

INTEGRATIVE ARTICLE

Open Access



Vaccine hesitancy: understanding better to address better

Dewesh Kumar^{1*}, Rahul Chandra², Medha Mathur³, Saurabh Samdariya⁴ and Neelesh Kapoor⁵

Abstract

Vaccine hesitancy is an emerging term in the socio-medical literature which describes an approach to vaccine decision making. It recognizes that there is a continuum between full acceptance and outright refusal of some or all vaccines and challenges the previous understanding of individuals or groups, as being either anti-vaccine or pro-vaccine. The behaviours responsible for vaccine hesitancy can be related to confidence, convenience and complacency. The causes of vaccine hesitancy can be described by the epidemiological triad i.e. the complex interaction of environmental- (i.e. external), agent- (i.e. vaccine) and host (or parent)- specific factors. Vaccine hesitancy is a complex and dynamic issue; future vaccination programs need to reflect and address these context-specific factors in both their design and evaluation. Many experts are of the view that it is best to counter vaccine hesitancy at the population level. They believe that it can be done by introducing more transparency into policy decision-making before immunization programs, providing up-to-date information to the public and health providers about the rigorous procedures undertaken before introduction of new vaccines, and through diversified post-marketing surveillance of vaccine-related events.

Keywords: Vaccine hesitancy, Vaccine confidence, Vaccine decision making, Vaccination

Introduction

Amongst all public health interventions, vaccines top the list (in efficacy) and saving millions of lives each year [1]. The success stories of eradication of small pox from the world, and the elimination of poliomyelitis from four of the World Health Organization regions, reflect highly on vaccination programs. They have immensely contributed to the decline in mortality and morbidity of many infectious diseases [2]. Success in vaccination programs is dependent on a high vaccination coverage rate. This directly protects the vaccinated individuals, and indirectly the whole community, by providing herd immunity and thereby reducing the transmission of vaccine preventable diseases (VPDs) [3].

The high rate of childhood vaccination coverage in most developed countries indicates that vaccination remains a widely accepted public health measure [4]. But the national estimates can be misleading and may not show the real picture of under-vaccinated or unvaccinated communities.

Various outbreaks of VPDs including measles, poliomyelitis, diphtheria and pertussis in several parts of the developed world have mainly been linked to under-vaccinated or non-vaccinated communities [5–8]. The reasons for under-vaccination in the developing and developed world are varied and have been studied in the past. It has also been noted that many vaccinated individuals have doubts and concerns regarding vaccination [9, 10].

Concept of vaccine hesitancy

The waning of public confidence in vaccines worldwide is a cause for concern and a major challenge for public health experts [11, 12]. The phenomenon was originally described as “vaccine resistance” or “vaccine opposition” by researchers but, lately, these expressions have been abandoned and a new term, “vaccine hesitancy” (VH) has emerged, replacing the older expressions, to describe the reluctance to be vaccinated. *Vaccine hesitancy according to Strategic Advisory Group of Experts (SAGE) Vaccine Hesitancy working group of World Health Organization (WHO) refers to delay in acceptance or refusal of vaccines despite availability of vaccine services. Vaccine*

* Correspondence: dr.dewesh@gmail.com

¹Department of Community Medicine and Family Medicine, All India Institute of Medical Sciences, Bhasni-II, Jodhpur, Rajasthan 342005, India
Full list of author information is available at the end of the article

hesitancy is complex and context specific, varying across geographies and vaccine types. It is influenced by factors such as complacency, convenience and confidence. Vaccine complacency is known to be present where the risk of vaccine preventable diseases is perceived to be low and where vaccination is not considered essential. It has been observed that vaccine hesitancy is heavily impacted by lack of confidence in the vaccine's safety and efficacy as well as fears regarding the reliability and competence of health system. Additionally, the quality of vaccination services and their convenience (e.g. physical availability, geographical accessibility and affordability) as well as the patient's willingness to pay, are all factors that impact the decision of whether or not to be vaccinated [13]. The term is useful for situations where vaccination services are available but vaccine acceptance is lower than the expected. Before this term was adopted and defined by the working group of SAGE-WHO, researchers used many different terminologies for this behavioral phenomenon (Table 1) [14–16].

Attitudes towards vaccines cannot be polarized into anti-vaccine or pro-vaccine as previously thought but, rather, a continuum between full acceptance, and outright

refusal, of some or all vaccines (Fig. 1) [13]. This is a complex phenomenon and vaccine specific issues must be understood contextually and conceptually [17]. It has also been determined by SAGE that although vaccine hesitancy may be present in circumstances where low vaccine uptake prevails due to flaws in vaccine availability such as stock-outs, infeasible travel/ distances to reach immunization clinics, missing vaccine program communication, or curtailment of vaccine services due to conflict, a natural disaster or other disruption, it is not always the principle driver of unvaccinated or under vaccinated members of the population. So, in low uptake situations where system failure is the major factor, hesitancy may be present but the priority is to address the factors limiting the accessibility and availability of vaccines. This means that vaccine coverage estimates cannot be regarded as a reliable indicator of vaccine hesitancy.

Research has shown that vaccination decision-making should be studied and understood in a broader socio-cultural context as vaccination is part of a “wider social world” and its decision making is highly influenced by various social factors [past experiences with health services, family histories, feelings of control, conversations with friends, etc.] [18]. Streefland and collaborators stated that “local vaccination cultures” develop from “shared beliefs about disease etiology, potency, efficacy and safety of modern medicine as well as vaccines and views related to preventive measures” alongwith “local health services experiences and vaccination settings” influence the individual decision about vaccination. It is also observed that concerns regarding child health and nutrition other than vaccination may take priority at times or has a role to play in the willingness to vaccinate [19].

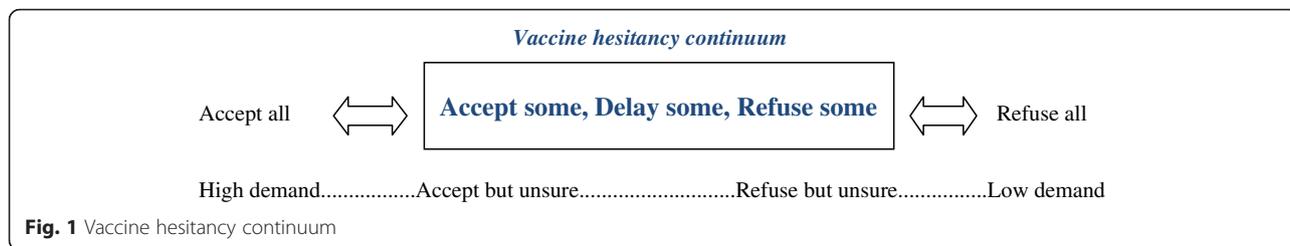
The relevance of immunization in today's context sometimes becomes questionable considering the legitimacy of science, expertise and medical authority [20]. The stress on health promotion about lifestyle and the growth of “consumerism” in health-care leading to individuals' involvement in their own health decisions may have also contributed to some extent to vaccine hesitancy [21]. Traditionally the doctors were the sole directors of patient care but with the rise of informed patients, the decision-making concerning their health process is now shared with patients who want to be active participants and with health professionals.

Determinants of vaccine hesitancy

The factors influencing vaccine hesitancy can be explained on the basis of the epidemiological triad i.e. the complex interaction of environmental (external) factors, agent factors (vaccine) and the host (parents) specific factors (Fig. 2). The determinants of vaccine hesitancy are numerous and context specific and are

Table 1 Various terminologies for vaccine related behavioural phenomenon

S.no	Researchers	Terms
1.	Gust et al. (Parental attitudes regarding vaccination)	Immunization advocates The go alongs to get alongs Health advocates Fence sitters Worried
2.	Keane et al. (Parent profiles)	Vaccine believer: parents who are convinced of the benefits of vaccination Cautious: parents emotionally involved with their child and who have an hard time watching them being vaccinated Relaxed: parents who were characterized by some scepticism about vaccines Unconvinced: parents who distrusted vaccinations and vaccination policy
3.	Benin et al. (Mother's attitudes and actions)	Accepters: who agreed with or did not question vaccination Vaccine-hesitant: who accepted vaccination but had significant concerns about vaccinating their infants Late vaccinators: who purposely delayed vaccinating or chose only some vaccines Rejecters: who completely rejected vaccination



presented separately but it is important to understand and acknowledge their interrelatedness [22].

Environmental/external factors

Patient-health professional relationship: Positive interaction is the keystone in maintaining confidence regarding vaccination [23]. The personal attitude of health care providers, along with their knowledge, determines how effectively they will recommend a vaccine to their patients. It is also known from previous reviews on nurses’ practice about the influenza vaccine that there is relationship between knowledge, attitudes and vaccination practices. A review of 12 research articles concluded that a higher degree of motivation for vaccination of influenza is proportionate to the coverage of vaccination amongst nurses and the promotion of vaccination in patients. A study in Switzerland also showed that nearly 5 % of non paediatric physicians delayed or denied MMR or DPT vaccination for their own children and the reason was the concern of “immune overload” [24–26]. Another school of thought believes that vaccine hesitancy may lead to the development of certain emotional responses amongst health care providers who face it [27].

The American Academy of Pediatrics’ Committee on Bioethics showed their solidarity towards families who showed their reluctance towards immunization as they were deprived of other health care facilities as well. It has been observed that some health care professionals face problems in discussing vaccine schedules and other recent advances in the field of vaccination [28]. Decision making regarding vaccination is based on trust of health professionals, government or public health institutions and their inter-relation. These relationships are of utmost importance in acceptance of the vaccines, as the public relies on their integrity, competence and faith in the government and public health authorities giving recommendations of appropriate vaccines which are effective, uncontaminated and can be administered safely [12, 29]. Benin and collaborators have proved in their research that due to lack of trust new mothers hesitated in vaccinating their children [16]. It has been noted that health professionals are the key sources of information on vaccination to those who are refusing vaccination and to vaccine hesitant patients [30]. The patient provider relationship is significant and the development of communication skills is the soul of nourishing this art. But it has also been seen that physician targeted

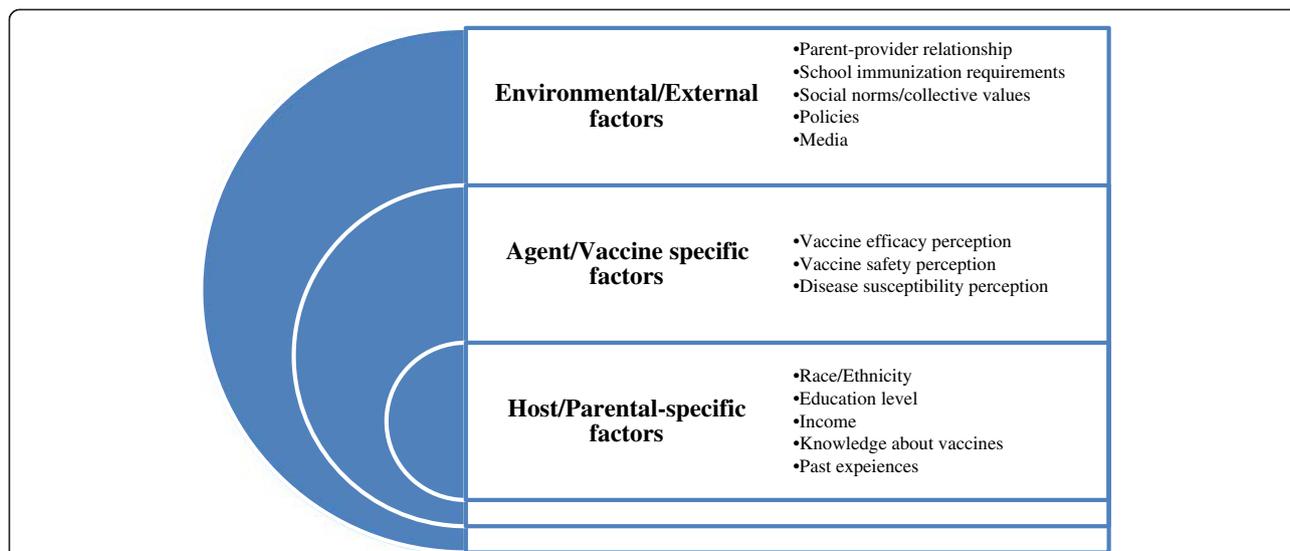


Fig. 2 The model for understanding factors influencing parental vaccine hesitancy based on epidemiological triad: (Adopted from Gowda and Dempsey)

communication intervention does not reduce maternal vaccine hesitancy or improve physician self-confidence so more research needs to be undertaken to explore the effective communication strategies to combat vaccine hesitancy [31].

School immunization requirements: The parents who exempt their children from school immunization programs had increased concerns over the vaccine safety and perceived less benefit from vaccines. Also there is lack of thrust from the school and education department in informing parents that if their child is not vaccinated then the chance of contracting the disease is higher in their children and can further transmit the disease in their peer groups. When parents are not provided proper information, they fail to consider the vaccine's importance and turn into vaccine hesitant.

Social Norms /collective values: If vaccination is viewed as a social responsibility then it can prove to be a driver in improving vaccine acceptance. If people in a community make it a norm to get their kids vaccinated and it becomes a point of social appreciation, then vaccination may improve [32]. Some qualitative studies show that vaccination is considered a routine practice in societies where everyone is getting their child vaccinated [18].

Vaccine Policies and Public Health: Some countries have laws which mandate the vaccination of children for admission in schools as a part of their policies for improving vaccine coverage but such policies have always attracted a platform for debate [33]. In a population based survey of United States of America nearly 10 % of parents were found to be against compulsory vaccination as they had negative beliefs about vaccines, safety and their protective capability [34]. Communication is an important asset of public health in providing proper information to the population. In developed nations, good quality vaccine surveillance is well established but its understanding and reliability is limited amongst general population and health care providers. There have been significant problems faced by public health professionals, policy makers and patients due to false data and information regarding vaccine safety and efficacy which has paved the path in licensing of vaccines and their inclusion in universal programs. [35]

Vaccine preventable diseases declined due to the increase in vaccines which succeeded in drawing the attention of parents and health professionals on vaccine usefulness and safety [36]. VPDs are reducing due to vaccination programs hence health professionals have no first-hand knowledge of the risks of the disease. So now attention has shifted from the risk of diseases to the risk of vaccination which is why it is appropriate to state that "vaccination is victim of its own success." [37] Some new vaccine preventable diseases are considered to be mild like chickenpox and gastroenteritis which compromises vaccine

acceptability by the family [38]. It is assumed that unacceptability of vaccines to individuals is due to the manipulations by anti-vaccination groups and also irrational, emotional and ill informed attitudes and hence interventions applied to increase the vaccine uptake in the form of probabilistic information usually fails [39].

Media and Communication: Media plays a significant role in vaccine uptake and influences the community both positively and negatively. Studies have proved that negative reports from media de-motivated the community regarding vaccine uptake [40]. The burning example of pertussis immunization shows that media controversies regarding immunization lead to decreased vaccine uptake and as a result a 10 to 100 times increase in the number of cases in unimmunized countries compared to immunized countries [41]. Nowadays the very effective platform of internet is being utilized to dispense negative publicity by anti-vaccination activists [42]. As a matter of fact anti vaccination content on the World Wide Web is amply available and is disseminating rumors, myths and wrong beliefs regarding vaccines which has led to a negative impact on vaccine uptake [43]. Actually in present scenario internet is the major source of information for people. There are various sources like social network where many experiences both positive and negative are shared by individuals. Such recitals add a new dimension to the health information: usually affected by pessimism, views which are related to vaccines, potentials and vaccine preventable diseases. There are studies which have proven that the information depicted through social websites is of inconsistent quality and that the majority of them have negative ingredients [44]. As an example, the quantum of correct information was just 51 % where association between MMR and Autism was searched by patients [45].

The most common propaganda on anti vaccination websites is regarding the "Hot lots" in vaccines, suspicion of poison in vaccines and many bad personal experiences after taking vaccines [46]. All these arguments indicate towards 'Denialism' by anti vaccination activists. The term Denialism has been defined as "the employment of rhetorical arguments to give the appearance of legitimate debate where there is none, an approach that has the ultimate goal of rejecting a proposition on which a scientific consensus exists." Diethelm and McKee have proved that denialists have many tactics to prove the relation between autism and vaccination like using "Conspiracy theories", creating fake experts, selecting those evidences which support the false results and building a bad report of vaccines in the community [47]. It has been seen that those individuals who deny or delay the vaccines are the ones who have done extensive internet searches on the vaccine related matter [48]. A very interesting study by Betsch and collaborators has concluded

that anti vaccination surfing for nearly 5–10 min had influenced people's decision of vaccinating their children in a negative manner [49].

Agent/vaccine specific factors

Vaccine efficacy perception: Perceptions about vaccine efficacy are an integral factor in vaccine decision making for vaccine hesitant parents. There is a significant concern over the relative efficacy of vaccine induced immunity versus immunity obtained through the natural course of events with a few parents preferring immunity acquired naturally to that acquired via vaccination. People in a few parts of the world have also started raising questions over vaccines such as the Oral Polio Vaccine, that despite giving multiple doses of vaccines on National Immunization Days (NIDs) and Sub-National Immunization days (SNIDs) with good coverage and quality maintenance, countries like India still took more than one and half decades to eliminate poliomyelitis from their country. Maintaining confidence over vaccines when used for long time in the same children is a tough fight for the program managers involved in immunization programs who have to convince the community and vaccine hesitant people about their prolonged use.

Vaccine safety perception: It is a well known fact that parents hesitating for a vaccine are more concerned about the immediate side effects or adverse events due to a vaccine, but the hesitancy spectrum extends to long lasting complications including neurologic conditions as well. Additional concerns regarding vaccine safety are the number and timing of recommended vaccines. Recently, many new vaccines have been introduced and additional new vaccines are in the pipeline which will be included in the recommended vaccination schedule and this number is likely to grow in the future. This has alarmed parents about the overloading of the immune system by receiving too many antigens in a short span of time which may be harmful instead of doing good to their children. Some parents are specifically worried about the cumulative pain and discomfort faced by the children after multiple shots given at once.

Vaccination has always been the subject of many controversies which have affected vaccine acceptance of various vaccines to varying degrees in the past as well as in the present. The incidences of the controversies are often within a particular context such as the association between the hepatitis B vaccine and multiple sclerosis in France that resulted in the suspension of the universal vaccination program in the 1990s, despite the lack of substantial evidence of such an association [50]. In India the controversy arose with the introduction of pentavalent vaccine regarding its adverse effects and efficacy and thereby the rationale in its introduction was questioned [51]. The well-known vaccination scare that occurred in

the United Kingdom was the false association between the MMR vaccination and autism, which rapidly spread worldwide and the concern of autism due to vaccines among parents is still present, although the purported association has been scientifically disproven [22].

Disease susceptibility perception: The perceptions of the importance of vaccination in maintaining health is an important factor for accepting vaccines. Vaccine acceptance has been found higher in those who perceive vaccination as an important entity to counter the detrimental consequences of vaccine preventable diseases. The overwhelming success of vaccination efforts has drastically reduced the incidence of VPDs all over the world, decreasing the exposure of these VPDs and their complications. This has resulted in perceiving such illnesses to be insignificant health threats. Personal experience with a limited form of a disease may have created a belief that disease related risks are low. This holds true for the varicella vaccine as many parents recall having had chicken pox in their childhood without any complications. Similarly some parents prefer their children acquiring natural immunity to giving a measles containing vaccine. Studies have proven that parents' beliefs regarding disease susceptibility play a significant role in deciding whether their children should get vaccinated or not. Common views regarding the reasons for vaccine hesitancy are: the inclination towards natural immunity, the age old belief that occurrence of vaccine-preventable diseases leads to the development of natural immunity and the belief that better hygiene can prevent diseases, rendering vaccines unnecessary [52]. Vaccine doubts among vaccine hesitant parents are further fuelled by the synergistic imbalance created between decreasing levels of perceived disease susceptibility and increasing concerns about vaccine safety.

Host/parental specific factors

Race, education and income: These individual characteristics may have a direct impact on the person's concept of the risks and benefits of vaccination along with the risks and sequelae of a VPD. Some studies demonstrate that African-Americans have lower immunization coverage levels compared to other race groups in America. This supports the fact that ethnicity/race is associated with differential levels and types of immunization concerns. However recent data after adjusting for poverty status have not shown significant difference in coverage levels by racial groups [53]. One of the factors implicated in vaccine hesitancy is the level of parental education and studies in the past have demonstrated greater distrust for medical professionals amongst communities with less formal education. Due to the lower education level, their information about vaccines and their effect is less as compared to more educated parents and the parents seek out alternative

sources such as family members and other parents in the community or the media for reliable information.

The propaganda of anti-vaccination messages is more than the pro-vaccination messages in these outlets contributing further to parental vaccine hesitancy. Socioeconomic factors appear to have conflicting associations with parental immunization acceptance reflecting differences in beliefs about vaccines by socioeconomic strata. In some studies parents with lower socioeconomic class have shown more concern about the safety and necessity of vaccines as compared to those with higher socio-economic status [34]. In another study, parents in a higher income group were more concerned approximately two fold with the safety of the shots. The apparent contradiction could be related to differing perceptions of what vaccine safety means among the different strata of population. For example parents in high income groups may relate vaccine safety to concerns such as autism or long term neurological conditions. The influence of social factors on vaccine hesitant behaviour may be the opposite to what is assumed i.e. it is often the non-elite or minority communities that have better acceptance and higher vaccine coverage than affluent and wealthier sections of the community [54]. Hence there are other factors which highly influence the vaccine uptake are previous experiences, accessibility and convenience of vaccination.

Parent's decision, knowledge and past experiences: There is enough evidence available which shows that parents decide for their children vaccines such as HPV, pneumococcal, seasonal flu or pandemic flu etc. Therefore the studies usually focus on parents for obtaining the information on the vaccine uptake in the community because most of these vaccines are targeted at children and adolescents. It has been observed that parents' decision making is influenced by social factors, cultural issues and the personal experiences of the individuals [55]. Acceptance of vaccination is found to be directly proportional to the quality of services available. In the case of children, fear of needle, pain and previous bitter experiences regarding vaccination leads to vaccine hesitancy [53]. Other than the above mentioned factors vaccine rejection is also associated with strong religious beliefs along with conventional trust of natural and artificial medicines. Even in developed countries like USA, vaccine refusal is sometimes connected to religious intentions [29]. Another important determinant of sub-optimal vaccine uptake is the direct and indirect cost of vaccines which influences the parent's decision directly and adds to vaccine hesitancy [56]. Vaccination acceptance depends on individuals' knowledge, information and awareness of when, where and who should be vaccinated. The immunization information needs to be disseminated properly to increase the knowledge of

parents which will enormously aid the reduction of vaccine hesitancy.

Way forward

Although it is quite difficult to quantify accurately the proportion of the population that could be categorized as vaccine-hesitant, there has been a growing consensus among experts worldwide that there is an increasing trend toward vaccine hesitancy. As depicted in this paper, individual decision-making regarding vaccination is a complex process and is dependent on emotional, cultural, social, spiritual and political factors as well as cognitive factors. Factually vaccine hesitancy was present even when the first vaccines were made available. However, vaccine hesitancy may have heightened by the current "changing scientific, cultural, medico-legal and media environments" despite increasing awareness about vaccines [19].

The renewed and growing interest in vaccine hesitancy has led to the development of different tools and strategies which can help to enhance vaccination acceptance which includes some social and commercial marketing principles and practices [57]. Many experts are of the view that its best to counter vaccine hesitancy at the population level and it can be done by including transparency in policy-making decisions regarding immunization programs, providing updated information to the public and health providers about the rigorous process undertaken before the introduction of new vaccines for the general population and diversified post-marketing surveillance of vaccine-related events. In addition, a special focus should be placed on listening to concerns and understanding the perceptions of the public to inform risk communication and to incorporate public perspectives in planning vaccine policies and programs.

To counter vaccine hesitancy, program managers initially must adequately identify the target population and understand the true nature of their particular vaccine and/or vaccination concerns. Then intervention strategies should be planned effectively considering the locally relevant factors operating in the population. But it is also important to bear in mind that low vaccine uptake may not be due to vaccine hesitancy alone. Finally, due to their critical role in sustaining the success of vaccination programs, there is an urgent need to undertake further research so as to understand why some health professionals, trained in medical sciences, still have doubts regarding the safety and effectiveness of vaccination. It is also worthwhile to note that causes of vaccine hesitancy vary from country to country and hence there is a need to identify locally relevant and context specific causal factors before intervention strategies to address them can be planned effectively. Although there is an effort going on at a global level to measure Vaccine Confidence Index and

the insights generated will definitely help in strengthening of local and global vaccine confidence in the years to come but measuring vaccine confidence is an emerging science and a lot more needs to be done in this field [12].

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DK conceived and conceptualized the intellectual content of the paper. RC performed the major literature search and drafted the manuscript. MM contributed in designing and reviewing of the manuscript. SS carried out the editing, proofreading and sequence alignment of the manuscript. NK has provided his valuable suggestions and inputs at every step in the preparation of manuscript and critically analyzed the content and its future implications. All authors read and approved the final manuscript.

Authors' information

Dr. Dewesh Kumar is currently working as a Senior Resident in the Department of Community Medicine and Family Medicine at AIIMS, Jodhpur, India. He has varied public health experiences of working in developmental sector as well as academic institutions for the last 10 years.

Dr. Rahul Chandra is a postgraduate student of Community Medicine at Rohilkhand Medical College and Hospital, Bareilly, U.P, India. He is a budding public health professional and his special area of interest is immunization.

Dr. Medha Mathur is a Senior Resident in the Department of Community Medicine and Family Medicine at AIIMS, Jodhpur, India. She is an academician and her research areas are maternal and child health.

Dr. Saurabh Samdariya is a Senior Resident in the Department of Radiation Oncology at AIIMS, Jodhpur, India. He is oncologist and his areas of interest include public health and preventive oncology.

Dr. Neelesh Kapoor is the State Technical Officer (New Delhi) in RMNCH + A Scale up project at IPE Global/USAID, India. He has rich experience of working in immunization programs and currently providing technical expertise to state in improving maternal and child health through health system strengthening.

Acknowledgement

We are grateful to AIIMS Jodhpur (India) which permitted us to access the articles available in its library without which this project would have been not possible.

Disclaimer

The views expressed in the paper are solely of authors and should not be attributed to any institutions/organizations they have been affiliated in the past or at present.

Author details

¹Department of Community Medicine and Family Medicine, All India Institute of Medical Sciences, Basni-II, Jodhpur, Rajasthan 342005, India. ²Department of Community Medicine, Rohilkhand Medical College and Hospital, Bareilly U.P, 243006, India. ³Department of Community Medicine and Family Medicine, All India Institute of Medical Sciences, Basni-II, Jodhpur, Rajasthan 342005, India. ⁴Department of Radiation Oncology, All India Institute of Medical Sciences, Basni-II, Jodhpur, Rajasthan 342005, India. ⁵RMNCH + A Scale up project, IPE Global/USAID, Sixth Floor, DSHM, B block, Vikas Bhawan-2, Civil Lines, New Delhi 110054, India.

Received: 10 July 2015 Accepted: 25 January 2016

References

- Bunker JP, Frazier HS, Mosteller F. Improving health: measuring effects of medical care. *Milbank Q*. 1994;72(2):225–58.
- Centers for Disease Control and Prevention (CDC). Ten great public health achievements—United States, 1900–1999. *MMWR Morb Mortal Wkly Rep*. 1999;48:241–3.
- Dube E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger J. Vaccine hesitancy: an overview. *Hum Vaccin Immunother*. 2013;9(8):1763–73.
- World Health Organization. Immunization summary - A statistical reference containing data through 2010. Geneva: WHO; 2012.
- Omer SB, Salmon DA, Orenstein WA, Dehart MP, Halsey N. Vaccine refusal, mandatory immunization, and the risks of vaccine-preventable diseases. *N Engl J Med*. 2009;360:1981–8. doi:10.1056/NEJMs0806477.
- Oostvogel PM, van Wijngaarden JK, van der Avoort HGAM, Mulders MN, Conyn-van Spaendonck MAE, Rümke HC, et al. Poliomyelitis outbreak in an unvaccinated community in The Netherlands, 1992–93. *Lancet*. 1994;344:665–70. doi:10.1016/S0140-6736(94)92091-5.
- Center for Disease Control and Prevention (CDC). Notes from the field: Pertussis—California, January–June 2010. *MMWR Morb Mortal Wkly Rep*. 2010;59:817.
- Falagas ME, Zarkadoulia E. Factors associated with suboptimal compliance to vaccinations in children in developed countries: a systematic review. *Curr Med Res Opin*. 2008;24:1719–41. doi:10.1185/03007990802085692.
- Kennedy A, Lavail K, Nowak G, Basket M, Landry S. Confidence about vaccines in the United States: understanding parents' perceptions. *Health Aff (Millwood)*. 2011;30:1151–9. doi:10.1377/hlthaff.2011.0396.
- Wu AC, Wisler-Sher DJ, Griswold K, Colson E, Shapiro ED, Holmboe ES, et al. Postpartum mothers' attitudes, knowledge, and trust regarding vaccination. *Matern Child Health J*. 2008;12:766–73. doi:10.1007/s10995-007-0302-4.
- Shetty P. Experts concerned about vaccination backlash. *Lancet*. 2010;375:970–1.
- Larson HJ, Schulz WS, Tucker JD, Smith DMD. Measuring Vaccine Confidence: Introducing a Global Vaccine Confidence Index. *PLOS Currents Outbreaks*. 2015. Edition 1. doi: 10.1371/currents.outbreaks.ce0f6177bc97332602a8e3fe7d7f7cc4.
- World Health Organization. Report of the SAGE working group on Vaccine Hesitancy. 2014. Available from: http://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf. Accessed on 15/04/2015
- Gust D, Brown C, Sheedy K, Hibbs B, Weaver D, Nowak G. Immunization attitudes and beliefs among parents: beyond a dichotomous perspective. *Am J Health Behav*. 2005;29:81–92. doi:10.5993/AJHB.29.1.7.
- Keane MT, Walter MV, Patel BI, Moorthy S, Stevens RB, Bradley KM, et al. Confidence in vaccination: a parent model. *Vaccine*. 2005;23:2486–93. doi:10.1016/j.vaccine.2004.10.026.
- Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. *Pediatrics*. 2006;117:1532–41. doi:10.1542/peds.2005-1728.
- Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. *Vaccine*. 2014;32:2150–59.
- Stefanoff P, Mamelund SE, Robinson M, Netterlid E, Tuells J, Bergsaker MA, et al. VACSATC working group on standardization of attitudinal studies in Europe Tracking parental attitudes on vaccination across European countries: The Vaccine Safety, Attitudes, Training and Communication Project (VACSATC). *Vaccine*. 2010;28:5731–7. doi:10.1016/j.vaccine.2010.06.009.
- Streefland P, Chowdhury AMR, Ramos-Jimenez P. Patterns of vaccination acceptance. *Soc Sci Med*. 1999;49:1705–16. doi:10.1016/S0277-9536(99)00239-7.
- Kata A. Anti-vaccine activists, Web 2.0, and the postmodern paradigm—an overview of tactics and tropes used online by the anti-vaccination movement. *Vaccine*. 2012;30:3778–89. doi: 10.1016/j.vaccine.2011.11.112.
- Kane MA. Commentary: public perception and the safety of immunization. *Vaccine*. 1998;16(Suppl):S73–5. doi:10.1016/S0264-410X(98)00302-8.
- Gowda C, Dempsey AF. The rise (and fall?) of parental vaccine hesitancy. *Hum Vaccin Immunother*. 2013;9(8):1755–62.
- Leask J, Kinnersley P, Jackson C, Cheater F, Bedford H, Rowles G. Communicating with parents about vaccination: a framework for health professionals. *BMC Pediatr*. 2012;12:154. doi:10.1186/1471-2431-12-154.
- Clark SJ, Cowan AE, Wortley PM. Influenza vaccination attitudes and practices among US registered nurses. *Am J Infect Control*. 2009;37:551–6. doi:10.1016/j.ajic.2009.02.012.
- Hollmeyer HG, Hayden F, Poland G, Buchholz U. Influenza vaccination of health care workers in hospitals—a review of studies on attitudes and predictors. *Vaccine*. 2009;27:3935–44. doi:10.1016/j.vaccine.2009.03.056.
- Posfay-Barbe KM, Heining U, Aebi C, Desgrandchamps D, Vaudaux B, Siegrist CA. How do physicians immunize their own children? Differences among pediatricians and nonpediatricians. *Pediatrics*. 2005;116:e623–33. doi:10.1542/peds.2005-0885.

27. Barrows MA, Coddington JA, Richards EA, Aaltonen PM. Parental Vaccine Hesitancy: Clinical Implications for Pediatric Providers. *J Pediatr Health Care*. 2015;29(4):385–94. doi:10.1016/j.pedhc.2015.04.019.
28. Leib S, Liberatos P, Edwards K. Pediatricians' experience with and response to parental vaccine safety concerns and vaccine refusals: a survey of Connecticut pediatricians. *Public Health Rep*. 2011;126 Suppl 2:13–23.
29. Hobson-West P. 'Trusting blindly can be the biggest risk of all': organised resistance to childhood vaccination in the UK. *Social Health Illn*. 2007;29:198–215. doi:10.1111/j.1467-9566.2007.00544.
30. Healy CM, Pickering LK. How to communicate with vaccine-hesitant parents. *Pediatrics*. 2011;127 Suppl 1:S127–33. doi:10.1542/peds.2010-1722S.
31. Henrikson NB, Opel DJ, Grothaus L, Nelson J, Scrol A, Dunn J. Physician communication training and parental vaccine hesitancy: a randomized trial. *Pediatrics*. 2015;136:70–9.
32. Sturm LA, Mays RM, Zimet GD. Parental beliefs and decision making about child and adolescent immunization: from polio to sexually transmitted infections. *J Dev Behav Pediatr*. 2005;26:441–52. doi:10.1097/00004703-200512000-00009.
33. Lantos JD, Jackson MA, Opel DJ, Marcuse EK, Myers AL, Connelly BL. Controversies in vaccine mandates. *Curr Probl Pediatr Adolesc Health Care*. 2010;40:38–58. doi:10.1016/j.cppeds.2010.01.003.
34. Kennedy AM, Brown CJ, Gust DA. Vaccine beliefs of parents who oppose compulsory vaccination. *Public Health Rep*. 2005;120:252–8.
35. Plotkin SA. Lessons learned concerning vaccine safety. *Vaccine*. 2002;20(Suppl 1):S16–9. doi:10.1016/S0264-410X(01)00303-6
36. Batson A. Sustainable introduction of affordable new vaccines: the targeting strategy. *Vaccine*. 1998;16(Suppl):S93–8. doi:10.1016/S0264-410X(98)00306-5.
37. Schwartz JL, Caplan AL. Vaccination refusal: ethics, individual rights, and the common good. *Prim Care*. 2011;38:717–28. doi:10.1016/j.pop.2011.07.009. ix.
38. Gust DA, Darling N, Kennedy A, Schwartz B. Parents with doubts about vaccines: which vaccines and reasons why. *Pediatrics*. 2008;122:718–25. doi:10.1542/peds.2007-0538.
39. Bedford H, Lansley M. More vaccines for children? Parents' views. *Vaccine*. 2007;25:7818–23. doi:10.1016/j.vaccine.2007.08.057.
40. Gangarosa EJ, Galazka AM, Wolfe CR, Phillips LM, Gangarosa RE, Miller E, et al. Impact of anti-vaccine movements on pertussis control: the untold story. *Lancet*. 1998;351:356–61. doi:10.1016/S0140-6736(97)04334-1.
41. Mason BW, Donnelly PD. Impact of a local newspaper campaign on the uptake of the measles mumps and rubella vaccine. *J Epidemiol Community Health*. 2000;54:473–4. doi:10.1136/jech.54.6.473.
42. Wolfe RM, Sharp LK, Lipsky MS. Content and design attributes of antivaccination web sites. *JAMA*. 2002;287:3245–8. doi:10.1001/jama.287.24.3245.
43. Zimmerman RK, Wolfe RM, Fox DE, Fox JR, Nowalk MP, Troy JA, et al. Vaccine criticism on the World Wide Web. *J Med Internet Res*. 2005;7, e17. doi:10.2196/jmir.7.2.e17.
44. Wittman HO, Zikmund-Fisher BJ. The defining characteristics of Web 2.0 and their potential influence in the online vaccination debate. *Vaccine*. 2012;30:3734–40. doi:10.1016/j.vaccine.2011.12.039.
45. Scullard P, Peacock C, Davies P. Googling children's health: reliability of medical advice on the internet. *Arch Dis Child*. 2010;95:580–2. doi:10.1136/adc.2009.168856.
46. Kata A. A postmodern Pandora's box: anti-vaccination misinformation on the Internet. *Vaccine*. 2010;28:1709–16. doi:10.1016/j.vaccine.2009.12.022.
47. Diethelm P, McKee M. Denialism: what is it and how should scientists respond? *Eur J Public Health*. 2009;19:2–4. doi:10.1093/eurpub/ckn139.
48. Dubé E, Bettinger JA, Halperin B, Bradet R, Lavoie F, Sauvageau C, et al. Determinants of parents' decision to vaccinate their children against rotavirus: results of a longitudinal study. *Health Educ Res*. 2012;27:1069–80. doi:10.1093/her/cys088.
49. Betsch C, Renkewitz F, Betsch T, Ulshöfer C. The influence of vaccine-critical websites on perceiving vaccination risks. *J Health Psychol*. 2010;15:446–55. doi:10.1177/1359105309353647.
50. François G, Duclos P, Margolis H, Lavanchy D, Siegrist CA, Meheus A, et al. Vaccine safety controversies and the future of vaccination programs. *Pediatr Infect Dis J*. 2005;24:953–61. doi:10.1097/01.inf.0000183853.16113.a6.
51. Nair H, Hazarika I, Patwari A. A roller-coaster ride: Introduction of pentavalent vaccine in India. *J Glob Health*. 2011;1(1):32–5.
52. 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.
53. Kennedy A, Basket M, Sheedy K. Vaccine attitudes, concerns, and information sources reported by parents of young children: results from the 2009 HealthStyles survey. *Pediatrics*. 2011;127 Suppl 1:S92–9. doi:10.1542/peds.2010-1722N.
54. Kaliner E, Moran-Gilad J, Grotto I, Somekh E, Kopel E, Gdalevich M et al. Silent reintroduction of wild-type poliovirus to Israel, 2013 – risk communication challenges in an argumentative atmosphere. *Euro Surveill*. 2014;19(7): http://dx.doi.org/10.2807/1560-7917.ES2014.19.7.20703
55. Velan B, Boyko V, Lerner-Geva L, Ziv A, Yagar Y, Kaplan G. Individualism, acceptance and differentiation as attitude traits in the public's response to vaccination. *Hum Vaccin Immunother*. 2012;8(9):1272–82. doi:10.4161/hv.21183.
56. Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. *J Clin Epidemiol*. 2005;58:1081–8. doi:10.1016/j.jclinepi.2005.09.002.
57. Nowak GJ, Gellin BG, MacDonald NE, Butler R; SAGE Working Group on Vaccine Hesitancy. Addressing vaccine hesitancy: The potential value of commercial and social marketing principles and practices. *Vaccine*. 2015. doi:10.1016/j.vaccine.2015.04.039.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at
www.biomedcentral.com/submit

