Review

Resources for assessing parents' vaccine hesitancy: a systematic review of the literature

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Keywords

Vaccine • Hesitancy • Parents • Questionnaire • Review

Summary

The concept of Vaccine Hesitancy has begun to appear in the scientific landscape, referring to the reluctance of a growing proportion of people to accept the vaccination offer. A variety of factors were identified as being associated with vaccine hesitancy but there was no universal algorithm and currently there aren't any established metrics to assess either the presence or impact of vaccine hesitancy. The aim of this study was to systematically review the published questionnaires evaluating parental vaccine hesitancy, to highlight the differences among these surveys and offer a general overview on this matter. This study offers a deeper perspective on the available questionnaires, helping future researches to identify the most suitable one according to their own aim and study setting.

Introduction

Vaccines have long been considered as one of the most important public health achievements of the past century and they have largely contributed to the decline in morbidity and mortality related to various infectious diseases [1]. Due to the effectiveness of vaccination programs, many people nowadays have limited or no experience with vaccine-preventable diseases (VPDs), thus parents increasingly assume that the risks associated with VPDs are minimal compared to potential health and safety risks of vaccinations themselves [2, 3]. The concept of Vaccine Hesitancy has subsequently begun to appear in the scientific landscape, referring to the reluctance of a growing proportion of people to accept the vaccination offer [4]. In fact, urban centres with large clusters of vaccine-hesitant individuals are particularly vulnerable to VPD outbreaks among exposed, unimmunized children, as observed with the measles outbreaks in the USA, Canada, and Europe [5-7]. 2014-2015 the Disneyland measles outbreak was a stark reminder of the direct influence of vaccine hesitancy and refusal [8].

The World Health Organization (WHO) defines vaccine hesitancy as the ''delay in acceptance or refusal of vaccines despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place and for different vaccines. This phenomenon is influenced by factors such as complacency, convenience and confidence" [9]. The "3Cs" Model, that highlights these three categories, was first proposed in 2011 by the WHO EURO Vaccine Communications Working Group. In the "3 Cs" model, confidence is defined as trust in the effectiveness and safety of vaccines, and in the system that delivers them. This includes the reliability and competence of health services and health professionals and the motivations of policy-makers who decide on the needed vaccines. Vaccination complacency exists where the perceived risks of vaccine-preventable diseases are low and vaccination is not deemed a necessary preventive action. Vaccination convenience is a significant factor when physical availability, affordability, willingness-to-pay, geographical accessibility, ability to understand (language and health literacy) and appeal of immunization services affect the vaccination uptake [10]. There is a wide variety of determinants of vaccine hesitancy. In 2015, the WHO EURO Vaccine Communications Working Group developed the Vaccine Hesitancy

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Determinants Matrix which categorized determinants into the following groups: contextual, individual and group influences, and vaccine and vaccination-specific issues [11]. Contextual influences include historic, social, cultural, environmental, economic, political and institutional factors which might influence vaccine hesitant populations. The most common is conspiracy theories, which include a fear that vaccines are introduced to serve the economic and/or political interests of pharmaceutical companies [12, 13].

Individual and group influences include personal perceptions or beliefs about vaccines and influences from the social environment such as the belief that vaccines are unsafe. Parents are more afraid of the adverse events related to vaccines, which are thought to be more frequent and more serious than they really are, than of the complications that could arise from infectious diseases [14]. Moreover, some individuals do not perceive a medical need for certain vaccines. Vaccine Hesitancy is a global, complex and constantly changing phenomenon, currently representing one of the most significant problems of public health: in 2019 the World Health Organization (WHO) listed vaccine hesitancy in its top ten threats to global health [15]. To understand the impact that the various determinants have on vaccine hesitancy and what factors can influence vaccination decisions, numerous studies have been conducted over the years [16, 17].

Despite the growing number of articles on vaccine hesitancy published in recent years, there are some discrepancies among publications in terms of what exactly falls under the umbrella of "vaccine hesitancy", a term that was only introduced by the SAGE Working Group in 2015. Therefore, in order to obtain as much information as possible on this issue, all studies investigating the determinants of vaccine hesitancy, without specifically using the term "vaccine hesitancy", were also included in this review. A variety of factors were identified as being associated with vaccine hesitancy but there was no universal algorithm and currently there aren't any established metrics to assess either the presence or impact of vaccine hesitancy. Study methods used to measure "vaccine hesitancy" are too heterogeneous and this makes it difficult to make inferences about the influence of specific factors on vaccine-hesitant behaviour. The aim of this study was to systematically review the published questionnaires evaluating parental vaccine hesitancy, to highlight the differences among these surveys and offer a general overview on this matter. Administration channel, sample size, type of vaccine being investigated, and the type of questions used in the questionnaire are some of the variables that can be considered, when designing a study to investigate vaccine hesitancy. The characteristics of each study, as well as the variables investigated, have been analyzed in order to enable future researchers to choose the most suitable tool for evaluating and measuring vaccine hesitancy over time and in different settings, according to their own needs and goals.

Methods

Search strategy

This is a systematic review conducted in accordance with the PRISMA Guidelines [18]. Several databases were consulted, including PubMed/Medline, Web of Science and The Cochrane Library. The latter was used to identify existing systematic reviews with a similar objective, in order to further screen the lists of references of potentially related articles that might have not been retrieved in the other databases. The systematic search was performed with no time filter, from inception to December 14th, 2017; however, a language limit was adopted, indeed only English and Italian articles were included in our review. The predefined search strategy that was used to identify potential relevant articles included four main aspects: parents or caregivers, vaccine hesitancy/acceptance, immunization and survey. Mesh and text words were combined with Boolean operators AND and OR. The full search strategy is: ((((((questionnair*[Title/Abstract] OR survey[Title/Abstract] OR "Surveys and Questionnaires"[Mesh])) AND (vaccin*[Title/Abstract] OR immuniz*[Title/Abstract] OR immunis*[Title/Abstract] OR shot*[Title/Abstract] OR jab*[Title/Abstract] OR "Vaccines"[Mesh] OR "Immunization"[Mesh] OR "Vaccination"[Mesh])) AND (hesitanc*[Title/Abstract] OR doubt*[Title/Abstract] OR concern*[Title/Abstract] OR criticis*[Title/Abstract] OR rumo*r[Title/Abstract] OR sceptic*[Title/Abstract] OR fear*[Title/Abstract] OR refus*[Title/Abstract] OR reject*[Title/Abstract] OR delay[Title/Abstract] OR accept*[Title/Abstract] OR consen*[Title/Abstract] OR intent*[Title/Abstract] OR confidence[Title/Abstract] OR adherence[Title/Abstract] OR complian*[Title/Abstract] OR uptake[Title/Abstract] OR engagement[Title/Abstract] OR *trust[Title/Abstract] OR a*titude[Title/Abstract] OR perception*[Title/Abstract] OR opinion*[Title/Abstract] OR belief*[Title/Abstract] OR behavi*r[Title/Abstract] OR choice*[Title/Abstract] OR practic*[Title/Abstract] OR barrier*[Title/Abstract] OR facilitator*[Title/Abstract] OR "Health Knowledge, Attitudes, Practice"[Mesh] OR "Vaccination Refusal"[Mesh] OR "Trust"[Mesh] OR "Behavior"[Mesh] OR "Patient Acceptance of Health Care"[Mesh]))) AND (parent*[Title/Abstract] OR caregiver*[Title/Abstract] OR guardian*[Title/Abstract] OR tutor*[Title/Abstract] OR mother*[Title/Abstract] OR father*[Title/Abstract] OR "legally acceptable representative"[Title/Abstract] OR "Parents"[Mesh])). In order to include all publications related to the topic, the list of references was manually screened for all relevant papers. Endnote was used as a software to manage all the retrieved references.

Inclusion criteria

Studies that fulfilled the inclusion criteria were considered in this review. Papers aimed at investigating parents/caregivers vaccine hesitancy through a survey/

questionnaire were considered eligible, regardless of the attitudes and behaviours of the interviewed subjects. As a matter of fact, vaccine hesitancy is complex and driven by a wide variety of factors, as explained by the 3C model developed by the SAGE Working Group. Therefore, knowing the determinants of Vaccine Hesitancy in specific subgroups of parents (such as those who do not trust or have lost confidence in vaccinations) is extremely important in order to develop the right strategies to address it. In addition, including studies selecting the study population according to a negative/positive attitude/behaviour towards vaccination might be helpful for future researchers interested in studying Vaccine Hesitancy in a specific subgroup of parents. Because vaccine hesitancy is a complex phenomenon, strictly depending on several aspects that are country-specific, and because the introduction of vaccine hesitancy as a term in the scientific community is relatively new, we also included studies evaluating public trust/distrust, perceptions, concerns, confidence, attitudes, beliefs about vaccines and vaccination programs. Moreover, we included all types of available vaccines. Furthermore, we only assessed original articles, while other types of publications were not included in the analysis. Lastly, due to the aim of the research, only observational studies were considered: along with cross-sectional studies, we included cohort studies and case-control studies. The last two types of studies are particularly helpful in order to obtain as much information as possible and to have a broader overview of this phenomenon: as a matter of fact, they allowed us to include studies where questionnaires or surveys were used to investigate vaccine hesitancy among parents.

Exclusion criteria

Studies were excluded from this review when they investigated vaccine hesitancy in target populations different from parents/caregivers/guardians, for instance physicians, educators, or directly the adolescents. Papers written in languages other than English and Italian were excluded, as well as not original articles (reviews, letters to editor, conference papers, editorials). Additionally, surveys aimed at assessing aspects different than vaccine hesitancy were not included. Lastly, articles were excluded if the vaccines examined were not for humans or were not commercially available yet (such as the HIV vaccine), or if the publications were on vaccine development.

Data extraction

Eight couples of reviewers (VG and CA, MN and GV, SP and FD, OG and IB, EA and SDN, OES and LK, OG and AC, FDG and LG), independently performed the screening of titles and abstracts, followed by data extraction of the included articles. Disagreement was solved through a discussion between the authors, if disagreement persisted a third author was consulted (PC). Full-texts were downloaded and consulted only for the included articles. The extracted data were reported in a predefined, ad hoc spreadsheet elaborated in Excel. For each included article, the following items were evaluated: first author's name and year of publication, when and where the study was conducted, study design and study aim, population characteristics and sample size, types of survey and administration, if the questionnaire was previously validated and if it was attached to the manuscript, number and type of questions, type of vaccine analysed, immunization behaviour and beliefs about vaccines.

Data coding

The included articles were coded by study period, country, language, study type and study aim, population characteristics, way of administration, number of items and items categories in the questionnaire, types of vaccine, immunization behaviour, beliefs about vaccine safety/efficacy. Regarding the latter, beliefs were coded as follows: i) no assessment of perceived safety/efficacy vaccines; ii) the assessment was performed and most of the respondents believe vaccinations to be safe/effective; iii) the assessment was performed and most of the respondents do not believe vaccinations to be safe/effective; iv) the assessment was performed but data were not available); v) the assessment was performed, but only qualitative and descriptive data were available (numerical data not available). As for the immunization behaviour, it was classified as follows: i) "acceptance", if the whole population consisted of people receiving the vaccination; ii) "refusal", if the whole population consisted of parents refusing the vaccination; iii) "hesitancy/scepticism/doubt", if the population consisted of both parents accepting the vaccine and parents refusing it; iv) if no information was available, it was considered as missing data.

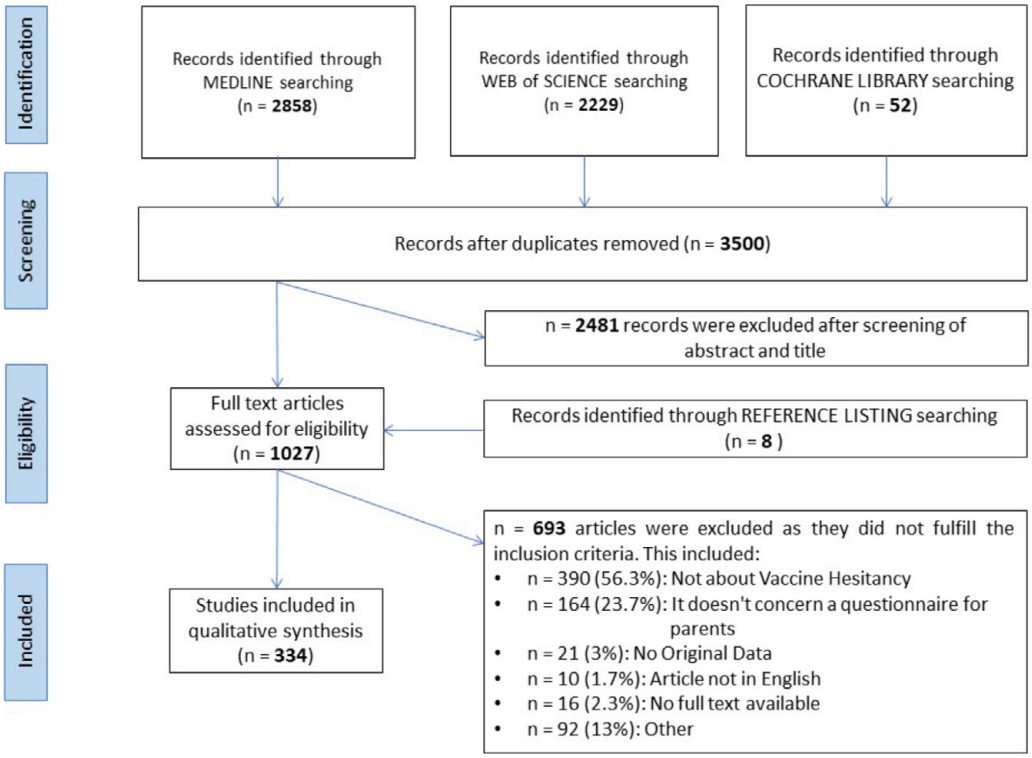
Results

We identified 5,139 records by running the pre-defined search strategies on the three selected databases (Medline, Web of Science, The Cochrane Library), and 8 additional records were retrieved from the manual searching of reference lists and citation chains of included papers. After removing duplicates, 3,500 papers were assessed for eligibility by title and abstract, and 2,481 papers were removed. After full text screening selection, 334 studies were included in the descriptive analysis and synthesis [3, 16, 19-350]. Figure 1 shows the selection flow. The main results of our systematic review are shown in Table I.

Study designs and study aims

Most of the included studies (60.4%, n = 202/334) were conducted between 2010 and 2019, while 30.5% (n = 102/334) articles reported a study period prior to 2008. In a total of 8.9% (n = 30/334) works the study period was not specified. Among the most recent studies, 48.8% (n = 100/334) were conducted in North or South America (Argentina, Brazil, Canada, Caribbean, El

Fig. 1. Flow chart of selection process.



Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Adler A, 2007	2007	Israel	Cross-sectional	Paper-based	1,474	Varicella	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Adorador A, 2011	2011	USA	Cross-sectional	Paper-based	108	Dtp	Closed	Not	Hesitancy/ scepticism/ doubt
Aharony N, 2017	2017	Israel	Cross-sectional	On-line	200	Child vaccines	Likert scale	With statistical methods	Refusal
Akis S, 2011	2011	Turkey	Cross-sectional	Paper-based	611	Flu	Closed	Not	Acceptance
Akmatov MK, 2009	2009	Kyrgyzstan	Cross-sectional	Paper-based	934	Child vaccines	Closed	Not	Acceptance
Alberts CJ, 2017	2017	Netherlands	Cross-sectional	Mail	1,309	Hpv	Closed	Statistical methods not reported	Acceptance
Alfredsson R, 2004	2004	Sweden	Cross-sectional	Paper-based	300	Mmr	Closed	With statistical methods	Acceptance
Allen JD, 2010	2010	USA	Cross-sectional	On-line	476	Hpv	Closed	Not	Acceptance
Allison MA, 2010	2010	USA	Cross-sectional	Paper-based	259	Flu	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt
Allred NJ, 2005	2005	USA	Cross-sectional	Mail	7,810	Dt	Closed	With statistical methods	Acceptance
Alshammari TM, 2018	2018	Saudi Arabia	Cross-sectional	Paper-based	467	Child vaccines	Closed	Statistical methods not reported	Acceptance

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Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Ambe JP, 2001	2001	Nigeria	Cross-sectional	Paper-based	500	Measles	Closed	Statistical methods not reported	Refusal
Aharon AA, 2017	2017	Israel	Cross-sectional	Paper-based	731	Hbv/dtp/mmr	Likert scale	Not	Refusal
Arrossi S, 2012	2012	Argentina	Cross-sectional	Paper-based	1,200	Hpv	Closed	With statistical methods	Acceptance
Azizi FSM, 2017	2017	Malesya	Cross-sectional	Paper-based	545	Child vaccines	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Baglioni A, 2014	2014	Italy	Cross-sectional	Paper-based	648	Hpv	Closed	With statistical methods	Acceptance
Bakhache P, 2013	2013	Multinational	Cross-sectional	On-line	2,460	Menb	Closed	Statistical methods not reported	Acceptance
Baldwin AS, 2013	2008-2010	USA	Cross-sectional	Paper-based	256	Hpv	Likert scale	With statistical methods	Acceptance
Bardenheier B, 2003	2000	USA	Cross-sectional	Paper-based	648	Hav	Closed	Not	Acceptance
Bardenheier B, 2004	2001	USA	Case-control	Paper-based	3,586	Mmr/ dtp/hbv	Likert scale	Not	Acceptance
Bardenheier BH, 2004	1997-1998	USA	Cross-sectional	Paper-based	3,552	Dtp/hib/ hbv/ polio	Closed	Not	Hesitancy/ scepticism/ doubt
Barnack JL, 2010	2006	USA	Cross-sectional	Mail	200	Hpv	Likert scale	Not	Acceptance
Barnack-Tavlaris JL, 2016	2009	USA	Cross-sectional	Telephone	4,666	Hpv	Closed	Not	Acceptance
Bazzano A, 2012	2007	USA	Cross-sectional	Telephone	197	Child vaccines	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Bedford H, 2007	2004	UK	Cross-sectional	Paper-based	859	New vaccines	Likert scale	Not	Acceptance
Beel ER, 2013	2010-2012	USA	Cross-sectional	Paper-based	511	Child vaccines	Closed	With statistical methods	Acceptance
Ben Natan M, 2011	2008	Israel	Cross-sectional	Paper-based	103	Hpv	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt
Ben Natan M, 2016	2015	Israel	Cross-sectional	Paper-based	200	Flu	Likert scale	With statistical methods	Acceptance
Ben Natan M, 2017	2016	Israel	Cross-sectional	Paper-based	200	Hpv	Likert scale	With statistical methods	Acceptance
Berenson AB, 2014	2011-2013	USA	Cross-sectional	Paper-based	1,256	Hpv	Closed	With statistical methods	Acceptance
Bettinger JA, 2016	2011	Canada	Cross-sectional	Mail	34	Flu	Closed	Not	Acceptance
Bham SQ, 2016	2015	Pakistan	Cross-sectional	Paper-based	210	Polio	Closed	Not	Acceptance
Bianco A, 2014	2014	Italy	Cross-sectional	Paper-based	566	Hpv	Likert scale	Not	Acceptance
Bigham M, 2006	2002-2003	Canada	Cross-sectional	Telephone	487	Hbv	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Alder S, 2015	2012	Argentina	Cross-sectional	Paper-based	180	Hpv	Closed	With statistical methods	Acceptance
Basu P, 2011	2008	India	Cross-sectional	Paper-based	522	Hpv	Closed	Statistical methods not reported	Acceptance
Blair A, 1997	1997	Australia	Cross-sectional	Paper-based	245	Child vaccines	Open field	Not	Acceptance
Blyth CC, 2014	2008–2012	Australia	Cross-sectional	Paper-based	2,576	Dtp/hib/hbv	Closed	Statistical methods not reported	Hesitancy/scepticism/doubt
Bodson J, 2016	2013	USA	Cross-sectional	Paper-based	119	Hpv	Closed	With statistical methods	Hesitancy/scepticism/doubt
Bonanni P, 2001	2001	Italy	Cross-sectional	Paper-based	300	Child vaccines	Closed	Not	Acceptance
Borena W, 2016	2015	Austria	Cross-sectional	Mail	439	Hpv	Closed	Not	Hesitancy/scepticism/doubt
Borras E, 2009	2003-2004	Spain	Cross-sectional	Telephone	630	Child vaccines	Closed	Not	Hesitancy/scepticism/doubt
Brabin L, 2006	2005	UK	Cross-sectional	Mail	317	Hpv	Mixed	With statistical methods	Hesitancy/scepticism/doubt
Brambleby P, 1989	1988	UK	Cross-sectional	Mail	977	Mmr	Mixed	Statistical methods not reported	Refusal
Breitkopf CR, 2009	2007	Vietnam	Cross-sectional	Paper-based	139	Hpv	Closed	Not	Hesitancy/scepticism/doubt
Brieger D, 2017	N.A.	Australia	Cross-sectional	Paper-based	201	Mmr	Mixed	Not	Hesitancy/scepticism/doubt
Brown B, 2017	2015-2016	USA	Cross-sectional	Paper-based	200	Hpv	Closed	Statistical methods not reported	Hesitancy/scepticism/doubt
Brown KF, 2011	2009	UK	Cross-sectional	Mail	535	Mmr	Mixed	Statistical methods not reported	Hesitancy/scepticism/doubt
Brunson EK, 2013	2010	USA	Cross-sectional	On-line	196	Child vaccines	Mixed	With statistical methods	Hesitancy/scepticism/doubt
Bults M, 2011	2009-2010	Netherlands	Cross-sectional	Face to face/mail	1900	Flu	Open field	With statistical methods	Refusal
Burdette AM, 2014	2014	USA	Cross-sectional	Telephone	20,000	Hpv	Closed	With statistical methods	Refusal
Busse JW, 2011	2010	Canada	Cross-sectional	Paper-based	95	Child vaccines	Closed	Statistical methods not reported	Hesitancy/scepticism/doubt
Buyuktiryaki B, 2014	2010	Turkey	Cross-sectional	Paper-based	625	Flu	Likert scale	Statistical methods not reported	Hesitancy/scepticism/doubt
Cacciatore MA, 2016	2014-2015	USA	Cross-sectional	On-line	2,000	Measles	Mixed	Not	Hesitancy/scepticism/doubt
Campbell H, 2017	2015	UK	Cross-sectional	Face to face	1,792	Child vaccines	Mixed	Not	Hesitancy/scepticism/doubt

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Carlos RC, 2011	N.A.	USA	Cross-sectional	Mail	937	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Casiday R, 2006	2004	UK	Cross-sectional	Mail	996	Mmr	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Cassell JA, 2006	2004	Uk	Cross-sectional	Mail	452	Mmr	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Cataldi JR, 2016	2015	USA	Cross-sectional	On-line	343	Mmr	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Chan JY, 2014	2012	Hong Kong	Cross-sectional	Paper-based	1,285	Varicella	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Chaparro RM, 2016	2012	Argentina	Cross-sectional	Paper-based	77	Hpv	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Chau JPC, 2017	2013	Hong Kong	Cross-sectional	Paper-based	623	Flu	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt
Chen CH, 2015	2011	Taiwan	Cross-sectional	Mail	1,300	Flu	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt
Chen MF, 2011	2009	Taiwan	Cross-sectional	Paper-based	2,778	Flu	Mixed	With statistical methods	Hesitancy/ scepticism/ doubt
Cheruvu VK, 2017	2017	USA	Cross-sectional	Telephone	21,467	Hpv	Closed	Not	Refusal
Chung YM, 2017	2012-2014	USA	Cross-sectional	On-line	5,121	Child vaccines	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Cipriano JJ, 2018	2016	USA	Cross-sectional	On-line	75	Hpv	Mixed	Not	Acceptance
Clark SJ, 2016	2012	USA	Cross-sectional	On-line	1,799	Hpv	Mixed	With statistical methods	Acceptance
Clark SJ, 2016	2012	USA	Cross-sectional	On-line	1,799	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Clark SJ, 2016	2013	USA	Cross-sectional	On-line	1,799	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Cockcroft A, 2014	2011	Nigeria	Cross-sectional	Paper-based	5,257	Measles	Closed	Not	Acceptance
Colon-Lopez V, 2016	2013	Puerto Rico	Cross-sectional	Paper-based	200	Hpv	Mixed	Not	Acceptance
Colon-Lopez V, 2015	2013	Puerto Rico	Cross-sectional	Paper-based	200	Hpv	Mixed	Not	Acceptance
Coniglio MA,2011	2008	Italy	Cross-sectional	Paper-based	1,500	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Constantine NA, 2007	2006	USA	Cross-sectional	Telephone	802	Hpv	Mixed	Not	Acceptance
Cooper Robbins SC, 2011	2007	Australia	Cross-sectional	Paper-based	169	Flu	Mixed	Not	Acceptance
Costa-Pinto JC, 2017	2014-2015	Australia	Cross-sectional	On-line	612	Child vaccines	Mixed	Not	Acceptance
Coyne-Beasley T, 2013	2008	USA	Cross-sectional	Telephone	1281	Mcv	Mixed	Not	Acceptance

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Cuninghame CJ, 1994	1991-1992	UK	Cross-sectional	Face to face/ telephone/mail	93	Child vaccines	Mixed	Not	Acceptance
Cunningham-Erves J, 2016	2012-2013	USA	Cross-sectional	Paper-based	242	Hpv	Likert scale	Not	Acceptance
Dahlstrom LA, 2010	2007	Sweden	Cross-sectional	Web /paper based	13,946	Hpv	N.A.	With statistical methods	Acceptance
Daley MF, 2007	2003	USA	Cross-sectional	Telephone	472	Flu	Mixed	Not	Acceptance
Danchin MH, 2017	2015-2016	Australia	Cross-sectional	Questionnaire (ipad), follow-up phone surveys	975	Child vaccines	Mixed	Not	Acceptance
Danis K, 2010	2004–2005	Greece	Cross-sectional	Paper-based	3,434	Child vaccines	Mixed	Not	Acceptance
Dannetun E, 2007	2005	Sweden	Cross-sectional	Paper-based and online	1,229	Hbv	Mixed	Statistical methods not reported	Acceptance
Dannetun E, 2005	2003	Sweden	Cross-sectional	Paper-based	173	Mmr	Mixed	Not	Refusal
Danova J, 2015	2013-2014	Repubblica Ceca	Cross-sectional	Paper-based	480	Child vaccines	Closed	Not	Refusal
Darden PM, 2013	2008–2010	USA	Cross-sectional	Telephone		Dtp/ mcv/ hpv	N.A.	Not	Refusal
Davis K, 2004	2003	USA	Cross-sectional	Paper-based	575	Hpv	Mixed	Not	Acceptance
Dawar M, 2002	1999	Canada	Cross-sectional	Telephone	191	Hbv/ dtp/hib	Mixed	Not	Acceptance
de Courval FP, 2003	2000	Canada	Cross-sectional	Telephone	663	Varicella	Mixed	Not	Refusal
de Visser R, 2008	2008	UK	Cross-sectional	Paper-based	353	Hpv	Likert scale	Not	Acceptance
Dempsey AF, 2011	N.A.	USA	Cross-sectional	Mail	830	Hpv	Mixed	Not	Acceptance
Dempsey AF, 2015	2012-2013	USA	Cross-sectional	On-line	54	Hpv	Mixed	Not	Acceptance
Dempsey AF, 2006	2009	USA	Cross-sectional	On-line	1,178	Hpv	Likert scale	Not	Acceptance
DiAnna Kinder F, 2017	N.A.	USA	Cross-sectional	Paper-based	72	Hpv	Mixed	Not	Refusal
Dinh TA, 2007	2005	Vietnam	Cross-sectional	Paper-based	181	Hpv	Likert scale	Statistical methods not reported	Acceptance
Dorell C, 2014	2010	USA	Cross-sectional	Telephone	4103	Hpv	Closed	Not	Hesitancy/ scepticism/ doubt
Dorell C, 2013	2010-2011	USA	Cross-sectional	Telephone	8,652	Hpv/dtp/ mcv	Closed	Not	Hesitancy/ scepticism/ doubt
Dorell C, 2011	2009-2010	USA	Cross-sectional	Telephone	20,066	Hpv/ mcv/dtp	Closed	Not	Hesitancy/ scepticism/ doubt
Dube E, 2012	2008-2009	Canada	Cohort	Paper-based	413	Rotavirus	Mixed	Not	Acceptance
Dube E, 2015	2014	Canada	Cross-sectional	Telephone	703	Menb	Likert scale	Statistical methods not reported	Acceptance
Dube E, 2017	2015	Canada	Cross-sectional	On-line	20,13	Child vaccines	Mixed	Not	Acceptance
Dube E, 2016	2014	Canada	Cross-sectional	Telephone	589	Child vaccines	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt

continues

follows

Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Ezat SW, 2013	2012	Malesya	Cross-sectional	Not reported	155	Hpv	N.A.	Not	Acceptance
Ezeanochie MC, 2014	2009	Nigeria	Cross-sectional	Paper-based	201	Hpv	Closed	Statistical methods not reported	Acceptance
Ezenwa BN, 2013	2012	Nigeria	Cross-sectional	Paper-based	290	Hpv	N.A.	Not	Acceptance
Farias CC, 2016	2015	Brazil	Cross-sectional	Paper-based	797	Hpv	Mixed	Not	Acceptance
Flood EM, 2010	2009	USA	Cross-sectional	On-line	500	Flu	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Flynn M, 2004	1999-2000	UK	Cohort	Paper-based	511	Mmr	Likert scale	Not	Hesitancy/ scepticism/ doubt
Freed GL, 2010	2009	USA	Cross-sectional	On-line	1,552	Mmr/ varicella/ mcv/ hpv	N.A.	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Freeman VA, 1999	1995	USA	Cross-sectional	Mail	247	Varicella	Closed	Not	Hesitancy/ scepticism/ doubt
Frew PM, 2016	2012-2014	USA	Cross-sectional	On-line	5,121	Child vaccines	Closed	Not	Acceptance
Frew PM, 2011	2009	USA	Cross-sectional	Not reported	223	Flu	Likert scale	Not	Refusal
Fry AM, 2001	1999-2000	USA	Case-control	Paper-based	66	Hib	Open field	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Fuchs EL, 2016	2011-2013	USA	Cross-sectional	Not reported	350	Hpv	Likert scale	Not	Hesitancy/ scepticism/ doubt
Garcia DA, 2014	2000	Colombia	Cross-sectional	Paper-based	4,802	Child vaccines	Mixed	Not	Hesitancy/ scepticism/ doubt
Gargano LM, 2013	2011	USA	Cross-sectional	Telephone	114	Flu/dtp/ mcv/ hpv	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gaudino JA, 2012	2004-2005	USA	Cross-sectional	On-line	1,588	Child vaccines	Likert scale	Not	Hesitancy/ scepticism/ doubt
Gefenaite G, 2012	2009	Netherlands	Case-control	Mail	469	Hpv	Closed	Not	Hesitancy/ scepticism/ doubt
Gellatly J, 2005	2003-2004	UK	Cross-sectional	Paper-based	110	Mmr	Likert scale	Not	Hesitancy/ scepticism/ doubt
Gellin BG, 2000	1999	USA	Cross-sectional	Telephone	1,600	Child vaccines	Likert scale	Not	Acceptance
Gentile A, 2015	2013	Argentina	Cross-sectional	Not reported	1,350	Flu	Likert scale	Not	Hesitancy/ scepticism/ doubt
Gerend MA, 2009	2008	USA	Cross-sectional	Paper-based	82	Hpv	Closed	Not	Acceptance
Gesser-Edelsburg A, 2016	2013	Israel	Cross-sectional	On-line	197	Polio	Open field	Not	Refusal
Giambi C, 2014	2012	Italy	Cross-sectional	Mail	1,738	Hpv	Mixed	Not	Refusal
Gilbert NL, 2016	2013	Canada	Cross-sectional	Telephone	5,720	Hpv	Likert scale	Not	Hesitancy/ scepticism/ doubt

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Gilkey MB, 2017	2014-2015	USA	Cross-sectional	On-line	1,484	Hpv	Closed	Not	Hesitancy/ scepticism/ doubt
Glanz JM, 2013	2009-2011	USA	Cross-sectional	Mail	854	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Glenn BA, 2015	2009	USA	Cross-sectional	Telephone	444	Hpv	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gomez Y, 2012	2010	USA	Cross-sectional	Paper-based	773	Flu	N.A.	Not	Hesitancy/ scepticism/ doubt
Gottlieb SL, 2009	2007	USA	Cross-sectional	Telephone	889	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Gowda C, 2013	2011	USA	Cross-sectional	On-line	79	Mmr	Likert scale	Not	Hesitancy/ scepticism/ doubt
Grabiel M, 2013	2012	USA	Cross-sectional	Paper-based	129	Hpv	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Grandahl M, 2014	2012	Sweden	Cross-sectional	Face to face	25	Hpv	Open field	Statistical methods not reported	Refusal
Grandahl M, 2017	2012	Sweden	Cross-sectional	Paper-based	200	Hpv	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Greenberg J, 2017	2015	Canada	Cross-sectional	On-line	1,121	Mmr	Likert scale	Statistical methods not reported	Acceptance
Greenfield LS, 2015	2012	USA	Cross-sectional	Face to face	157	Dtp/ mcv/ hpv	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Griebeler M, 2012	2010	USA	Cross-sectional	Paper-based	102	Hpv	Likert scale	Statistical methods not reported	Acceptance
Guerry SL, 2011	2007-2008	USA	Cross-sectional	Telephone	509	Hpv	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gundogdu Z, 2011	2009-2010	Turkey	Cross-sectional	Paper-based	300	Varicella	Likert scale	With statistical methods	Acceptance
Gunduz S, 2014	2011-2012	Turkey	Cross-sectional	Paper-based	285	Flu	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gupta R, 2013	2009-2010	USA	Cross-sectional	Paper-based and online	381	Flu	Closed	Not	Hesitancy/ scepticism/ doubt
Gust D, 2005	2002	USA	Cross-sectional	Mail	697	Child vaccines	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gust DA, 2006	2004-2005	USA	Cross-sectional	Telephone	2,286	Mmr/ dtp/hbv	Closed	Not	Hesitancy/ scepticism/ doubt
Gust DA, 2008	2003-2004	USA	Cross-sectional	Telephone	3,924	Child vaccines	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gust DA, 2005	2003	USA	Cross-sectional	Mail	642	Child vaccines	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Gust DA, 2004	2001	USA	Case-control	Mail	1,477	Mmr/ dtp/hbv	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Gust DA, 2003	2002	USA	Cross-sectional	Mail	1,768	Child vaccines	Likert scale	Statistical methods not reported	Acceptance
Gustafson R, 2005	2003	Canada	Cross-sectional	Telephone	1,246	Varicella	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Haesebaert J, 2012	2008	France	Cross-sectional	Face to face	32	Hpv	Open field	Statistical methods not reported	Acceptance
Hagan D, 2016	2013	Ghana	Cross-sectional	Paper-based	303	Child vaccines	Closed	Statistical methods not reported	Acceptance
Hagemann C, 2017	2009-2011	Germany	Cross-sectional	Paper-based	1,998	Varicella/ measles	N.A.	With statistical methods	Hesitancy/ scepticism/ doubt
Hak E, 2005	N.A.	Netherland	Cross-sectional	Not reported	283	Influenza/ hbv/bcg	Likert scale	Not	Refusal
Hamama-Raz Y, 2016	2014	Israel	Cross-sectional	On-line	314	Child vaccines	Likert scale	Not	Acceptance
Han K, Zheng H, 2014	2010	China	Cross-sectional	Face to face	1,530	Bcg/dtp/ polio/ mcv/ hbv	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Hanley SJ, 2012	2010	Japan	Cross-sectional	Paper-based	862	Hpv	Likert scale	Not	Acceptance
Hanley SJ, 2014	2010	Japan	Cross-sectional	Paper-based	54	Hpv	Likert scale	Not	Acceptance
Harmsen IA, 2012	2011	Netherlands	Cross-sectional	Paper-based	906	Hbv	Likert scale	Not	Acceptance
He L, 2015	2013	China	Cross-sectional	Face to face	298	Flu	Open field	Not	Hesitancy/ scepticism/ doubt
Healy CM, 2014	N.A.	USA	Cross-sectional	Not reported	401	Hib/pcv/ mcv/ flu/hbv/ hav/hpv/ rotavirus	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Henrikson NB, 2017	2013-2015	USA	Cohort	Telephone	237	Child vaccines	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Hertweck SP, 2013	N.A.	USA	Cross-sectional	On-line	68	Hpv	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Hilyard KM, 2014	2010	USA	Cross-sectional	Not reported	684	Flu	Closed	Not	Hesitancy/ scepticism/ doubt
Hofman R, 2014	2009-2011	Netherlands	Cohort	Mail	793	Hpv	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Hofstetter AM, 2015	2011	USA	Cross-sectional	Face to face	128	Flu	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Hon KL, 2016	N.A.	Hong Kong	Cross-sectional	Paper-based	3,479	Flu	N.A.	Not	Hesitancy/ scepticism/ doubt
Hontelez JA, 2010	N.A.	Netherland	Cross-sectional	Paper-based	198	Hbv	Likert scale	Not	Hesitancy/ scepticism/ doubt
Horn L, 2010	2008	USA	Cross-sectional	Paper-based	325	Hpv	Likert scale	With statistical methods	Acceptance

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
How CH, 2016	2014	Singapore	Cross-sectional	Face to face	200	Pcv	Likert scale	Not	Hesitancy/ scepticism/ doubt
Hu Y, 2017	2014	China	Cross-sectional	Face to face	2,772	Child vaccines	N.A.	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Hwang JH, 2017	2014	South Korea	Cross-sectional	Face to face	638	Flu	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Ilter E, 2010	2009	Turkey	Cross-sectional	Face to face	525	Hpv	Likert scale	Not	Hesitancy/ scepticism/ doubt
Imburgia TM, 2017	2014	USA	Cross-sectional	On-line	2,363	Flu	Likert scale	Not	Hesitancy/ scepticism/ doubt
Impicciatore P, 2000	1997	Italy	Cross-sectional	Face to face	1,035	Mmr	Closed	With statistical methods	Acceptance
Jani JV, 2008	2001	Mozambique	Cross-sectional	Face to face	668	Child vaccines	N.A.	Statistical methods not reported	Acceptance
Jaspers L, 2011	2009	Indonesia	Cross-sectional	Face to face	746	Hpv	Closed	Not	Acceptance
Jessop LJ, 2010	2001-2004	UK	Cohort	Paper-based	749	Mmr	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Jolley D, 2014	2012	UK	Cross-sectional	On-line	89	Child vaccines	Likert scale	Statistical methods not reported	N.A.
Joseph NP, 2012	2008-2009	USA	Cross-sectional	Face to face	70	Hpv	Open field	With statistical methods	Hesitancy/ scepticism/ doubt
Joseph NP, 2015	N.A.		Cross-sectional	Paper-based	55	Hpv	Closed	With statistical methods	N.A.
Jung M, 2013	N.A.		Cross-sectional	On-line	639	Flu	N.A.	Not	Hesitancy/ scepticism/ doubt
Kadis JA, 2011	2009	USA	Cross-sectional	On-line	496	Hpv	Closed	Statistical methods not reported	Acceptance
Kahn JA, 2009	2006-2007	USA	Cross-sectional	Paper-based	7,207	Hpv	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt
Kalucka SK, 2016	N.A.	Poland	Cross-sectional	Paper-based	140	Child vaccines	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Katz ML, 2012	2009	USA	Cross-sectional	Paper-based	111	Hpv	Likert scale	Not	Hesitancy/ scepticism/ doubt
Haesebaert J, 2014	2008	France	Cross-sectional	Paper-based	99	Hpv	Open field	With statistical methods	Hesitancy/ scepticism/ doubt
Kaya A, 2017	2016	Turkey	Cross-sectional	Paper-based	102	Flu	Mixed	Not	Acceptance
Kelley CA, 2015	N.A.		Case-control	Paper-based	229	Child vaccines	Mixed	Statistical methods not reported	Refusal
Kempe A, 2007	2003	USA	Cross-sectional	Telephone	472	Flu	Mixed	Statistical methods not reported	Hesitancy/ scepticism/ doubt

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Kennedy A, 2011	2009	USA	Cross-sectional	Mail	475	Child vaccines	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Kennedy A, 2011	2010	USA	Cross-sectional	Mail	376	Child vaccines	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Kennedy AM, 2005	2002	USA	Cross-sectional	Mail	1527	Child vaccines	Likert scale	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Kepka D, 2015	2013	USA	Cross-sectional	Paper-based	118	Hpv	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Kepka D, 2015	2013	USA	Cross-sectional	Paper-based	67	Hpv	Mixed	With statistical methods	Hesitancy/ scepticism/ doubt
Kepka DL, 2012	2009	USA	Cross-sectional	Paper-based	578	Hpv	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Kester LM, 2013	2010	USA	Cross-sectional	On-line	501	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Kettunen C, 2017	N.A.	USA	Cross-sectional	Mail	84	Child vaccines	Mixed	Statistical methods not reported	Acceptance
Kim KM, 2017	2014-2015	South Korea	Cross-sectional	Paper-based	200	Hpv	Mixed	Not	Acceptance
Kinder FD. 2016	N.A.	USA	Cross-sectional	Paper-based	72	Hpv	Mixed	Not	Refusal
Ko HS, 2015	N.A.	South Korea	Cross-sectional	Paper-based	308	Dtp	Closed	Not	Acceptance
Kong KA, 2014	2013	South Korea	Cross-sectional	Telephone	800	Hav	Mixed	Statistical methods not reported	Acceptance
Krawczyk A, 2015	2010	Canada	Cross-sectional	Mail	774	Hpv	Likert scale	Not	Hesitancy/ scepticism/ doubt
Krawczyk A, 2015	2010	Canada	Cross-sectional	Mail	708	Hpv	Open field	Not	Refusal
Krieger JL, 2011	N.A.	USA	Cross-sectional	Paper-based	182	Hpv	Closed	Not	Acceptance
Lavail KH, 2013	2010	USA	Case-control	Mail	376	Child vaccines	Likert scale	Not	Acceptance
Le Ngoc Tho S, 2015	2013	France	Cross-sectional	Paper-based	1,270	Menb	Mixed	With statistical methods	Acceptance
Lechuga J, 2012	N.A.	USA	Cross-sectional	Paper-based	150	Hpv	Open field	Not	Acceptance
Lee KN, 2017	2015-2016	South Korea	Cross-sectional	Paper-based	140	Hpv	Mixed	Not	Acceptance
Lee Mortensen G, 2015	2013	Multinational	Cross-sectional	Paper-based	1,837	Hpv	Closed	Not	Acceptance
Lehmann BA, 2017	2015	Netherlands	Cross-sectional	Paper-based	1,615	Child vaccines	Mixed	Not	Acceptance
Lewis T, 1988	1988	USA	Cohort	Mail	2,029	Dtp	N.A.	Not	N.A.
Liao Q, 2016	2012-2013	Hong Kong	Cross-sectional	Telephone	1,226	Flu	Mixed	Not	Acceptance
Lin CJ, 2006	2003-2004	USA	Cross-sectional	Paper-based	951	Flu	Mixed	Not	Acceptance
Linam WM, 2014	2010-2011	USA	Cross-sectional	Paper-based	372	Flu	Mixed	Not	Acceptance
Lindley MC, 2016	2013	USA	Cross-sectional	Mail	6,676	Hpv	Mixed	Not	Acceptance

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Livni G, 2017	2012	Israel	Cross-sectional	Paper-based	186	Flu	Mixed	Statistical methods not reported	Acceptance
Loke AY, 2017	2010	Hong Kong	Cross-sectional	Paper-based	170	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Low MSF, 2017	2015-2016	Singapore	Cross-sectional	On-line	332	Flu	Mixed	Statistical methods not reported	Acceptance
Luthy KE, 2010	N.A.	USA	Cross-sectional	Paper-based	86	Child vaccines	Mixed	Not	Hesitancy/ scepticism/ doubt
Luthy KE, 2013	N.A.	USA	Cross-sectional	Paper-based	801	Child vaccines	Mixed	Not	Hesitancy/ scepticism/ doubt
Luthy KE, 2009	N.A.	USA	Cross-sectional	Paper-based	86	Child vaccines	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Maayan-Metzger A, 2005	2003	Israel	Case-control	Paper-based	204	Hbv	Closed	Not	Hesitancy/ scepticism/ doubt
MacDonald SE, 2014	N.A.	Canada	Case-control	Mail	444	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
MacDougall DM, 2016	2010-2012	Canada	Case-control	Paper-based	722	Rotavirus	Mixed	Statistical methods not reported	Acceptance
Madhivanan P, 2014	2010	India	Cross-sectional	Mail	797	Hpv	Likert scale	Not	Acceptance
Mameli C, 2014	2013	Italy	Cross-sectional	Paper-based	1,842	Menb	Closed	Not	Hesitancy/ scepticism/ doubt
Marlow LA, 2007	2006	UK	Cross-sectional	Paper-based	684	Hpv	Mixed	Not	Acceptance
Marlow LA, 2007	2006	UK	Cross-sectional	Paper-based	684	Hpv	Likert scale	With statistical methods	Acceptance
Marshall H, 2014	2012	Australia	Cross-sectional	Paper-based	966	Menb	N.A.	With statistical methods	Acceptance
Marshall H, 2007	2006	Australia	Cross-sectional	Telephone	2,002	Hpv	Closed	With statistical methods	Acceptance
Mayet AY, 2017	2013	Saudi Arabia	Cross-sectional	Paper-based	998	Flu	Mixed	Not	Hesitancy/ scepticism/ doubt
McCauley MM, 2012	2010	USA	Cross-sectional	Telephone	690	Child vaccines	Likert scale	Statistical methods not reported	N.A.
McHale P, 2016	2012-2013	UK	Cross-sectional	Telephone	47	Mmr	Open field	Statistical methods not reported	N.A.
Melman ST, 1999	1995-1997	USA	Cross-sectional	Paper-based	1,059	Child vaccines	Open field	Not	N.A.
Meszaros JR, 1996	N.A.	USA	Cross-sectional	Paper-based	294	Pertussis	Mixed	Not	N.A.
Michael CA, 2014	2012	Nigeria	Cross-sectional	Paper-based	48	Polio	Open field	Not	N.A.
Michael CE, 2014	2009	Nigeria	Cross-sectional	Paper-based	201	Hpv	Closed	Not	Acceptance

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Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Middleman AB, 2002	2000	USA	Cross-sectional	Paper-based	563	Hbv	Closed	Not	Hesitancy/ scepticism/ doubt
Milteer RM, 1996	1991-1994	USA	Cross-sectional	Paper-based	175	Child vaccines	Open field	Not	N.A.
Morales-Campos DY, 2017	2011-2013	Cameron	Cross-sectional	Paper-based	317	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Morhason-Bello IO, 2015	2012	Nigeria	Cross-sectional	Paper-based	1,002	Hpv	Likert scale	With statistical methods	Acceptance
Morrone T, 2017	2015	Italy	Cross-sectional	Paper-based	543	Menb	N.A.	With statistical methods	N.A.
Moulsdale P, 2017	2014	UK	Cross-sectional	Paper-based	86	Flu	Likert scale	Not	Acceptance
Muhwezi WW, 2014	2012	Uganda	Cross-sectional	Paper-based	870	Hpv	Closed	With statistical methods	Acceptance
Murakami H, 2014	2007	Pakistan	Cross-sectional	Paper-based	630	Polio	Open field	Not	Refusal
My C, 2017	2012	Australia	Cross-sectional	On-line	452	Flu	Closed	Not	Hesitancy/ scepticism/ doubt
Naeem M, 2011	2010	Pakistan	Cross-sectional	Paper-based	548	Polio	Closed	Not	Hesitancy/ scepticism/ doubt
Naeem M, 2011	2010	Pakistan	Cross-sectional	Paper-based	506	Hbv	Closed	Not	Hesitancy/ scepticism/ doubt
Namuigi P, 2005	2003	Papua New Guinea	Cross-sectional	Paper-based	120	Measles	Closed	Not	Hesitancy/ scepticism/ doubt
Niederhauser VP, 2007	2003-2004	USA	Cross-sectional	Paper-based	64	Child vaccines	Open field	Not	Hesitancy/ scepticism/ doubt
Oladokun RE, 2010	2009	Nigeria	Cross-sectional	Paper-based	248	Bcg/ polio/ dtp/ masles/ hbv	Closed	Statistical methods not reported	Acceptance
Onnela JP, 2016	2012	India	Cohort	Paper-based	2,462	Polio	Closed	Statistical methods not reported	Acceptance
Oria PA, 2013	2010	Kenya	Cross-sectional	Paper-based	7,177	Flu	Mixed	Not	N.A.
Ozawa S, 2017	2013	Nigeria	Cross-sectional	Paper-based	198	Dtp/ measles/ polio	Closed	Statistical methods not reported	N.A.
Paek HJ, 2015	2014	South Korea	Cross-sectional	Paper-based	1,017	Child vaccines	Mixed	Not	N.A.
Painter JE, 2011	2009	USA	Cross-sectional	Paper-based	102	Flu	Mixed	Not	N.A.
Parrella A, 2013	2011	Australia	Cross-sectional	Telephone	469	Child vaccines	Likert scale	Not	N.A.
Parrella A, 2012	2010	New Zeland	Cross-sectional	Telephone	179	Dtp/ polio/ hbv/hib/ rotavirus/ mmrv/ mcv/pcv/ flu	Closed	Statistical methods not reported	N.A.
Paulussen TG, 2006	1999	Netherland	Cross-sectional	On-line	491	Dtp/ polio/ hib/mmr	Closed	Not	N.A.

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Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Peleg N, 2015	2011	Israel	Cross-sectional	Paper-based	273	Flu	Closed	Statistical methods not reported	N.A.
Pelucchi C, 2010	2008	Italy	Cross-sectional	Paper-based	3,026	Hpv	N.A.	Not	N.A.
Perez S, 2016	N.A.	Canada	Cross-sectional	On-line	2,272	Hpv	Closed	Statistical methods not reported	N.A.
Perez S, 2017	2014	Canada	Cross-sectional	On-line	2,272	Hpv	Closed	With statistical methods	N.A.
Perez S, 2016	2014	Canada	Cross-sectional	On-line	2,272	Hpv	Closed	Statistical methods not reported	N.A.
Perez S, 2016	2014	Canada	Cross-sectional	On-line	2,272	Hpv	Closed	Statistical methods not reported	N.A.
Podolsky R, 2009	N.A.	Usa	Cross-sectional	Paper-based	308	Hpv	Mixed	Statistical methods not reported	N.A.
Pot M, 2017	2015-2016	Netherlands	Cross-sectional	On-line	8,062	Hpv	Closed	Not	N.A.
Reiter PL, 2013	2008-2010	Usa	Cross-sectional	Mail	1,951	Hpv	Mixed	Statistical methods not reported	N.A.
Restivo V, 2015	2012-2013	Italy	Cross-sectional	Telephone	443	Mmr	Closed	Not	N.A.
Roberts JR, 2015	2011-2012	USA	Cross-sectional	Paper-based	363	Dtp/ mcv/ hpv	Closed	Statistical methods not reported	N.A.
Robitz R, 2011	2007-2008	USA	Cross-sectional	Telephone	484	Hpv	Closed	Statistical methods not reported	N.A.
Rogers C, 2014	N.A.	USA	Cross-sectional	On-line	51	Child vaccines	Closed	Not	N.A.
Ruffin MT, 2012	2006-2008	USA	Case-control	Telephone	1,131	Hpv	Closed	Not	N.A.
Salmon DA, 2005	2002-2003	USA	Case-control	Mail	1,367	Polio/ mmrv/ dtp/hib/ hbv	Closed	Not	N.A.
Salmon DA, 2009	N.A.	USA	Case-control	Mail	963	Child vaccines	Closed	Not	N.A.
Sam IC, 2009	2007	Malaysia	Cross-sectional	Paper-based	362	Hpv	Mixed	Not	N.A.
Sampson R, 2011	2008	UK	Cross-sectional	I part mail, ii part interview	7	Flu	Closed	Not	N.A.
Rickert VI, 2015	2012-2013	USA	Cross-sectional	On-line	501	Child vaccines/ flu/pcv/ mmr/ varicella/ dtp/hav/ hbv/hpv/ mcv	Closed	Not	N.A.
Rose SB, 2012	2008-2009	New Zeland	Cross-sectional	Paper-based	769	Hpv	Closed	Not	N.A.
Santibanez TA, 2016	2011-2012	USA	Cross-sectional	Telephone	19,178	Flu	Closed	Not	Hesitancy/ scepticism/ doubt

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Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Saqer A, 2017	2017	Emirati Arabi	Cross-sectional	Paper-based	400	Hpv	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Schollin Ask L, 2017	2014	Sweden	Cross-sectional	On-line	1,063	Rotavirus	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Schwarz NG, 2009	2009	Gabon	Cross-sectional	Paper-based	40	Child vaccines	Closed	Statistical methods not reported	Acceptance
Selmouni F, 2015	2015	Marocco	Cross-sectional	Paper-based	1,312	Hpv	Open field	Not	Acceptance
Sengupta B, 1998	1998	India	Cross-sectional	Paper-based	656	Polio	Mixed	Not	Hesitancy/ scepticism/ doubt
Seven M, 2015	2015	Turkey	Cross-sectional	Paper-based	368	Hpv	Closed	Not	N.A.
Shao SJ, 2015	2014	Caraibi	Cross-sectional	Paper-based	35	Hpv	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Shapiro GK, 2016	2014	Canada	Cross-sectional	On-line	1,427	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Shapiro GK, 2017	2016-2017	Canada	Cross-sectional	On-line	4,606	Hpv	Open field	Statistical methods not reported	Acceptance
Shawn DH, 1987	1986	Canada	Cross-sectional	Paper-based	133	Hib	Closed	Statistical methods not reported	Hesitancy/ scepticism/ doubt
Sheikh A, 2013	2012-2013	Pakistan	Cross-sectional	Paper-based	1,044	Polio/ tetanus/ measles	Closed	Not	Hesitancy/ scepticism/ doubt
Shuaib FM, 2010	2008	Jamaica	Case-control	Paper-based	285	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Skinner J, 1995	1992	Australia	Cohort	Mail	1,004	Child vaccines	Mixed	Statistical methods not reported	Acceptance
Smailbegovic MS, 2003	1999	UK	Case-control	On-line	129	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Smith MJ, 2009	2009	USA	Cross-sectional	On-line	121	Child vaccines	Mixed	Not	Hesitancy/ scepticism/ doubt
Smith PJ, 2011	2009	USA	Cross-sectional	Telephone	11,206	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Smith PJ, 2010	2003	USA	Cross-sectional	Telephone	2,921	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Smith PJ, 2006	2001-2002	USA	Cross-sectional	Telephone	7,695	Child vaccines	Closed	Not	Hesitancy/ scepticism/ doubt
Smith PJ, 2015	2010-2013	USA	Cross-sectional	Telephone	19,144	Measles	Closed	Not	Hesitancy/ scepticism/ doubt
Smith PJ, 2016	2010-2014	USA	Cross-sectional	Telephone	8,490	Hpv	Closed	Not	Hesitancy/ scepticism/ doubt
Sohail MM, 2015	N.A.	Pakistan	Cross-sectional	Paper-based	200	Child vaccines	Mixed	Not	Acceptance

continues

follows

Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Songthap A, 2012	2012	Thailandia	Cross-sectional	Paper-based	664	Hpv	Closed	Not	Hesitancy/ scepticism/ doubt
Soyer OU, 2011	2003	USA	Cross-sectional	Telephone	500	Flu	Mixed	Not	Acceptance
Staras SA, 2014	2009	Usa	Cross-sectional	Telephone	2,422	Hpv	Closed	Not	Acceptance
SteelFisher GK, 2015	2013-2014	Multinational	Cross-sectional	Paper-based	6,025	Polio	Closed	Not	Acceptance
Stefanoff P, 2010	2008-2009	Multinational	Cross-sectional	Telephone, paper-based, mail	6,611	Child vaccines	Mixed	Not	Acceptance
Stein Zamir C, 2017	2015	Israel	Cross-sectional	Paper-based	45	Child vaccines	Closed	Not	Acceptance
Stephenson JD, 1987	1986	Canada	Cross-sectional	Paper-based	133	Hib	Closed	Not	Hesitancy/ scepticism/ doubt
Stockwell MS, 2014	2007-2008	USA	Cross-sectional	Paper-based	705	Child vaccines	Mixed	Not	Acceptance
Strelitz B, 2015	2013-2014	USA	Cross-sectional	Paper-based	152	Flu	Likert scale	Not	Hesitancy/ scepticism/ doubt
Stretch R, 2008	2007-2008	UK	Cross-sectional	Paper-based	651	Hpv	Likert scale	Statistical methods not reported	Acceptance
Suarez-Castaneda E, 2014	2011	El Salvador	Cross-sectional	Paper-based	2,550	Child vaccines	Mixed	Not	Acceptance
Sundaram SS, 2010	N.A.	UK	Cross-sectional	Paper-based	50	Hpv	Likert scale	Not	Acceptance
Tadesse H, 2009	2008	Ethiopia	Case-control	Paper-based	266	Child vaccines	Mixed	Statistical methods not reported	Acceptance
Tagbo BN, 2014	2014	Nigeria	Cross-sectional	Paper-based	426	Polio	Likert scale	With statistical methods	Hesitancy/ scepticism/ doubt
Taiwo L, 2017	2015	Nigeria	Cross-sectional	Paper-based	379	Child vaccines	Mixed	Not	Hesitancy/ scepticism/ doubt
Takahashi K, 2014	1999-2003	Japan	Cross-sectional	Paper-based	120	Measles	Mixed	Not	Refusal
Tam WW, 2015	2003	HongKong	Cross-sectional	Paper-based	5,617	Varicella	Likert scale	Not	Acceptance
Tan TNQ, 2017	2011-2013	USA	Cross-sectional	Paper-based	516	Hpv	Mixed	Not	Acceptance
Tang CW, 2011	2006-2008	Taiwan	Cross-sectional	Paper-based	539	Child vaccines	Mixed	Statistical methods not reported	Acceptance
Taylor JA, 1996	1993	USA	Case-control	Paper-based	194	Child vaccines	Likert scale	Statistical methods not reported	Acceptance
Taylor JA, 2002	1998-2000	USA	Cross-sectional	Paper-based	13,520	Child vaccines	Mixed	Not	Acceptance
Thomas T, 2015	N.A.	Georgia	Cross-sectional	Paper-based	37	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Thomas TL, 2012	2010-2011	USA	Cross-sectional	Paper-based	400	Hpv	Mixed	Not	Hesitancy/ scepticism/ doubt
Thomas TL, 2013	2009	USA	Cross-sectional	Paper-based	200	Hpv	Likert scale	Statistical methods not reported	N.A.

continues

follows

Tab. I. Main characteristics of the included studies.

Author, year	Study period	Country	Study design	Administration channel	Sample size	Type of vaccine	Type of questions	Validation	Immunization behaviour
Thomas TL, 2017	2010-2011	USA	Cross-sectional	Paper-based	341	Hpv	Likert scale	Not	Acceptance
Thompson EL, 2017	2012-2015	USA	Cross-sectional	Telephone	59,897	Hpv	Closed	With statistical methods	Hesitancy/ scepticism/ doubt
Tisi G, 2013	2011	Italy	Cross-sectional	Paper-based	161	Hpv	Mixed	Not	Acceptance
Taylor, JA, 2000	1997-1998	USA	Cross-sectional	Paper-based	598	Varicella	Likert scale	Not	Hesitancy/ scepticism/ doubt
Schwartz B, 2000	2000-2001	USA	Cross-sectional	Telephone	12,060	Hbv/dtp/ measles/ varicella	Mixed	Not	N.A.
Streng A, 2010	2006-2008	Germany	Cross-sectional	Paper-based	1,088	Varicella	Mixed	Statistical methods not reported	Acceptance
Opel DJ, 2011	2010	USA	Cross-sectional	Mail	228	Dtp/ polio/ mmr	Likert scale	Not	Hesitancy/ scepticism/ doubt
World Health Organization, 1997	1994	Italy	Cross-sectional	Face to face	1,800	Dtp/ polio	Closed	With statistical methods	Hesitancy/ scepticism/ doubt

N.A.: not available.

Salvator, Puerto Rico and USA). 14.4% of the studies (n = 48/334)) investigated the Asian population (Hong Kong, China, India, Indonesia, Israel, Japan, South Korea, Kyrgyzstan, Malaysia, Pakistan, Saudi Arabia, United Arab Emirates, Singapore, Taiwan, Thailand and Turkey), 12.8% (n = 26/334) the studies were about European people (Italy, Sweden, United Kingdom, Spain, Greece, France, Germany and the Netherlands), and 11.7% (n = 24/334) of the studies the population was from African and Oceanic countries (Cameroon, Ghana, Kenya, Gabon, Nigeria, Uganda, Morocco, Australia and New Zealand). Only 1.9% of the studies (n = 5/334) were carried out in multiple countries and were therefore classified as multinational surveys.

Almost all of the examined studies, 92.8% (n = 310/334), are cross-sectional; 4.8% (n = 16/334) are case-control studies and finally 2.4% (n = 8/334) are cohort studies.

Even though all the studies included in our review aimed at investigating the phenomenon of vaccine hesitancy, each of them focused on specific aspects of this behaviour. In this respect, the main purpose in 30.8% (n = 103/334) of the studies was to investigate parental knowledge, attitudes, practices, beliefs, awareness, concerns and sources of information about childhood vaccinations. In 21.6% (n = 72/334) of the studies the main objective was focused on investigating parents' attitudes towards childhood vaccinations and exploring possible influential or determining factors. 18.6% (n = 62/334) and 15.0% (n = 50/334) of the studies were aimed respectively at identifying the factors associated with the parental decision to vaccinate and at examining the potential reasons for refusing immunization of their children. In 4.5% (n = 15/334) of the cases, a broad assessment of the vaccine hesitancy phenomenon was specifically investigated.

According to the 3C model, vaccine convenience is determined by physical availability, affordability and willingness-to-pay, geographical accessibility, ability to understand (consisting of both language and health literacy) and appeal of immunization services [9]. Therefore, potential barriers to immunization were also considered in our research and were investigated in 3.6% (n = 12/334) of the studies. Particular attention to the aspect of non-compliance with the vaccination schedule, such as following the correct timing and the complete administration of all the required vaccine doses, was only investigated in 3.3% (n = 11/334) of the analysed studies. Finally, 9 studies (n = 2.7%) explored the various determinants that can condition parental decisions or attitudes towards the immunization of children with pre-existing pathologies or health problems.

Population characteristics

The population interviewed mainly consisted of parents – without any further details (73.1%, n = 244/334) – in approximately 20% of the studies (n = 66/334) the mother was the only parent surveyed, and only 1 study recruited selectively fathers. The sample size ranged from 7 to 59,897, the mean population included was about 1,647 people.

In primary studies, parents were recruited regardless of their attitudes and beliefs in 68.9% of the studies (n = 230/334), while in the remaining 103 articles, the primary

studies selected the population based on their attitude: about 13.5% of the studies (45/334) were conducted in people with a positive attitude of acceptance, 38 studies (11.4%) were conducted among a hesitant population and 20 (6%) selected a population with an attitude of refusal towards vaccines. The definition of "acceptant/hesitant/refusing" behaviour was described in every article considered, and even though the specific characteristics might be slightly different among different studies, we relied on the classification provided by each article to analyse our results. Recruiting parents on the basis of their attitude towards vaccinations was very important in order to analyse the determinants of Vaccine Hesitancy in each different subgroup.

Questionnaires characteristics

The Authors reported both the number and the type of items only in 38.0% (n = 127/334) of the included studies. Regarding the type, more than half (37.7%, n = 126/334) consisted of closed questions. Likert scales were the second most common type used in the questionnaires (23.6%, n = 79/334), while open-ended questions were used in 14.9% of the studies (n = 50/334).

Frequently the studies were conducted using a self-reported questionnaire (69.2%, n = 231/334), or interview (28.1%, n = 94/334), while in 2.7% (n = 9/334) of the studies data were collected in a multi-phase study. Considering the questionnaires, they were mainly administered either on paper (41.6%, n = 139/334) or as an online version (13.5%, n = 45/334). Other administration channels were mail, face to face interviews (9.9%, n = 33/334) or telephone interviews (13.5% 45/334).

However, in 80.2% of the studies, the questionnaire was not attached to the paper and for this reason it was not possible to obtain any further information. Lastly, in 42.8% of the studies (n = 143/334) the questionnaire had been previously validated; however, statistical methods were reported only in 14.8% of the sample (n = 51/334); while in 57.2% (n = 191/334) of the papers the questionnaire had not been validated.

Vaccines and immunization behaviours

22.4% (n = 75/334) of the included articles regarded childhood vaccinations in general, without addressing a specific vaccine. The HPV vaccine was the most frequently investigated (39.2%, n = 133/334), followed by influenza (13.5%, n = 47/334), measles (10.8%, n = 36/334) and varicella or varicella containing vaccine (MMRV) (4.5%, n = 15/334). 67.4% (n = 225/334) of the papers assessed the attitude towards one specific vaccine (monovalent or combined): 5,7% (n = 19/334) of the articles assessed attitudes towards polio vaccine, while 6,3% (n = 22/334) assessed HBV vaccine; a lower percentage reported the behaviour towards meningococcal vaccinations (1.7% - n = 6/334 MenB and 3.6% - n = 12/334 quadrivalent vaccine), Hib vaccine, HAV vaccine, rotavirus and BCG vaccination. 7.5% (n = 25/334) of the studies focused on more than one vaccine, such as diphtheria, tetanus and pertussis vaccination.

Data about the immunization behaviours were reported in 88% of the studies (n = 294/334). In particular, the subjects involved in the studies showed a behaviour defined as "acceptance" in 38.6% studies (38.6%, n = 129/334), as "hesitancy/scepticism/doubt" in 43.4% (n = 145/334) of the studies (and as "refusal" in 6.6% (n = 22/334) of the studies. In 10.5% (n = 35/334) of the studies assessed this information was not detected.

Parents' beliefs about vaccine safety/efficacy

Parents' beliefs about vaccine safety/efficacy were evaluated in most (58.7%; n = 196/334) of the papers included in the review. In particular, 52.4% (n = 175/334) gave a quantitative evaluation, among which 53.7% (n = 94/175) showed that the majority of the sample believed vaccines to be safe and effective, 4.6% of the studies (n = 8/175) showed that the minority of the subjects interviewed believed in vaccine safety/efficacy, while 41.7% (73/175) outlined how the beliefs about vaccines' safety/efficacy are one of the most important barriers in vaccination. Other studies (10.7%, n = 21/196) gave a qualitative and descriptive approach to the issue of "vaccine safety/efficacy". No information was given in 41.3% of the studies (n = 138/334).

Discussion

This manuscript shows the results of an extensive systematic review conducted using three scientific databases (PubMed/Medline, Web of Science and The Cochrane Library). Out of 3,508 retrieved studies, 334 papers were included in the qualitative evaluation. The inclusion of a great number of relevant studies, of which two thirds have been conducted in the last 10 years, reflects the relevance of this issue nowadays: investigating and therefore understanding the phenomenon of vaccine hesitancy is a necessary step in the process of overcoming it. As a matter of fact, it is extremely important to counteract this attitude, as it might lead to a decrease in vaccination coverage and therefore increase the risk of future epidemics of VPDs. The original papers included in the analysis were mainly studies conducted in western countries, while 1/4 were performed in Asia and 1/7 in Africa and Oceania.

Even if all the studies included in the review aimed at exploring VH among parents or guardians, they differ in their study design, overall number of items, context and response formats. Most of the times, three different types of questions were used in the articles examined: closed questions, likert scales questions and open-ended questions (however, a combination of these types of questions was often used as well). Most of studies had a cross-sectional design and were conducted in the last ten years, aimed to investigate parental knowledge, attitudes, practices and beliefs about childhood vaccinations, while only a small percentage (4.5%) investigated the specific

reasons for vaccine hesitancy. Closed questions were the most frequent, mainly through the administration of a self-reported questionnaire, but in most cases it was impossible to get more information about the tool used, because only in 20% of studies the questionnaire was attached to the article.

Closed questions, allowing a quantitative analysis, are a very useful tool although they don't permit to explain with more details the reasons behind VH for vaccine preventable diseases. In fact, it can be defined as "the means for testing objective theories by examining the relationship among variables which in turn can be measured so that numbered data can be analyzed using statistical procedures". On the other hand, a qualitative approach is more likely to use open questions as research tool. Open ended questions don't enable comparisons between different studies but they do provide more detailed information of the issues examined. In fact, a qualitative approach is useful when statistical procedures and numeric data may be insufficient to capture how patients and health care professionals feel about patients' care , enabling researchers to understand the world as another experiences it [351]. Qualitative tools are connected to the way human behavior can be explained, within the framework of the social structures in which that behavior takes place. However, closed questions represent the easiest way to explore a topic and simplify the analysis for the Authors. It should be considered that the way of administration varied among the studies and might have had an impact on the quality of the data generated [352]. Moreover, since questionnaires are a sort of "diagnostic" epidemiological tool, they should be previously validated in order to effectively measure their outcomes [353]. However, only a small percentage of questionnaire had been previously validated in the studies analysed. This aspect should be taken into account, since effectively monitoring VH and identifying beliefs about vaccines is extremely important in order to fully understand the nature of such hesitancy, to compare the phenomenon among countries and over the time, and lastly, to implement the appropriate types of intervention. In addition, only 14.8% of the included studies reported the statistical methods used to validate the questionnaire in detail.

This review shows that the most frequently analysed vaccines are HPV and flu, followed by measles and varicella containing vaccines. They were mainly investigated for the perception about risks and safety, as well for the low vaccine coverages (compared to the WHO target), which is partly due to the reduction in the perceived risk of these diseases [354]. In this perspective, the reinforcement of mandatory vaccination laws in some European countries (e.g. Italy and France) led to an increase in vaccination coverage, mainly because this intervention tackled the complacency component of VH [355, 356]. In Italy, the reinforcement of the mandatory vaccination law dramatically reduced the number of parents who missed the measles vaccination due to definitive informed dissent or unwillingness to attend the appointment [357].

Fathers were specifically investigated only in 1 study included [175] in this review: further studies should investigate this population, in order to determinate possible gender differences in VH definition. It can be speculated that fathers are little involved, by healthcare professionals, in the vaccination decisions of their children. On the contrary, the involvement of both parents could be important in order to recover the confidence of families, which has diminished over time. In this perspective, healthcare professionals should be adequately trained and properly equipped with communication skills to clearly, transparently and comprehensively deal with this problem [358, 359]. Healthcare professionals are the main source of information on the issue of vaccinations, but they are not the only one: parents frequently rely on the information they obtain on the internet, especially regarding vaccinations and the related diseases [360-362].

Before generalizing the results of this review, some limitation should be acknowledged. First, a small percentage of included studies was validated, and the questions identified didn't address all the determinants in the Vaccine Hesitancy Matrix.

Secondly, the findings from studies investigating specific vaccines should not be generalized to all vaccines. Moreover, VH evolves rapidly in time and some determinants could change quickly, not only according to the perception of danger of the diseases reported by media in different countries but also due to other socio-cultural influences. Monitoring the trend is important in order to measure parental VH in time and to better understand parents' concerns and behaviors. Generally speaking, the availability of a good and accurate tool, tested and validated in all settings, and subsequently refined, is necessary to compare the results, to assess the dynamic nature of VH and to develop tailored communication strategies [363-366]. Furthermore, most of the information, especially related to the vaccination status were self-reported and no vaccination cards or Immunization Information System (IIS) were used to verify the information. Healthcare professionals and scientists should be encouraged to use the new technologies, as for instance the IIS, to monitoring both the vaccination coverage and the VH trends [367, 368]. Moreover, according to a recent review, the IIS might greatly improve and counter VH [369].

Nevertheless, a point of strength of this review is the variety of vaccine preventable diseases included. Moreover, to the best of our knowledge, this is the first systematic review that extensively assessed the developed questionnaires aimed to evaluate the parents' VH.

Conclusions

To conclude, VH is a public health challenge as confirmed by the high number of studies and questionnaires retrieved. No questionnaire can be considered the absolute best a priori, but this study offers a deeper perspective on the available questionnaires, therefore

helping future researches to identify the most suitable one according to their own aim and study setting.
Further studies monitoring VH should take into account the questionnaires already available in literature, therefore allowing to improve intra- and inter-country comparability among countries and over time, reducing the time waste in developing a new questionnaire, and improving the financial sustainability of research. Moreover, using a validate questionnaire will improve the methodological quality of future studies.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

VG and PC conceived the study, PC, GV, IB, GD, MN, OG, FD, PS, SDN, SP, AC, LG, FDA, FDG, EA, OES, LK, CA, VG performed a search of the literature, drafted and revised the manuscript. GD revised the language. VG and IB revised critically the manuscript. All authors read and approved the last version of the manuscript.

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