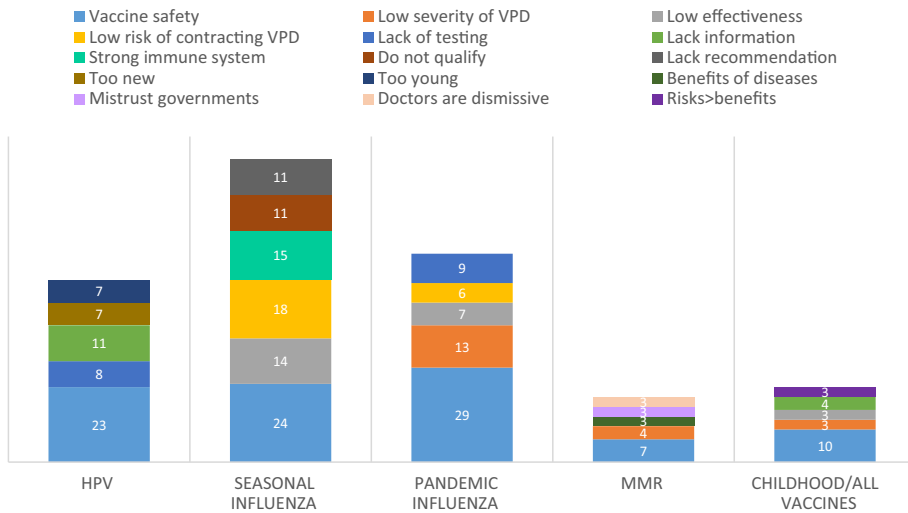


Fig. 4. Five most common concerns about risks and benefits of vaccination in Europe by vaccine (n = number of studies).

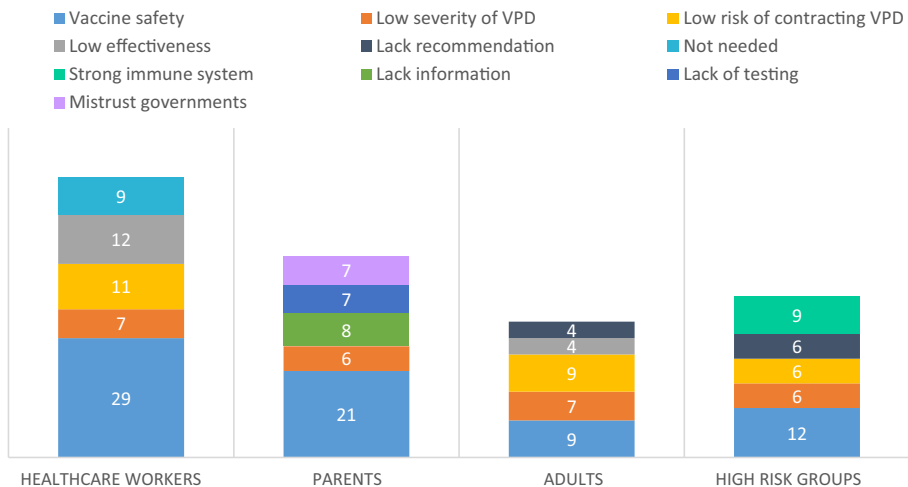


Fig. 5. Five most common concerns about risks and benefits of vaccination in Europe by population group (n = number of studies).

[104,130], and a preference for homeopathy, screening or sexual abstinence [105,117,130]. There were also beliefs that HPV infection can strengthen the immune system [104].

Issues about vaccine providers were raised in some studies, such as a lack of patient trust in their doctors [130], the fact that some doctors do not recommend the HPV vaccine [117,130], doctors being dismissive of parents' concerns [104,123], or doctors pressuring to vaccinate [104]. Some studies reported that parents discussed parental responsibility to protect children against vaccine adverse reactions [104,105,107], and others the influence of negative media reports [104,129].

Finally, there were also reports of general anti-vaccination feelings [104,130], beliefs that children receive too many vaccines [123,124], that their immune systems are too fragile [104,107], a lack of privacy when being vaccinated [111,132], concerns about pain of injection and cleanliness of needles [111,116], and the importance of parental consent for vaccination [115,130].

3.4. MMR vaccines

Twelve articles studied MMR vaccination [132–142] and found that the most important concerns were about safety, with some articles reporting particular worries about autism [132,134,136–138,140,141]. A few studies also reported beliefs that the diseases prevented by the MMR vaccine are mild, treatable, and not dangerous [135,138,140,142] and that children actually benefit from these infections [134,141,142]. Mistrust of governments was high [135,137,139], together with perceptions that doctors are dismissive of parents safety concerns [133,137,142]. Lack of trust was reported towards health authorities [132], pharmaceutical companies [139], researchers [135], and doctors [142].

Some information challenges were reported, including a lack of information [139,140], perceptions about inadequate evidence of vaccine safety [137,139], and reports of conflicting messages [133,135]. Some studies found that participants felt that children are too fragile [133] to receive vaccines with too many antigens [134], and therefore preferred homeopathy [134,136]. Two studies reported influences from negative previous experiences with MMR vaccination [139,142] and another two studies found participants believed healthy children do not need the vaccine [134,138]. One study found that parents believe the risks of vaccinating are higher than benefits [142]. Other parents were reported to believe that children are too young to be vaccinated [136] and to express concerns about adjuvants as well as the fear vaccination could create new disease strains [138]. Finally, studies found that parents of autistic children blamed themselves for vaccinating their children [133].

3.5. Childhood vaccination

Eleven articles studied concerns about childhood vaccination in general [143–154]. The most common concerns were about adverse reactions [144–148,150–154]. Other studies reported that participants believed that vaccine preventable diseases are not dangerous [147,148,150] but instead are beneficial for child development [149,150]. Some also believed that risks of vaccination outweigh benefits [147,150,154]. Studies found that interviewed participants reported inadequate information and evidence [143,144,147,153] and disagreements between experts on vaccine safety [144]. There were beliefs that vaccines do not work or have a short duration of protection [143,146,150,154], supporting the perception that vaccines are not useful [146,153,154].

Lack of trust in health authorities [147,154] and doctors [147] was reported, with patient reports of doctors only discussing the benefits of vaccination [145]. Studies found that parents reported being influenced by friends and families [150], negative reports

in the media [150,153], previous negative personal experience [150], and society [152]. Other concerns mentioned in studies were about combination vaccines [147], adjuvants [150], children receiving too many vaccines [145], and injecting foreign substances into the body [152].

Studies found that parents from religious communities reported strong trust in God, and beliefs that they should not interfere with divine providence [151,152], as well as the perception that separation from other communities lowers the risk of infectious diseases transmission [152]. Some studies also reported that parents who visit anthroposophical child welfare centres explained that healthy children do not require vaccination [149], and that alternative prevention methods should be favoured as the immune system is not developed enough to handle vaccines [150].

4. Discussion

Over the past decade, a number of studies have been published that help to characterise risk perceptions relating to vaccines and vaccination by European populations, and their findings have been reviewed, analysed and summarised in this article. The majority of studies were conducted in the United Kingdom, France and the Netherlands, with a main focus on the seasonal influenza vaccine, the HPV vaccine and the pandemic influenza vaccine. These characteristics could be a reflection of the presence of research institutes in these countries with relevant research interests but could also be linked to the introduction of and the high number of safety concerns about the HPV vaccine, the poor uptake of H1N1 vaccination during the 2009 pandemic, as well as previous historic vaccination crisis in these countries such as the MMR-autism crisis in the UK [144,155] or the hepatitis B-multiple sclerosis crisis in France [156]. As no country is safe from a potential decrease of public confidence in vaccination, more robust behavioural research needs to be conducted particularly in countries where fewer studies were identified, such as Eastern Europe. This review also points to the need for the use of media monitoring tools that listen to populations' concerns in "real-time" given the changing nature of sentiments. While surveys, questionnaires and qualitative research are useful for exploring public concerns about vaccination, they fail to detect sudden changes in confidence levels. For instance, although this study reviewed articles published between 2004 and 2014, it failed to detect concerns raised in Denmark about HPV vaccination that started in 2013. There are currently very few such systems in place [157], but as European citizens are increasingly exposed to health information on the internet and social media [158], it is important to continuously monitor and analyse online information to detect any changes in perceptions of vaccinations risks.

Across all countries and vaccines, the largest area of concern was vaccine safety. Different types of concerns about vaccine safety were however identified for different vaccines: for instance, while perceived adverse events described for HPV vaccination were often long-term and severe, those for influenza vaccination were milder and often consisted of the beliefs that the vaccine causes flu-like symptoms. There were also reports of more general fears observed for all vaccines, related to uncertainty about the safety of the vaccine. Uncertainty issues reveal a different challenge: the one of mistrust, for instance of information provided about the safety of the vaccine. While providing comprehensive and up-to-date information to the public about the risks and the benefits of vaccination is essential, these findings show that they need to be complemented by trust building strategies to sustain vaccine coverage and acceptance. Population perceptions of risk might also reveal real safety issues; and it is therefore important

not to dismiss those concerns, but instead to consider them carefully and to investigate them further where appropriate.

Other major concerns identified included perceptions of low likelihood of contracting VPDs and perceived low severity of diseases. These results can partially be explained by the high number of new vaccine products which have been introduced in Europe over the past decade, as well as the decrease in prevalence of VPDs for older and routine vaccines [7,156,159,160]. Vaccination is often thought to be a victim of its own success [1,161]: as VPDs are eliminated from regions with high vaccination coverage and adverse VPDs outcomes become less visible, individuals have no first-hand knowledge of the risks of these diseases and start questioning the benefits of vaccination over the risks [7]. The review also found that although some concerns are important for all vaccines (i.e. perceived adverse events, or mistrust), some are more common in relation to specific vaccines. For instance, concerns about flu vaccination are typically related to not perceiving a need for the vaccine or not believing the disease is severe, while concerns about new vaccines such as H1N1 or HPV are linked to uncertainties and the belief there is insufficient evidence or testing of the vaccine.

Reports of individuals believing that risks outweigh the benefits of vaccination were reported for all vaccines. This is problematic, as individual decision-making has been shown to be more affected by perceived losses rather than equivalent gains [162–165]. If individuals make decisions about vaccination based on how they perceive different risks, it is important that they understand the risks of not vaccinating in terms of susceptibility to and severity of VPDs. While scientists tend to talk about risks for populations and public health (i.e. rate of VPDs in a population), individuals are mostly interested in individual risks for themselves and their children (i.e. individual side effects), which should be considered when designing communication strategies. This could be reflected in vaccine provider communication to parents, which should acknowledge parental individual risk perceptions and present both risks and benefits of vaccination at an individual rather than a population level. Official information documents about vaccination should also be developed to focus both on individual and population risks and benefits of vaccination.

Another important issue reported in this review is the public perception that there is a lack of adequate information about all vaccines. Although this is partly linked to quality of the communication and information system, it is also largely influenced by mistrust. This is reflected by the fact that some studies found that participants were still describing concerns that MMR might cause autism although they knew that experts and scientists had not found any evidence for this association. Providing information is not, by itself, sufficient to change people's behaviour. Some studies show that vaccine refusers are usually more informed than vaccine acceptors, as they often research information themselves online or talk to other parents about their experiences with vaccination [7,157,166]. It is therefore important to move beyond “knowledge deficit models of communication” and develop tailored communication and engagement strategies with an effective listening mechanism, that provide for continuous listening to populations' perceptions of vaccines. A proactive approach to responding to vaccination scares should be encouraged with communication strategies ready in advance to respond to different types of challenges and concerns [158]. Certain tools, such as the WHO guidance on “How to respond to vocal vaccine deniers in public” [167], are available to help national immunisation programme managers prepare such strategies. Managing inaccurate perceptions of vaccinations risks is as important as the management of scientifically confirmed risks [157]. Communication strategies should be developed as a dynamic process and include input from a range of actors such as immunisation managers, vaccine providers, but also parents [7,158].

4.1. Limitations

There are some limitations to this review which should be considered when interpreting results. The selection of articles and data extraction of the systematic review was conducted by one researcher and quality assessment of the articles was not performed. The impact of this limitation was attenuated by using multiple researchers to develop the search strategy and the exclusion and inclusion criteria, and closely review the data extraction and analysis. Only articles published in English, French and Spanish were included in the analysis which might have led to underrepresentation of certain countries. Two separate analysis for qualitative and quantitative studies identified by the review might have provided more detailed results, while the arbitrary decision to select concerns reported by a minimum of 20% of study participants might have impacted the results. Finally, articles published after November 2014 were not included in this review; the authors suggest updating the review regularly to detect any changes in concerns about the risks and benefits of vaccination in Europe.

Acknowledgements

We would like to show our gratitude to the members of the ADVANCE project for their help in reviewing this manuscript: Priya Bahri, Jorgen Bauwens, Antonella Chiucchiuini, Liesbeth Mollema, Tin Tin Htar Myint, Judith Perez Gomez, and Marianne van der Sande.

Funding

This study was conducted under the ADVANCE project, by the Innovative Medicines Initiative (Grant agreement n°115557), resources of which are composed of financial contribution from the European Union's Seventh Framework Programme (FP7/2007–2013) and EFPIA companies' in kind contribution. The funder had no involvement in the study design, collection, analysis, interpretation of data, in the writing of the report, and in the decision to submit the article for publication.

Disclaimer

The LSHTM research group “The Vaccine Confidence Project” has received funding for other studies and projects from the Bill & Melinda Gates Foundation, the Centre for Strategic and International Studies, EU Innovative Medicines Initiative, GSK, Merck, National Institute for Health Research (UK), Novartis, ECDC, and WHO.

Contributors

EK and HL co-lead the review, analysed and interpreted the data and prepared the manuscript. EK lead the data collection and the review of papers.

Conflict of interest

None.

References

- [1] Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. *The Lancet*. 378 9790 :526–35.
- [2] Gust DA, Woodruff R, Kennedy A, Brown C, Sheedy K, Hibbs B. Parental perceptions surrounding risks and benefits of immunization. *Semin Pediatr Infect Dis*. 2003;14(3):207–12.
- [3] Bond L, Nolan T, Pattison P, Carlin J. Vaccine preventable diseases and immunisations: a qualitative study of mothers' perceptions of severity.

- susceptibility, benefits and barriers. *Australian New Zealand J Public Health* 1998;22(4):441–6.
- [4] Davis TC, Fredrickson DD, Arnold CL, Cross JT, Humiston SG, Green KW, et al. Childhood vaccine risk/benefit communication in private practice office settings: a national survey. *Pediatrics* 2001;107. e17–e.
 - [5] Serpell L, Green J. Parental decision-making in childhood vaccination. *Vaccine* 2006;24(19):4041–6.
 - [6] Slovic P. Perception of risk. *Science* 1987;236:280–5.
 - [7] Dube E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger J. Vaccine hesitancy: an overview. *Hum Vaccin Immunother* 2013;9(8):1763–73.
 - [8] 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(19):2150–9.
 - [9] Brandt C, Rabenau HF, Bornmann S, Gottschalk R, Wicker S. The impact of the 2009 influenza A(H1N1) pandemic on attitudes of healthcare workers toward seasonal influenza vaccination 2010/11. *Eurosurveillance*. 2011;16(17).
 - [10] Socan M, Erculj V, Lajovic J. Knowledge and attitudes on pandemic and seasonal influenza vaccination among Slovenian physicians and dentists. *Europ J Pub Health* 2013;23(1):92–7.
 - [11] Mereckiene J, O'Donnell J, Collins C, Cotter S, Igoe D, O'Flanagan D. Risk groups and uptake of influenza and pneumococcal vaccine in Ireland. *Euro surveillance: bulletin europeen sur les maladies transmissibles = Europ Commun Dis Bull* 2007;12(12):E13–4.
 - [12] Delelis-Fanien AS, Seite F, Priner M, Paccalin M. Vaccine coverage against influenza and pneumococcal infections in patients aged 65 and over: a survey on 299 outpatients. *Revue de Med Interne* 2009;30(8):656–60.
 - [13] Schoefer Y, Schaberg T, Raspe H, Schaefer T. Determinants of influenza and pneumococcal vaccination in patients with chronic lung diseases. *J Infect* 2007;55(4):347–52.
 - [14] Looijmans-van den Akker I, van den Heuvel PM, Verheij TJM, van Delden JJM, van Essen GA, Hak E. No intention to comply with influenza and pneumococcal vaccination: behavioural determinants among smokers and non-smokers. *Preventive Med* 2007;45(5):380–5.
 - [15] Opstelten W, van Essen GA, Hak E. Determinants of non-compliance with herpes zoster vaccination in the community-dwelling elderly. *Vaccine* 2009;27(2):192–6.
 - [16] Longuet R, Willot S, Ginies JL, Pelatan C, Breton E, Segura JF, et al. Immunization status in children with inflammatory bowel disease. *European J Pediatr* 2014;173(5):603–8.
 - [17] Winnock M, Neau D, Castera L, Viot J, Lacoste D, Pellegrin JL, et al. Hepatitis B vaccination in HIV-infected patients: a survey of physicians and patients participating in the Aquitaine cohort. *Gastroenterol Clinique et Biologie* 2006;30(2):189–95.
 - [18] Bedford H, Lansley M. More vaccines for children? Parents' views. *Vaccine* 2007;25(45):7818–23.
 - [19] Baars JE, Boon BJ, Garretsen HF, van de Mheen D. The reach of a hepatitis B vaccination programme among men who have sex with men. *Europ J Pub Health* 2011;21(3):333–7.
 - [20] Murphy D, Dandeker C, Horn O, Hotopf M, Hull L, Jones M, et al. UK armed forces responses to an informed consent policy for anthrax vaccination: a paradoxical effect? *Vaccine* 2006;24(16):3109–14.
 - [21] Murphy D, Marteau T, Hotopf M, Rona RJ, Wessely S. Why do UK military personnel refuse the anthrax vaccination? *Biosec Bioterror* 2008;6(3):237–42.
 - [22] Chantler T, Newton S, Lees A, Diggle L, Mayon-White R, Pollard AJ, et al. Parental views on the introduction of an infant pneumococcal vaccine. *Commun Practition: J Commun Practition Health Visitors' Associat* 2006;79(7):213–6.
 - [23] Tickner S, Leman PJ, Woodcock A. 'It's just the normal thing to do': Exploring parental decision-making about the 'five-in-one' vaccine. *Vaccine* 2007;25(42):7399–409.
 - [24] Wicker S, Zielen S, Rose MA. Attitudes of healthcare workers toward pertussis vaccination. *Expert Rev Vaccines* 2008;7(9):1325–8.
 - [25] Allaert FA, Blanc A, Megard Y, Bertrand I. Parents' attitudes towards varicella vaccination acceptance in France and Germany: effect of vaccine recommendation and reimbursement (a survey). *J Pub Health* 2009;17(2):1–6.
 - [26] Teich N, Klugmann T, Tiedemann A, Holler B, Mossner J, Liebetrau A, et al. Vaccination coverage in immunosuppressed patients: results of a regional health services research study. *Deutsches Arzteblatt Internat* 2011;108(7):105–11.
 - [27] Lewthwaite P, Campion K, Blackburn B, Kemp E, Major D, Sarangi K. Healthcare workers' attitude towards influenza vaccination after the 2009 pandemic. *Occupat Med* 2014;64(5):348–51.
 - [28] Opstelten W, van Essen GA, Heijnen ML, Ballieux MJP, Goudswaard AN. High vaccination rates for seasonal and pandemic (A/H1N1) influenza among healthcare workers in Dutch general practice. *Vaccine* 2010;28(38):6164–8.
 - [29] Tanguy M, Boyeau C, Pean S, Marijon E, Delhumeau A, Fanello S. Acceptance of seasonal and pandemic A (H1N1) 2009 influenza vaccination by healthcare workers in a French Teaching Hospital. *Vaccine* 2011;29(25):4190–4.
 - [30] Boyeau C, Tanguy M, Pean S, Delhumeau A, Fanello S. [Seasonal and pandemic A (H1N1) 2009 influenza vaccination coverage among health-care workers in a French university hospital]. *Sante Publique (Vandoeuvre-Les-Nancy)*. 2011;23(1):19–29.
 - [31] Rubin GJ, Potts HW, Michie S. Likely uptake of swine and seasonal flu vaccines among healthcare workers. A cross-sectional analysis of UK telephone survey data. *Vaccine* 2011;29(13):2421–8.
 - [32] Viredda S, Alejandra Restrepo M, Arranz E, Magan-Tapia P, Fernandez-Ruiz M, Gomez de la Camara A, et al. Seasonal and Pandemic A (H1N1) 2009 influenza vaccination coverage and attitudes among health-care workers in a Spanish University Hospital. *Vaccine* 2010;28(30):4751–7.
 - [33] Wicker S, Rabenau HF, von Gierke L, Francois G, Hambach R, De Schryver A. Hepatitis B and influenza vaccines: important occupational vaccines differently perceived among medical students. *Vaccine* 2013;31(44):5111–7.
 - [34] Lehmann BA, Ruiter RAC, Wicker S, van Dam D, Kok G. "I don't see an added value for myself": a qualitative study exploring the social cognitive variables associated with influenza vaccination of Belgian, Dutch and German healthcare personnel. *Bmc Public Health*. 2014;14.
 - [35] Raftopoulos V. Attitudes of nurses in Greece towards influenza vaccination. *Nursing standard (Royal College of Nursing (Great Britain))*: 1987. 2008;23(4):35–42.
 - [36] Dedoukou X, Nikolopoulos G, Maragos A, Giannoulidou S, Maltezou HC. Attitudes towards vaccination against seasonal influenza of health-care workers in primary health-care settings in Greece. *Vaccine* 2010;28(37):5931–3.
 - [37] Gavazzi G, Filali-Zegzouti Y, Guyon AC, De Wazieres B, Lejeune B, Golmard JL, et al. French healthcare workers in geriatric healthcare settings staunchly opposed to influenza vaccination: the VESTA study. *Vaccine* 2011;29(8):1611–6.
 - [38] Opstelten W, Essen GA, Ballieux MJP, Goudswaard AN. Influenza immunization of Dutch general practitioners: vaccination rate and attitudes towards vaccination. *Vaccine* 2008;26(47):5918–21.
 - [39] O'Reilly FW, Cran GW, Stevens AB. Factors affecting influenza vaccine uptake among health care workers. *Occupat Med* 2005;55(6):474–9.
 - [40] Wicker S, Rabenau HF, Doerr HW, Allwinn R. Influenza vaccination compliance among health care workers in a German university hospital. *Infection*. 2009;37(3):197–202.
 - [41] Maltezou HC, Maragos A, Katerelos P, Paisi A, Karageorgou K, Papadimitriou T, et al. Influenza vaccination acceptance among health-care workers: A nationwide survey. *Vaccine* 2008;26(11):1408–10.
 - [42] Canning HSJ, Phillips S. Allsup Health care worker beliefs about influenza vaccine and reasons for non-vaccination - A cross-sectional survey. *J Clin Nurs* 2005;14(8 A):922–5.
 - [43] Ishola Jr DA, Permalloo N, Cordery RJ, Anderson SR. Midwives' influenza vaccine uptake and their views on vaccination of pregnant women. *J Pub Health* 2013;35(4):570–7.
 - [44] Kelly C, Duthheil F, Haniez P, Boudet G, Rouffiac K, Traore O, et al. Analysis of motivations for antifu vaccination of the Clermont-Ferrand University Hospital staff. *Med et Maladies Infect* 2008;38(11):574–85.
 - [45] Ehrenstein BP, Hanses F, Blaas S, Mandraka F, Audefert F, Salzberger B. Perceived risks of adverse effects and influenza vaccination: a survey of hospital employees. *Europ J Pub Health* 2010;20(5):495–9.
 - [46] Smedley J, Poole J, Waclawski E, Stevens A, Harrison J, Watson J, et al. Influenza immunisation: Attitudes and beliefs of UK healthcare workers. *Occupat Environmen Med* 2007;64(4):223–7.
 - [47] Loulergue P, Moulin F, Vidal-Trecaan G, Absi Z, Demontpion C, Menager C, et al. Knowledge, attitudes and vaccination coverage of healthcare workers regarding occupational vaccinations. *Vaccine* 2009;27(31):4240–3.
 - [48] Qureshi AM, Hughes NJM, Murphy E, Primrose WR. Factors influencing uptake of influenza vaccination among hospital-based health care workers. *Occupat Med* 2004;54(3):197–201.
 - [49] Blasi F, Palange P, Rohde G, Severin T, Cornaglia G, Finch R. Healthcare workers and influenza vaccination: an ERS-ESCMID Web-based survey. *Clin Microbiol Infect* 2011;17(8):1223–5.
 - [50] Kardas P, Zasowska A, Dec J, Stachurska M. Reasons for low influenza vaccination coverage: cross-sectional survey in Poland. *Croat Med J* 2011;52(2):126–33.
 - [51] Muller D, Szucs TD. Influenza vaccination coverage rates in 5 European countries: a population-based cross-sectional analysis of the seasons 02/03, 03/04 and 04/05. *Infection* 2007;35(5):308–19.
 - [52] Szucs TD, Muller D. Influenza vaccination coverage rates in five European countries - A population-based cross-sectional analysis of two consecutive influenza seasons. *Vaccine* 2005;23(43):5055–63.
 - [53] Blank PR, Freiburghaus AU, Schwenkglenks MM, Szucs TD, Kunze U. Influenza vaccination coverage rates in Austria in 2006/07 - a representative cross-sectional telephone survey. *Wiener Med Wochenschrift* 2008;158(19–20):583–8.
 - [54] Blank PR, Schwenkglenks M, Szucs TD. Influenza vaccination coverage rates in five European countries during season 2006/07 and trends over six consecutive seasons. *BMC Public Health* 2008;8.
 - [55] Kroneman MW, van Essen GA, Tackem M, Paget WJ, Verheij R. Does a population survey provide reliable influenza vaccine uptake rates among high-risk groups? - A case-study of The Netherlands. *Vaccine* 2004;22(17–18):2163–70.
 - [56] Zijtregot EAM, Wilschut J, Koelma N, Van Delden JJ, Stolk RP, Steenbergen JV, et al. Which factors are important in adults' uptake of a (pre)pandemic influenza vaccine? *Vaccine* 2010;28(1):207–27.
 - [57] Evans MR, Prout H, Prior L, Tapper-Jones LM, Butler CC. A qualitative study of lay beliefs about influenza immunisation in older people. *British J General Pract* 2007;57(538):352–8.

- [58] Kwong EW-y, Pang SM-c, Choi P-p, Wong TK-s. Influenza vaccine preference and uptake among older people in nine countries. *Journal of Advanced Nursing*. 2010;66(10):2297–308.
- [59] Mangtani P, Breeze E, Stirling S, Hanciles S, Kovats S, Fletcher A. Cross-sectional survey of older peoples' views related to influenza vaccine uptake. *BMC Public Health* 2006;6:249.
- [60] Burns VE, Ring C, Carroll D. Factors influencing influenza vaccination uptake in an elderly, community-based sample. *Vaccine* 2005;23(27):3604–8.
- [61] Colley E. Influenza vaccination in adults with a long-term condition. *Commun Pract: J Commun Practitioner Health Visitors' Associat* 2008;81(4):25–8.
- [62] Keenan H, Campbell J, Evans PH. Influenza vaccination in patients with asthma: why is the uptake so low? *British J General Practice* 2007;57(538):359–63.
- [63] Mouthon L, Mestre C, Berezne A, Poiraudou S, Marchand C, Guilpain P, et al. Low influenza vaccination rate among patients with systemic sclerosis. *Rheumatology* 2010;49(3):600–6.
- [64] Kroneman M, Essen GAV, Paget WJ. Influenza vaccination coverage and reasons to refrain among high-risk persons in four European countries. *Vaccine* 2006;24(5):622–8.
- [65] Hunt C, Arthur A. Student nurses' reasons behind the decision to receive or decline influenza vaccine: a cross-sectional survey. *Vaccine* 2012;30(40):5824–9.
- [66] Machowicz R, Wysomirski T, Ciecianska J, Mahboobi N, Wnekowicz E, Obrowski M, et al. Knowledge, Attitudes, and Influenza Vaccination of Medical Students in Warsaw, Strasbourg, and Teheran. *Europ J Med Res* 2010;15:235–40.
- [67] Hernandez-Garcia I, Gonzalez-Celador R, Gimenez-Julvez Teresa M. Attitudes of Medical Students about Influenza Vaccination. *Revista Espanola De Salud Publica* 2014;88(3):407–18.
- [68] Schindler M, Blanchard-Rohner G, Meier S, Tejada BMD, Siegrist CA, Burton-Jeangros C. Vaccination against seasonal flu in Switzerland: the indecision of pregnant women encouraged by healthcare professionals. *Revue d'Epidemiologie et de. Sante Publique* 2012;60(6):447–53.
- [69] Boedeker B, Walter D, Reiter S, Wichmann O. Cross-sectional study on factors associated with influenza vaccine uptake and pertussis vaccination status among pregnant women in Germany. *Vaccine* 2014;32(33):4131–9.
- [70] Maltezou HC, Kalogriopoulou K, Pergialiotis V, Siahaniidou T, Skiathitou AV, Katerelos P, et al. Acceptance of a post-partum influenza vaccination (cocooning) strategy for neonates in Greece. *Vaccine* 2012;30(40):5871–4.
- [71] Sampson R, Wong L, Macvicar R. Parental reasons for non-uptake of influenza vaccination in young at-risk groups: a qualitative study. *British J General Pract* 2011;61(588):e386–91.
- [72] Bonaccorsi G, Lorini C, Santomauro F, Guarducci S, Pellegrino E, Puggelli F, et al. Predictive factors associated with the acceptance of pandemic and seasonal influenza vaccination in health care workers and students in Tuscany, Central Italy. *Human vaccines Immunotherap* 2013;9(12):2603–12.
- [73] Wicker S, Rabenau HF, Betz W, Lauer HC. Attitudes of dental healthcare workers towards the influenza vaccination. *Internat J Hygiene Environment Health* 2012;215(4):482–6.
- [74] Chantler T, Pace D, Wright A, Pollard AJ, Yu LM, Nguyen-Van-Tam JS, et al. Uptake and acceptability of influenza vaccination in day nursery children. *Commun Practitioner: J Commun Practitioner Health Visit Associat* 2007;80(12):32–6.
- [75] Lehmann BA, Ruiter RA, Kok G. A qualitative study of the coverage of influenza vaccination on Dutch news sites and social media websites. *BMC Public Health* 2013;13:547.
- [76] Kroneman M, Essen GAV. Stagnating influenza vaccine coverage rates among high-risk groups in Poland and Sweden in 2003/4 and 2004/5. *Eurosurveillance*. 2007;12(4).
- [77] Manish P, Clark T, Dillon H, Rajesh K, Stephenson I. Willingness of healthcare workers to accept voluntary stockpiled H5N1 vaccine in advance of pandemic activity. *Vaccine*. 2009;27(8):1242–7.
- [78] Chor JSY, Pada SK, Stephenson I, Giggins WB, Tambyah PA, Clarke TW, et al. Seasonal influenza vaccination predicts pandemic H1N1 vaccination uptake among healthcare workers in three countries. *Vaccine* 2011;29(43):7364–9.
- [79] Barriere J, Vanjak D, Kriegel I, Otto J, Peyrade F, Esteve M, et al. Acceptance of the 2009 A(H1N1) influenza vaccine among hospital workers in two French cancer centers. *Vaccine* 2010;28(43):7030–4.
- [80] Valour F, Benet T, Chidiac C. Study g. Pandemic A(H1N1)2009 influenza vaccination in Lyon University Hospitals, France: perception and attitudes of hospital workers. *Vaccine* 2013;31(4):592–5.
- [81] Head S, Atkin S, Allan K, Ferguson C, Lutchnun S, Cordery R. Vaccinating health care workers during an influenza pandemic. *Occupat Med* 2012;62(8):651–4.
- [82] Rachiotis G, Mouchtouri VA, Kremastinou J, Gourgoulianis K, Hadjichristodoulou C. Low acceptance of vaccination against the 2009 pandemic influenza A(H1N1) among healthcare workers in Greece. *Eurosurveillance* 2010;15(6):3.
- [83] Maltezou HC, Dedoukou X, Patrinos S, Maragos A, Poufta S, Gargalianos P, et al. Determinants of intention to get vaccinated against novel (pandemic) influenza A H1N1 among health-care workers in a nationwide survey. *J Infect* 2010;61(3):252–8.
- [84] Chen S, Hawkins G, Aspinall E, Neil P. Factors influencing uptake of influenza A (H1N1) vaccine amongst healthcare workers in a regional pediatric centre: lessons for improving vaccination rates. *Vaccine* 2012;30(2):493–7.
- [85] Parry HM, Damery S, Fergusson A, Draper H, Bion J, Low AE. Pandemic influenza A (H1N1) 2009 in a critical care and theatre setting: beliefs and attitudes towards staff vaccination. *J Hospital Infect* 2011;78(4):302–7.
- [86] Bjorkman I, Sanner MA. The Swedish A(H1N1) vaccination campaign—why did not all Swedes take the vaccination? *Health Policy* 2013;109(1):63–70.
- [87] Walter D, Boehmer MM, Reiter S, Krause G, Wichmann O. Risk perception and information-seeking behaviour during the 2009/10 influenza A(H1N1)pdm09 pandemic in Germany. *Eurosurveillance* 2012;17(13):9–16.
- [88] Boehmer MM, Walter D, Falkenhorst G, Mueters S, Krause G, Wichmann O. Barriers to pandemic influenza vaccination and uptake of seasonal influenza vaccine in the post-pandemic season in Germany. *Bmc Public Health*. 2012;12.
- [89] Borjesson M, Enander A. Perceptions and sociodemographic factors influencing vaccination uptake and precautionary behaviours in response to the A/H1N1 influenza in Sweden. *Scandinavian J Pub Health* 2014;42(2):215–22.
- [90] Schwarzinger M, Flicoteaux R, Cortarenoda S, Obadia Y, Moatti JP. Low acceptability of A/H1N1 pandemic vaccination in french adult population: Did public health policy fuel public dissonance? *PLoS ONE*. 2010;5(4).
- [91] Setbon M, Raude J. Factors in vaccination intention against the pandemic influenza A/H1N1. *Europ J Pub Health* 2010;20(5):490–4.
- [92] Renner B, Reuter T. Predicting vaccination using numerical and affective risk perceptions: the case of A/H1N1 influenza. *Vaccine* 2012;30(49):7019–26.
- [93] Sim JA, Ulanika AA, Katikireddi SV, Gorman D. 'Out of two bad choices, I took the slightly better one': vaccination dilemmas for Scottish and Polish migrant women during the H1N1 influenza pandemic. *Public Health* 2011;125(8):505–11.
- [94] Av Lier, Steens A, Ferreira JA, van der Maas NA, Melker HE. Acceptance of vaccination during pregnancy: experience with 2009 influenza A (H1N1) in the Netherlands. *Vaccine* 2012;30(18):2892–9.
- [95] Moukarram H, Nargund A, Photiou A, Kiran TSU. Awareness and acceptance of the pandemic influenza (H1N1 v 2009) vaccination among antenatal patients in a district general hospital. *J Obst Gynaecology* 2012;32(6):537–9.
- [96] Mavros MN, Mitsikostas PK, Kontopidis IG, Moris DN, Dimopoulos G, Falagas ME. H1N1v influenza vaccine in Greek medical students. *Europ J Pub Health* 2011;21(3):329–32.
- [97] Musinguzi G, Mandere NM, Asamoah BO, Foreman E. A cross-sectional internet-based survey of influenza A (H1N1) pandemic: risk perceptions, behavioural responses and vaccination practices at Lund University, Sweden. *J Pub Health Epidemiology* 2012;4(4):78–87.
- [98] Bults M, Beaujean DJ, Richardus JH, van Steenberg JE, Voeten HA. Pandemic influenza A (H1N1) vaccination in The Netherlands: parental reasoning underlying child vaccination choices. *Vaccine* 2011;29(37):6226–35.
- [99] Janks M, Cooke S, Odedra A, Kang H, Bellman M, Jordan RE. Factors affecting acceptance and intention to receive pandemic influenza A H1N1 vaccine among primary school children: A cross-sectional study in Birmingham, UK. *Influenza Research and Treatment*. 2012;2012(182565).
- [100] d'Alessandro E, Hubert D, Launay O, Bassinet L, Lortholary O, Jaffre Y, et al. Determinants of refusal of A/H1N1 pandemic vaccination in a high risk population: A qualitative approach. *PLoS ONE*. 2012;7(4).
- [101] Syssa V, Livanios T, Psychogiou M, Malliori M, Tsioutras S, Nikolakopoulos I, et al. Public perceptions in relation to intention to receive pandemic influenza vaccination in a random population sample: evidence from a cross-sectional telephone survey. *Euro surveillance: bulletin european sur les maladies transmissibles = European communicable disease bulletin*. 2009;14(49).
- [102] Stavroulopoulos A, Stamogiannis G, Aresti V. Pandemic 2009 influenza H1N1 virus vaccination: compliance and safety in a single hemodialysis center. *Renal Failure* 2010;32(9):1044–8.
- [103] Blank PR, Bonnelye G, Ducastel A, Szucs TD. Attitudes of the General Public and General Practitioners in Five Countries towards Pandemic and Seasonal Influenza Vaccines during Season 2009/2010. *PLoS ONE*. 2012;7(10).
- [104] Grandahl M, Oscarsson M, Stenhammar C, Neveus T, Westerling R, Tyden T. Not the right time: why parents refuse to let their daughters have the human papillomavirus vaccination. *Acta Paediatrica, Internat J Paediat* 2014;103(4):436–41.
- [105] Hofman R, Van Empelen P, Vogel I, Raat H, Van Ballegooijen M, Korff J. Parental decisional strategies regarding HPV vaccination before media debates: a focus group study. *J Health Communicat Internat Perspect* 2013;18(7):866–80.
- [106] Gottvall M, Grandahl M, Hoglund AT, Larsson M, Stenhammar C, Andrae B, et al. Trust versus concerns—how parents reason when they accept HPV vaccination for their young daughter. *Upsala J Med Sci* 2013;118(4):263–70.
- [107] Noakes K, Yarwood J, Salisbury D. Parental response to the introduction of a vaccine against human papilloma virus. *Human Vaccines* 2006;2(6):243–8.
- [108] Mortensen GL. Parental attitudes towards vaccinating sons with human papillomavirus vaccine. *Danish Medical Bulletin*. 2010;57(12).
- [109] Gefenaite G, Smit M, Nijman HW, Tami A, Drijfhout IH, Pascal A, et al. Comparatively low attendance during Human Papillomavirus catch-up vaccination among teenage girls in the Netherlands: Insights from a behavioral survey among parents. *Bmc Public Health*. 2012;12.
- [110] Brabin L, Roberts SA, Farzaneh F, Kitchener HC. Future acceptance of adolescent human papillomavirus vaccination: a survey of parental attitudes. *Vaccine* 2006;24(16):3087–94.

- [111] Hilton S, Smith E. I thought cancer was one of those random things. I didn't know cancer could be caught...: Adolescent girls' understandings and experiences of the HPV programme in the UK. *Vaccine* 2011;29(26):4409–15.
- [112] Williams K, Forster A, Marlow L, Waller J. Attitudes towards human papillomavirus vaccination: a qualitative study of vaccinated and unvaccinated girls aged 17–18 years. *J Family Plann Reproduct Health Care* 2011;37(1):22–5.
- [113] Forster AS, Marlow LAV, Wardle J, Stephenson J, Waller J. Understanding adolescents' intentions to have the HPV vaccine. *Vaccine* 2010;28(7):1673–6.
- [114] Forster AS, Marlow LA, Wardle J, Stephenson J, Waller J. Interest in having HPV vaccination among adolescent boys in England. *Vaccine* 2012;30(30):4505–10.
- [115] Paul-Ebhohimhen V, Huc S, Tissington H, Oates K, Stark C. HPV vaccination: vaccine acceptance, side effects and screening intentions. *Commun Practitioner: J Commun Practitioner Health Visitors' Associat* 2010;83(6):30–3.
- [116] Oscarsson MG, Hannerfors AK, Tyden T. Young women's decision-making process for HPV vaccination. *Sex Reproduct Health* 2012;3(4):141–6.
- [117] Haesebaert J, Lutringer-Magnin D, Kalecinski J, Barone G, Jacquard A-C, Regnier V, et al. French women's knowledge of and attitudes towards cervical cancer prevention and the acceptability of HPV vaccination among those with 14–18 year old daughters: a quantitative-qualitative study. *Bmc Public Health*. 2012;12.
- [118] Craciun C, Baban A. "Who will take the blame?": understanding the reasons why Romanian mothers decline HPV vaccination for their daughters. *Vaccine*. 2012;30(48):6789–93.
- [119] Korfage IJ, Essink-Bot ML, Daamen R, Mols F, Van Ballegooijen M. Women show mixed intentions regarding the uptake of HPV vaccinations in pre-adolescents: a questionnaire study. *Europ J Cancer*. 2008;44(9):1186–92.
- [120] Sotiriadis A, Dagklis T, Siamanta V, Chatzigeorgiou K, Agorastos T, Group LS. Increasing fear of adverse effects drops intention to vaccinate after the introduction of prophylactic HPV vaccine. *Arch Gynecol Obs* 2012;285(6):1719–24.
- [121] Waller J, Marlow LAV, Wardle J. Mothers' attitudes towards preventing cervical cancer through human papillomavirus vaccination: a qualitative study. *Cancer Epidemiol, Biomarkers Prevent* 2006;15(7):1257–61.
- [122] Marlow LA, Wardle J, Waller J. Attitudes to HPV vaccination among ethnic minority mothers in the UK: an exploratory qualitative study. *Human Vaccines* 2009;5(2):105–10.
- [123] Marlow LA, Waller J, Wardle J. Trust and experience as predictors of HPV vaccine acceptance. *Human Vaccines* 2007;3(5):171–5.
- [124] Marlow LA, Waller J, Wardle J. Parental attitudes to pre-pubertal HPV vaccination. *Vaccine* 2007;25(11):1945–52.
- [125] Oscarsson MG, Dahlberg A, Tyden T. Midwives at youth clinics attitude to HPV vaccination and their role in cervical cancer prevention. *Sex Reproduct Health* 2011;2(4):137–42.
- [126] Lutringer-Magnin D, Kalecinski J, Barone G, Leocmach Y, Regnier V, Jacquard AC, et al. Human papillomavirus (HPV) vaccination: perception and practice among French general practitioners in the year since licensing. *Vaccine* 2011;29(32):5322–8.
- [127] Papagiannis D, Rachiotis G, Symvoulakis EK, Daponte A, Grivea IN, Syrogiannopoulos GA, et al. Vaccination against human papillomavirus among 865 female students from the health professions in central Greece: a questionnaire-based cross-sectional study. *J Multidisciplin Health* 2013;6:435–9.
- [128] Tisi G, Salinaro F, Apostoli P, Bassani R, Bellicini A, Groppi L, et al. HPV vaccination acceptability in young boys. *Anna dell'Istituto Superiore di Sanita*. 2013;49(3):286–91.
- [129] Gordon D, Waller J, Marlow LA. Attitudes to HPV vaccination among mothers in the British Jewish community: reasons for accepting or declining the vaccine. *Vaccine*. 2011;29(43):7350–6.
- [130] Penta MA, Baban A. Dangerous agent or saviour? HPV vaccine representations on online discussion forums in Romania. *Internat J Behav Med* 2014;21(1):20–8.
- [131] Marek E, Dergez T, Kricskovics A, Kovac K, Rebek-Nagy G, Gocze K, et al. Difficulties in the prevention of cervical cancer: Adults' attitudes towards HPV vaccination 3 years after introducing the vaccine in Hungary. *Vaccine* 2011;29(32):5122–9.
- [132] Kennedy C, Gray Brunton C, Hogg R. 'Just that little bit of doubt': Scottish parents', teenage girls' and health professionals' views of the MMR, H1N1 and HPV vaccines. *Internat J Behav Med* 2014;21(1):3–10.
- [133] Hilton S, Hunt K, Peticrew M. MMR: Marginalised, misrepresented and rejected? Autism: A focus group study. *Archiv Dis Child* 2007;92(4):322–7.
- [134] Hilton S, Peticrew M, Hunt K. Combined vaccines are like a sudden onslaught to the body's immune system: Parental concerns about vaccine 'overload' and 'immune-vulnerability'. *Vaccine* 2006;24(20):4321–7.
- [135] Gardner B, Davies A, McAteer J, Michie S. Beliefs underlying UK parents' views towards MMR promotion interventions: a qualitative study. *Psychol, Health Med* 2010;15(2):220–30.
- [136] Dannetun E, Tegnell A, Hermansson G, Giesecke J. Parents' reported reasons for avoiding MMR vaccination: a telephone survey. *Scand J Primary Health Care* 2005;23(3):149–53.
- [137] Casiday R, Cresswell T, Wilson D, Panter-Brick C. A survey of UK parental attitudes to the MMR vaccine and trust in medical authority. *Vaccine* 2006;24(2):177–84.
- [138] Brown KF, Long SJ, Ramsay M, Hudson MJ, Green J, Vincent CA, et al. U.K. parents' decision-making about measles-mumps-rubella (MMR) vaccine 1 years after the MMR-autism controversy: a qualitative analysis. *Vaccine* 2012;30(10):1855–64.
- [139] Cassell JA, Leach M, Poltorak MS, Mercer CH, Iversen A, Fairhead JR. Is the cultural context of MMR rejection a key to an effective public health discourse? *Public Health* 2006;120(9):783–94.
- [140] Pulcini C, Massin S, Launay O, Verger P. Knowledge, attitudes, beliefs and practices of general practitioners towards measles and MMR vaccination in southeastern France in 2012. *Clin Microbiol Infect* 2014;20(1):38–43.
- [141] Alfreidsson R, Svensson E, Trollfors B, Borres MP. Why do parents hesitate to vaccinate their children against measles, mumps and rubella? *Acta Paediatr, Internat J Paediatr* 2004;93(9):1232–7.
- [142] McMurray R, Cheater FM, Weighall A, Nelson C, Schweiger M, Mukherjee S. Managing controversy through consultation: a qualitative study of communication and trust around MMR vaccination decisions. *British J General Practice*. 2004;54(504):520–5.
- [143] Tickner S, Leman PJ, Woodcock A. Parents' views about pre-school immunization: an interview study in southern England. *Child: Care, Health Develop* 2010;36(2):190–7.
- [144] Stefanoff P, Mamelund SE, Robinson M, Netterlid E, Tuells J, Bergsaker MA, et al. Tracking parental attitudes on vaccination across European countries: The Vaccine Safety, Attitudes, Training and Communication Project (VACSATC). *Vaccine* 2010;28(35):5731–7.
- [145] Paulussen TG, Hoekstra F, Lanting CI, Buijs GB, Hirasen RA. Determinants of Dutch parents' decisions to vaccinate their child. *Vaccine* 2006;24(5):644–51.
- [146] Mollema L, Wijers N, Hahne SJM, Klis FRMvd, Boshuizen HC, Melker HED. Participation in and attitude towards the national immunization program in the Netherlands: data from population-based questionnaires. *BMC Public Health*. 2012;12(57).
- [147] Moran N, Shickle D, Richardson E. European citizens' opinions on immunisation. *Vaccine* 2008;26(3):411–8.
- [148] Stampi S, Ricci R, Ruffilli I, Zanetti F. Compulsory and recommended vaccination in Italy: Evaluation of coverage and non-compliance between 1998–2002 in Northern Italy. *BMC Public Health*. 2005;5(42).
- [149] Harmsen IA, Ruiters RAC, Paulussen TGW, Mollema L, Kok G, Melker HED. Factors that influence vaccination decision-making by parents who visit an anthroposophical child welfare center: a focus group study. *Advances in Preventive Medicine*. 2012;175694(32).
- [150] Harmsen IA, Mollema L, Ruiters RAC, Paulussen TGW, de Melker HE, Kok G. Why parents refuse childhood vaccination: a qualitative study using online focus groups. *Bmc Public Health*. 2013;13.
- [151] Ruijs WLM, Hautvast JLA, van Ijzendoorn G, van Ansem WJC, van der Velden K, Hulscher MEJL. How orthodox protestant parents decide on the vaccination of their children: a qualitative study. *Bmc Public Health*. 2012;12.
- [152] Henderson L, Millett C, Thorogood N. Perceptions of childhood immunization in a minority community: qualitative study. *J Royal Soc Med* 2008;101(5):244–51.
- [153] Maconachie M, Lewendon G. Immunising children in primary care in the UK - what are the concerns of principal immunisers? (Special issue: Health promotion and public health across the UK). *Health Educat J* 2004;63(1):40–9.
- [154] Martinez-Diz S, Martinez Romero M, Fernandez-Prada M, Cruz Piqueras M, Molina Ruano R, Fernandez Sierra MA. Demands and expectations of parents who refuse vaccinations and perspective of health professional on the refusal to vaccinate. *Anales De Pediatria* 2014;80(6):370–8.
- [155] Poland GA, Spier R. Fear, misinformation, and innumerates: how the Wakefield paper, the press, and advocacy groups damaged the public health. *Vaccine* 2010;28(12):2361–2.
- [156] Françoise G, Ducloux P, Margolis H, Lavanchy D, Siegrist C-A, Meheus A, et al. Vaccine Safety Controversies and the Future of Vaccination Programs. *The Pediatric Infectious Disease Journal*. 2005;24(11):953–61.
- [157] Larson H, Brocard Paterson P, Erond N. The globalization of risk and risk perception: why we need a new model of risk communication for vaccines. *Drug Saf* 2012;35(11):1053–9.
- [158] Betsch C, Brewer NT, Brocard P, Davies P, Gaissmaier W, Haase N, et al. Opportunities and challenges of Web 2.0 for vaccination decisions. *Vaccine* 2012;30(25):3727–33.
- [159] Levine MM, Levine OS. Influence of disease burden, public perception, and other factors on new vaccine development, implementation, and continued use. *Lancet* 1997;350(9088):1386–92.
- [160] Plotkin SA. Vaccines: past, present and future. *Nat Med* 2005;11(4 Suppl):S5–S11.
- [161] Yaqub O, Castle-Clarke S, Sevdalis N, Chataway J. Attitudes to vaccination: a critical review. *Soc Sci Med* 2014;112:1–11.
- [162] Kahneman D, Tversky A. Prospect theory: an analysis of decision under Risk. *Econometrica* 1979;47(2):263–91.
- [163] Ritov I, Baron J. Outcome Knowledge, Regret, and Omission Bias. *Organization Behav Human Decision Processes* 1995;64(2):119–27.
- [164] Ritov I, Baron J. Status-quo and omission biases. *J Risk Uncertainty* 1992;5(1):49–61.
- [165] Zeelenberg M. Anticipated regret, expected feedback and behavioral decision making. *J Behav Decis Making* 1999;12(2):93–106.
- [166] Smith PJ, Humiston SG, Marcuse EK, Zhao Z, Dorell CG, Howes C, et al. Parental delay or refusal of vaccine doses, childhood vaccination coverage at 24 months of age, and the Health Belief Model. *Public Health Rep* 2011;126(Suppl 2):135–46.
- [167] World Health Organisation. How to respond to vocal vaccine deniers in public. Copenhagen: WHO Regional Office for Europe; 2016.