A systematic review of parental vaccine hesitancy and refusal in childhood vaccination

Amalie Dyda (mailto:amalie.dyda@mq.edu.au)
Australian Institute of Health Innovation
https://orcid.org/0000-0003-2806-4834

Catherine King
National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases

Aditi Dey
National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases

Julie Leask
The University of Sydney Susan Wakil School of Nursing and Midwifery

Adam Dunn
Australian Institute of Health Innovation

Research article

Keywords: Hesitancy, refusal, immunization/immunisation, vaccination, vaccines

Posted Date: September 18th, 2019

DOI: https://doi.org/10.21203/rs.2.14640/v1

License: Creative Commons Attribution 4.0 International License.
Read Full License

Version of Record: A version of this preprint was published at BMC Public Health on August 2nd, 2020. See the published version at https://doi.org/10.1186/s12889-020-09327-8.
Abstract

Background Acceptance of vaccines is an important predictor of vaccine uptake. This has public health implications as those who are not vaccinated are at a higher risk of infection from vaccine preventable diseases. We aimed to systematically review studies of parental attitudes and beliefs in childhood vaccination, with a focus on the methods used to measure hesitancy and refusal.

Methods We identified and reviewed primary research studies using quantitative methods and investigating vaccine attitudes and beliefs published between January 2012 and May 2018. Studies were included if they involved a quantitative survey of the attitudes and beliefs of parents about vaccinations recommended for children. We undertook a narrative synthesis of the results with a focus on evaluating variation in the use of behavioural theories, validated survey instruments, and localisation and adaptation of questions to suit local context.

Results A total of 116 studies met the inclusion criteria; 99 used a cross sectional study design, 5 used a case control study design, 4 used a pre-post study design and 8 used mixed methods study designs. Sample sizes of included studies ranged from 49 to 12,259. Thirty-six countries were represented in the included studies. The most commonly used tool was the Parent Attitudes about Childhood Vaccines (PACV) Survey. Questions eliciting vaccination attitudes and beliefs varied widely.

Conclusions There was heterogeneity in the types of measures used in studies investigating attitudes and beliefs about vaccination in parents. Broader and more consistent use of validated survey instruments for measuring parental attitudes and beliefs about childhood vaccination would help to better understand localised differences in the reasons for vaccine hesitancy and refusal.

Introduction

Childhood vaccination rates vary widely by country and region, and the reasons for these variations are likely to be context-specific (1-3). While access to vaccination is a perennial challenge, acceptance also remains an issue of importance to uptake (4). Acceptance of vaccines is important to health because problems with acceptance can have a substantial impact on vaccination coverage and risk of outbreaks, particularly in high income settings (5). Not only are unvaccinated individuals at higher risk of infection and adverse health outcomes, but under-vaccinated populations are at higher risk of more severe outbreaks (6-8).

A range of questionnaires have been developed and tested for measuring vaccination attitudes and beliefs (9). A systematic review of vaccine hesitancy covering published literature from 2007 to 2012 identified 262 studies about childhood vaccines, of which 76 were multivariate studies and 60 where participants were primary caregivers (10). The largest recent questionnaires in the area include The Vaccine Confidence Project (11) which
collected 65,819 responses across 67 countries (12), and the Wellcome Global Monitor 2018 (13), which collected more than 140,000 responses from 140 countries. Both were based on the same set of questions, which included items about vaccine importance, effectiveness, safety, and religious compatibility.

Studies using questionnaires to understand vaccine attitudes and beliefs often modify existing items to incorporate the local context of a specific country or region. There is high variability with respect to use of behavioural theories to inform constructs and items and the comprehensiveness of validation, such as whether the items predict vaccination uptake. Moreover, high variability in how constructs such as vaccine confidence are measured between different questionnaires makes it difficult to assess how attitudes and beliefs vary globally.

Our aim was to examine how parental attitudes and beliefs towards childhood vaccination were measured in questionnaires through a systematic review of the literature. Our specific focus was on the questionnaires used to measure vaccine hesitancy and studies reporting associations with intentions and outcomes.

**Methods**

*Search strategy*

This review was developed in line with the PRISMA guidelines (14). Key bibliographic databases were searched to identify relevant articles. The databases searched included: OVID Medline (1946 to March Week 4 2018), OVID Embase (1974 to April 19 2018), PsycINFO (1987 –April Week 2 2018), Cochrane Library databases including Database of Systematic Reviews (Issue 5 of 12, May 2018), Central Register of Controlled Trials (Issue 4 of 12, April 2018), Database of Abstracts of Reviews of Effects (Issue 2 of 4, April 2015), NHS Economic Evaluation Database (Issue 2 of 4, April 2015) and Health Technology Assessments (Issue 4 of 4, October 2016), SCOPUS (1823-May 2018) and Web of Science Core Collection including Science Citation Index Expanded (1900-May 2018), Social Sciences Citation Index (1900-May 2018), Arts & Humanities Citation Index (1975-May 2018), Emerging Sources Citation Index (2015-May 2018), Conference Proceedings Citation Index - Science (1990-May 2018), Conference Proceedings Citation Index - Social Sciences & Humanities (1990-May 2018), Book Citation Index– Science (2005-May 2018),
Book Citation Index– Social Sciences & Humanities January (2005-May 2018), Current Chemical Reactions (1985-May 2018) and Index Chemicus (1993-May 2018).

Search terms included thesaurus terms (where available) such as ‘Immunization’, ‘Immunization programs’, ‘Vaccines’, ‘Decision Making’, ‘Decision Theory’, ‘Attitude to Health’, ‘Health Behavior’, ‘Risk Assessment’, ‘Trust’, ‘Uncertainty’, ‘Vaccination Refusal’, ‘Anti-Vaccination movement’, ‘Child, Preschool’ and ‘Infant’ (see Appendix 2 for the full search strategy). These were used with relevant associated text terms. Truncation was utilised to ensure all variant spelling endings of text words were retrieved. The searches were limited to items published from 2012 and ‘Humans’. The last search was conducted on 19 May 2018. Articles reviewed for inclusion were limited from January 2012 to May 2018 to avoid duplicating the findings of a 2014 systematic review that reviewed the global literature on vaccine hesitancy (10).

Inclusion criteria

Studies were included if they were quantitative primary studies investigating parental vaccine attitudes and/or beliefs; regardless of whether they considered one or a combination of vaccines or vaccine-preventable diseases; and published after January 2012. Studies were excluded if they investigated vaccination barriers not associated with attitudes or beliefs (e.g. measuring access other than as a factor affecting convenience); adult and adolescent vaccination; or if they were not reported in English. We applied no geographical constraints.

All titles and abstracts or executive summaries found through the search strategy were screened independently by two authors (Adam Dunn and Amalie Dyda) to determine if they were relevant to the review. The full text of those articles that appeared to meet the inclusion criteria were retrieved and reviewed for relevance independently by the same two authors. The reference lists of all included items were searched to identify any additional items for inclusion.

Data extraction and synthesis
Data were extracted by one author (Amalie Dyda) and confirmed by a second author (Adam Dunn). A standard data extraction form developed by the authors was used. For each study, study design information extracted from the articles included the method of recruitment and the location and type of participants; the number of participants recruited (and completing the study, where appropriate); the vaccine or set of vaccines of relevance to the study; and details of the questions used to measure attitudes and belief about vaccination including any description of behavioural theories used to inform the questionnaire design, and whether the questions were taken directly or adapted from existing instruments.

Data extracted from each study were tabulated and grouped by study type and study characteristics including sample size, recruitment method, and location. We also extracted information about the use of behavioural theories and the use or adaptation of validated questionnaires. We summarised associations between vaccine hesitancy and intentions or status by country and questionnaire to determine whether there were any consistent differences by country after accounting for differences in questionnaire designs.

**Results**

The initial search strategy returned 41,570 titles and abstracts, of which 23,201 were removed as duplicates. Title and abstract screening identified 673 full text items for review. Of these, 116 met the inclusion criteria (Figure 1). A review of the included articles’ reference lists did not identify any additional items for inclusion.

*Summary of included studies*

Of the included studies, 99 (85.3%) used a cross sectional study design (Table 1). Sample sizes across all 116 included studies ranged from 49 to 12,259 participants, with a median of 455 participants. Parental attitudes and beliefs about childhood vaccines in general were studied in 57 (49.1%) studies; and attitudes and beliefs about influenza vaccination (including pandemic H1N1 influenza) in 35 (30.2%). The other 24 (20.7%) studies asked participants about attitudes and beliefs for other specific vaccines, such as polio and rotavirus vaccines.
Thirty-four countries were represented in the included studies (Figure 2). The most common country in which studies were conducted was the United States (n=36), followed by Canada (n=9) and the United Kingdom (n=8). When aggregated by the number of participants, the United States included the largest number (40,155 participants), followed by Canada (7,200 participants), and the United Kingdom (3,273 participants).

Use of questionnaires and survey instruments

The questions asked of participants varied substantially across the set of included studies. There was heterogeneity both in terms of the specific questions asked of participants as well as the provenance of those questions in theory or from standardised questionnaire sets.

The most commonly used standard questionnaire was the Parent Attitudes about Childhood Vaccines (PACV) Survey Tool, used in 4 studies with its full format with 15 questions (15-18). In some studies, the PACV questions were adapted to match the local context or study population, such as in Malaysia (17) and for expectant parents in the United States (15). In 2 studies, a subset of the PACV questions were used (19, 20). Other questionnaires used included 7 studies based on national immunisation surveys or health department of health questionnaires (21-27), 1 study based on the Parental Attitudes toward MMR Vaccine and Trust in Medical Authority questionnaire (28), and 1 that used the Vaccine Safety, Attitudes, Training and Communication measures (29).

A total of 62 (53.4%) included studies developed questionnaires by reviewing previous literature or using previously developed questionnaires and/or frameworks, 4 developed questionnaires with experts in the field, 1 used a self-developed scale, and 1 conducted a pre-study qualitative evaluation of the target population to elicit appropriate questions. The remaining 48 studies did not report having used previous examples as the basis for the designs of their questionnaires.

A variety of theoretical frameworks were used to inform the design of the questionnaires used in the studies. The most common was the Health Belief Model (HBM), which was explicitly stated as having been used to inform the questions in 22 (19.0%) studies (26, 28, 30-49), followed by the Theory of Planned Behaviour, which was used in 5 (4.3%) studies.
Other studies that were adapted from existing questionnaires may have implicitly been based on these or other theoretical frameworks as a consequence of having adapted from other questionnaires but did not explicitly claim the theoretical framework as a basis for their questions.

**Questions about intention to vaccinate or vaccination status**

Of the 116 included studies, 38 (32.8%) included questions in which parents were directly asked about their vaccination intentions for one or more antigens. The specific questions that were asked varied across the set of studies. Examples included, “If you had another infant today, would you want him or her to get all the recommended shots?, “I would get a flu vaccine for my child under 5, every year, if it was free”, and “If your child were offered it at some point in the future, would you vaccinate them against swine flu?”. This variation precluded a synthesis of the results, and the proportion of participants responding in the affirmative varied substantially across the set of studies.

Among the 16 (13.8%) studies in which parents were directly asked about whether they would have children vaccinated for all childhood vaccines, the percentages ranged from 75% in a study involving 200 parents in the United States (56) to 98% in a study involving 54 parents in Canada (31). For the 9 (7.8%) studies that asked about intentions in relation to influenza vaccination, the percentages ranged from 29% in a study involving 236 parents in Canada (57) to 92% in a before and after study at a clinic involving 5,284 and 5,755 different groups of parents in rural Kenya (58).

**Associations between attitudes and beliefs with vaccination intentions or vaccination status**

We identified 13 (11.2%) studies reporting on the association between attitudes and beliefs with vaccine intentions. All of these studies identified a significant association between attitudes and beliefs with intentions. In 8 of the 13 studies, associations were found for questions related to the severity of the disease (18, 21, 30, 32, 38, 59-61), and these studies were conducted in the United States (n=3), the Gambia, Israel, Germany, the United Kingdom and Sweden. In 7 of the 13 studies, associations were found for questions related to the susceptibility of the disease (18, 21, 30, 32, 38, 45, 53), and these studies were conducted in the United States (n=2), the Gambia, Israel, the Netherlands, the United
Kingdom and South Korea. In 4 of the 13 studies, associations were found for questions related to the efficacy of the vaccine (21, 43, 61, 62), and these studies were conducted in the United States, Canada, Italy and Sweden. In 3 of the 13 studies, associations were found for questions related to safety of the vaccines (18, 60, 62), and these studies were conducted in the United States (n=2) and Italy.

Among the 116 included studies, 57 (49.1%) reported on the association between attitudes and beliefs with vaccination status. All studies identified an association between attitudes and beliefs with vaccination status, with concern about safety and efficacy the most commonly reported associations with lower vaccine uptake. In 26 of the 57 studies, an association between vaccination status and beliefs about the safety of vaccines were identified (29, 39, 40, 48, 49, 55, 63-83) and these studies were most commonly conducted in the United States (n=9) and China (n=4). Among the 26 studies that found an association between vaccination status and beliefs about the safety of vaccines, participants were asked about all childhood vaccines in 10 studies (55, 63, 67-72, 74-76), and about influenza vaccines in 12 (39, 40, 49, 64-66, 73, 77, 79-81, 83). In 10 of the 57 studies, an association was found between belief in the efficacy of the vaccine with vaccination status (24, 39, 47, 64, 73, 77, 80, 82-84), and these studies were most commonly conducted in Israel (n=3) and Japan (n=2). Of the 10 of 57 studies that found an association between belief in the efficacy of the vaccine and vaccination status, 2 investigated all childhood vaccines (24, 84), and 7 investigated attitudes and beliefs about influenza vaccine (39, 47, 64, 73, 77, 80). In 11 of the 57 studies, an association was found between vaccination status and trust in doctors and health care professionals or recommendations from a doctor (24, 41, 66, 69, 80, 85-89). Of those, 6 participants were asked about all childhood vaccines (24, 68, 69, 85-87), and influenza vaccines in 4 studies (41, 66, 80, 88).

**Discussion**

There was little consistency in the provenance of the questions used to measure attitudes and beliefs across studies. For theoretical frameworks, we found that the HBM was most commonly used to support the development of questionnaires, which was consistent with previous reviews (10). The HBM posits that perceptions of susceptibility, severity, benefit
and barriers, cues to action and self-efficacy predict behaviour. This and other models place emphasis on risk appraisals as important predictors of vaccination. Use of the HBM is complicated by the fact that all related perceptions could apply to vaccination uptake as much as disease outcomes. Since these models look at individual psychological factors by design, they are weaker at measuring other factors like false contraindications, social influence, or access to services or vaccines. Further, many models fail to measure trust, yet trust in vaccination arises as a relevant phenomenon in both qualitative accounts of under-vaccination and the influence of vaccine safety scares (90). Trust is often “ill-defined and a loosely measured concept” (91). Recent work on the moral foundations of behaviour suggests that measuring constructs such as contamination and liberty are also relevant (92, 93). Further work is needed to incorporate moral foundations, other feelings and attitudes and beliefs, trust, and practical barriers into a single model of vaccination behaviour and test its robustness.

The geographical distribution of primary studies included in the review was generally consistent with a previous review on attitudes and beliefs regarding vaccination (10), in which most included studies were conducted in North America and Europe. Among the subset of studies that used consistent measures, there was no clear difference in rates of vaccine hesitancy between countries, nor any clear pattern in the attitudes and beliefs that exhibited the strongest associations with intention. Given that the subset that used consistent measures was a relatively small subset of the studies, this result is a reflection of the small number of studies rather than evidence of consistency in what matters most to parents exhibiting vaccine hesitancy.

Future studies in this area may benefit from considering standardised questions on vaccine attitudes and beliefs and other barriers or facilitators (9). Large international surveys based on a standardised set of questions may be useful for providing international comparisons with context-specific additional questions. To consider the local context, qualitative investigations could supplement the broad based quantitative knowledge from surveys. Both forms of data collection are useful but are also resource intensive and relatively slow to report.
Current outbreaks of measles in the US highlight this need. From 1st January to 18th July 2019 there were a total of 1148 cases of measles identified in the US which is the largest number of infections reported since 1992. Outbreaks are occurring across a number of states, with an outbreak in Rockland County, reporting the majority (78.4%) of cases have not been vaccinated. The potential for mainstream media, social media, and other sources of misinformation to introduce or exacerbate concerns in the community may outpace our collective ability to measure and report on attitudes and beliefs, which may hinder our ability to support the design of evidence-informed and localised interventions for debunking or mitigating the impact of misinformation. Hence, there is a need to identify attitudes and beliefs with methods that survey individuals but also with methods that rapidly collect data in real-time using novel methods.

There were two main limitations to the review approach and conduct. The first limitation was that the geographical distribution of the studies included in the review may be biased by the exclusion of studies not written in English. Second, we did not undertake a meta-analysis to compare results across studies because of the heterogeneity of the questions asked in each of the included surveys, which limits our ability to summarise associations between attitudes and intentions or status within or across countries.

Conclusions

Despite the number of studies investigating parental attitudes and beliefs about childhood vaccination which were conducted in at least 36 countries, heterogeneity in survey designs make comparison and synthesis difficult. Cross-sectional survey designs are commonly used without large population-based sample sizes, further limiting our ability to understand and then act on the local concerns of parents. Methods to measure parental attitudes and beliefs about vaccination could be improved with validated and standardised yet flexible instruments, supplemented with qualitative investigations and new ways to monitor attitudes that are able to reach marginalised and under-served populations.

Declarations
Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Availability of data and materials
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Funding
This project was funded by the Australian National Health and Medical Research Council (NHMRC) Project Grant APP1128968.

Authors' contributions
A.Dyda led the design and coordination of the review. CK designed and conducted the literature searches, and was a contributor in writing the manuscript. A.Dey assisted in the design of the review and provided critical intellectual content throughout. JL was a major contributor to the design of the review and provided critical intellectual content throughout. A.Dunn was also a major contributor to the design of the review, and assisted with removing duplicates and screening of titles, abstracts and full review of papers for inclusion. All authors contributed to the revision of the manuscript and providing intellectual content. All authors read and approved the final manuscript.

Acknowledgements
Not applicable.

References

1. Hill HA, Elam-Evans LD, Yankey D, Singleton JA, Kang Y. Vaccination coverage among children aged 19-35 months - United States, 2017. Morbidity and Mortality Weekly Report. 2018;67(40):1123-8.
2. International Institute for Population Sciences (IIPS) and ICF. National family health survey (NFHS-4), 2015-16: India. Mumbai: IIPS. 2017

3. National Centre for Immunisation Research and Surveillance. Coverage data and reports 2019 [Available from: http://www.ncirs.org.au/health-professionals/coverage-data-and-reports.

4. Larson HJ. The biggest pandemic risk? Viral misinformation. Nature 2018;562, 309.

5. Smith LE, Amlot R, Weinman J, Yiend J, Rubin GJ. A systematic review of factors affecting vaccine uptake in young children. Vaccine. 2017;35(45):6059-69.

6. Phadke VK, Bednarczyk RA, Salmon DA, Omer SB. Association between vaccine refusal and vaccine-preventable diseases in the United States: A review of measles and pertussis. JAMA. 2016;315(11):1149-58.

7. Omer SB, Enger KS, Moulton LH, Halsey NA, Stokley S, Salmon DA. Geographic clustering of nonmedical exemptions to school immunization requirements and associations with geographic clustering of pertussis. American Journal of Epidemiology. 2008;168(12):1389-96.

8. Salathe M, Bonhoeffer S. The effect of opinion clustering on disease outbreaks. Journal of the Royal Society Interface. 2008;5(29):1505-8.

9. Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PLOS ONE. 2018;13(12):e0208601-e.

10. Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007-2012. Vaccine. 2014;32(19):2150-9.

11. Larson HJ. The state of vaccine confidence. Lancet (London, England). 2018;392(10161):2244-6.

12. Larson HJ, de Figueiredo A, Xiaohong Z, Schulz WS, Verger P, Johnston IG, et al. The state of vaccine confidence 2016: Global insights through a 67-country survey. EBioMedicine. 2016;12:295-301.

13. Gallup (2019) wellcome global monitor– first wave findings. 2019.

14. Prisma- preferred reporting items for systematic reviews and meta-analyses 2013 [Available from: http://www.prisma-statement.org/.

15. Cunningham RM, Minard CG, Guffey D, Swaim LS, Opel DJ, Boom JA. Prevalence of vaccine hesitancy among expectant mothers in Houston, Texas. Academic Pediatrics. 2018;18(2):154-60.

16. Henrikson NB, Anderson ML, Opel DJ, Dunn J, Marcuse EK, Grossman DC. Longitudinal trends in vaccine hesitancy in a cohort of mothers surveyed in Washington State, 2013-2015. Public Health Reports [Internet]. 2017; 132(4):[451-4]. Available from: http://cochranelibrary-wiley.com/o/cochrane/clcentral/articles/885/CN-01400885/frame.html.

17. Mohd Azizi FS, Kew Y, Moy FM. Vaccine hesitancy among parents in a multi-ethnic country, Malaysia. Vaccine. 2017;35(22):2955-61.

18. Orr C, Beck AF. Measuring vaccine hesitancy in a minority community. Clinical Pediatrics. 2017;56(8):784-8.
19. Oladejo O, Allen K, Amin A, Frew PM, Bednarczyk RA, Omer SB. Comparative analysis of the parent attitudes about childhood vaccines (pacv) short scale and the five categories of vaccine acceptance identified by Gust et al. Vaccine. 2016;34(41):4964-8.

20. Schoeppe J, Cheadle A, Melton M, Faubion T, Miller C, Matthys J, et al. The immunity community: A community engagement strategy for reducing vaccine hesitancy. Health Promotion Practice. 2017;18(5):654-61.

21. Cataldi JR, Dempsey AF, O'Leary ST. Measles, the media, and MMR: Impact of the 2014-15 measles outbreak. Vaccine. 2016;34(50):6375-80.

22. LaVail KH, Kennedy AM. The role of attitudes about vaccine safety, efficacy, and value in explaining parents' reported vaccination behavior. Health Education & Behavior. 2013;40(5):544-51.

23. Luthy KE, Beckstrand RL, Meyers C. Common perceptions of parents requesting personal exemption from vaccination. Journal of School Nursing. 2013;29(2):95-103.

24. Schönberger K, Ludwig MS, Wildner M, Kalies H. Timely mmr vaccination in infancy: Influence of attitudes and medical advice on the willingness to vaccinate. Klinische Padiatrie. 2012;224(7):437-42.

25. Shrestha S, Shrestha M, Wagle RR, Bhandari G. Predictors of incompletion of immunization among children residing in the slums of Kathmandu Valley, Nepal: A case-control study. BMC Public Health. 2016;16:970.

26. Smith PJ, Marcuse EK, Seward JF, Zhao Z, Orenstein WA. Children and adolescents unvaccinated against measles: Geographic clustering, parents' beliefs, and missed opportunities. Public Health Reports. 2015;130(5):485-504.

27. Walsh S, Thomas DR, Mason BW, Evans MR. The impact of the media on the decision of parents in South Wales to accept measles-mumps-rubella (MMR) immunization. Epidemiology and Infection. 2015;143(3):550-60.

28. Leonard WL. Parental confidence in U.S. Government and medical authorities, measles (rubeloa) knowledge, and MMR vaccine compliance. Dissertation Abstracts International: Section B: The Sciences and Engineering. 2017;77(7-B(E)).

29. Umeh GC, Nomhwange TI, Shamang AF, Zakari F, Musa Al, Dogo PM, et al. Attitude and subjective wellbeing of non-compliant mothers to childhood oral polio vaccine supplemental immunization in northern Nigeria. BMC Public Health. 2018;18.

30. Armitage ET, Camara J, Bah S, Forster AS, Clarke E, Kampmann B, et al. Acceptability of intranasal live attenuated influenza vaccine; influenza knowledge and vaccine intent in The Gambia. Vaccine. 2018;36(13):1772-80.

31. Atkinson KM, Ducharme R, Westeinde J, Wilson SE, Deeks SL, Pascali D, et al. Vaccination attitudes and mobile readiness: A survey of expectant and new mothers. Human Vaccines & Immunotherapeutics. 2015;11(4):1039-45.

32. Ben Natan M, Kabha S, Yehia M, Hamza O. Factors that influence Israeli Muslim Arab parents’ intention to vaccinate their children against influenza. Journal of Pediatric Nursing-Nursing Care of
33. Chen CH, Chiu PJ, Chih YC, Yeh GL. Determinants of influenza vaccination among young Taiwanese children. Vaccine. 2015;33(16):1993-8.

34. Cheung S, Wang HL, Mascola L, El Amin AN, Pannaraj PS. Parental perceptions and predictors of consent for school-located influenza vaccination in urban elementary school children in the United States. Influenza and Other Respiratory Viruses. 2015;9(5):255-62.

35. Chun Chau JP, Lo SHS, Chow Choi K, Kin Chau MH, Tong DWK, Kwong T, et al. Factors determining the uptake of influenza vaccination among children with chronic conditions. Pediatric Infectious Disease Journal [Internet]. 2017. Available from: http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/525/CN-01333525/frame.html.

36. He L, Liao QY, Huang YQ, Feng S, Zhuang XM. Parents' perception and their decision on their children's vaccination against seasonal influenza in Guangzhou. Chinese Medical Journal. 2015;128(3):327-41.

37. Hwang JH, Lim CH, Kim DH, Eun BW, Jo DS, Song YH, et al. A survey of parental perception and pattern of action in response to influenza-like illness in their children: Including healthcare use and vaccination in Korea. Journal of Korean Medical Science. 2017;32(2):204-11.

38. Janks M, Cooke S, Odedra A, Kang H, Bellman M, Jordan RE. Factors affecting acceptance and intention to receive pandemic influenza a h1n1 vaccine among primary school children: A cross-sectional study in birmingham, uk. Influenza Research and Treatment. 2012 (182565).

39. Kempe A, Daley MF, Pyrzanowski J, Vogt TM, Campagna EJ, Dickinson LM, et al. School-located influenza vaccination with third-party billing: What do parents think? Academic Pediatrics. 2014;14(3):241-8.

40. Lau JT, Mo PK, Cai YS, Tsui HY, Choi KC. Coverage and parental perceptions of influenza vaccination among parents of children aged 6 to 23 months in Hong Kong. BMC Public Health.13:1026.

41. Malosh R, Ohmit SE, Petrie JG, Thompson MG, Aiello AE, Monto AS. Factors associated with influenza vaccine receipt in community dwelling adults and their children. Vaccine. 2014;32(16):1841-7.

42. Mergler MJ, Omer SB, Pan WKY, Navar-Boggan AM, Orenstein W, Marcuse EK, et al. Association of vaccine-related attitudes and beliefs between parents and health care providers. Vaccine. 2013;31(41):4591-5.

43. Morin A, Lemaître T, Farrands A, Carrier N, Gagneur A. Maternal knowledge, attitudes and beliefs regarding gastroenteritis and rotavirus vaccine before implementing vaccination program: Which key messages in light of a new immunization program? Vaccine. 2012;30(41):5921-7.

44. O'Leary ST, Barnard J, Lockhart S, Kolasa M, Shmueli D, Dickinson LM, et al. Urban and rural differences in parental attitudes about influenza vaccination and vaccine delivery models. Journal of Rural Health. 2015;31(4):421-30.

45. Paek HJ, Shin KA, Park K. Determinants of caregivers' vaccination intention with respect to child age group: A cross-sectional survey in South Korea. BMJ Open. 2015;5(9).
46. Saitoh A, Sato I, Shinozaki T, Kamiya H, Nagata S. Improved parental attitudes and beliefs through stepwise perinatal vaccination education. Human Vaccines & Immunotherapeutics [Internet]. 2017:[1-7]. Available from: http://cochranelibrary-wiley.com/o/cochrane/clcentral/articles/856/CN-01419856/frame.html.

47. Tsuchiya Y, Shida N, Machida K. Flu vaccination acceptance among children and awareness of mothers in japan. In: Spier R, editor. 7th Vaccine & ISV Annual Global Congress. Procedia in Vaccinology. 82014. p. 12-7.

48. Wagner AL, Boulton ML, Sun X, Mukherjee B, Huang Z, Harmsen IA, et al. Perceptions of measles, pneumonia, and meningitis vaccines among caregivers in shanghai, china, and the health belief model: A cross-sectional study. BMC Pediatrics. 2017;17.

49. Wu CST, Kwong EWY, Wong HT, Lo SH, Wong ASW. Beliefs and knowledge about vaccination against AH1N1pdm09 infection and uptake factors among Chinese parents. International Journal of Environmental Research and Public Health. 2014;11(2):1989-2002.

50. 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 Education Research. 2012;27(6):1069-80.

51. Dube E, Gagnon D, Ouakki M, Bettinger JA, Witteman HO, MacDonald S, et al. Measuring vaccine acceptance among Canadian parents: A survey of the Canadian immunization research network. Vaccine. 2018;36(4):545-52.

52. Fadel CW, Colson ER, Corwin MJ, Rybin D, Heeren TC, Wang CL, et al. Maternal attitudes and other factors associated with infant vaccination status in the United States, 2011-2014. Journal of Pediatrics. 2017;185:136.

53. Harmsen IA, Lambooij MS, Ruiter RAC, Mollema L, Veldwijk J, van Weert Y, et al. Psychosocial determinants of parents' intention to vaccinate their newborn child against hepatitis B. Vaccine. 2012;30(32):4771-7.

54. MacDougall DM, Halperin BA, Langley JM, MacKinnon-Cameron D, Li L, Halperin SA, et al. Knowledge, attitudes, beliefs, and behaviors of parents and healthcare providers before and after implementation of a universal rotavirus vaccination program. Vaccine. 2016;34(5):687-95.

55. Thorpe EL, Zimmerman RK, Steinhart JD, Lewis KN, Michaels MG. Homeschooling parents' practices and beliefs about childhood immunizations. Vaccine. 2012;30(6):1149-53.

56. Weiner JL, Fisher AM, Nowak GJ, Basket MM, Gellin BG. Childhood immunizations first-time expectant mothers' knowledge, beliefs, intentions, and behaviors. Vaccine. 2015;33:D92-D8.

57. Dubé E, Gagnon D, Huot C, Paré R, Jacques S, Kossowski A, et al. Influenza immunization of chronically ill children in pediatric tertiary care hospitals. Human Vaccines & Immunotherapeutics. 2014;10(10):2935-41.

58. Oria PA, Arunga G, Lebo E, Wong JM, Emukule G, Muthoka P, et al. Assessing parents' knowledge and attitudes towards seasonal influenza vaccination of children before and after a seasonal influenza
vaccination effectiveness study in low-income urban and rural Kenya, 2010-2011. BMC Public Health. 2013;13.

59. Boes L, Boedeker B, Schmich P, Wetzstein M, Wichmann O, Remschmidt C. Factors associated with parental acceptance of seasonal influenza vaccination for their children – a telephone survey in the adult population in Germany. Vaccine. 2017;35(30):3789-96.

60. Brown DS, Arnold SE, Asay G, Lorick SA, Cho BH, Basurto-Davila R, et al. Parent attitudes about school-located influenza vaccination clinics. Vaccine. 2014;32(9):1043-8.

61. Schollin Ask L, Hjern A, Lindstrand A, Olen O, Sjögren E, Blennow M, et al. Receiving early information and trusting Swedish child health centre nurses increased parents’ willingness to vaccinate against rotavirus infections. Acta Paediatrica. 2017;106(8):1309-16.

62. Pelullo CP, Marino S, Valdes Abuadili AJ, Signoriello G, Attena F. Is it reasonable to abandon obligatory vaccinations in Italy? A 2013 survey. [erratum appears in euro surveill. 2014;19(36)]. European Communicable Disease Bulletin. 2014;19(35):04.

63. Angadi MM, Pulikkottil Jose A, Udgiri R, Masali KA, Sorganvi V. A study of knowledge, attitude and practices on immunization of children in urban slums of Bijapur City, Karnataka. Journal of Clinical and Diagnostic Research. 2013;7(12):2803-6.

64. Blyth CC, Richmond PC, Jacoby P, Thornton P, Regan A, Robins C, et al. The impact of pandemic A(H1N1)pdm09 influenza and vaccine-associated adverse events on parental attitudes and influenza vaccine uptake in young children. Vaccine.32(32):4075-81.

65. Buyuktiryaki B, Soyer OU, Erkocoglu M, Dogan A, Azkur D, Kocabas CN, et al. What a pandemic teaches us about vaccination attitudes of parents of children with asthma. Vaccine. 2014;32(20):2275-80.

66. Chow MYK, King C, Booy R, Julie L. Parents intentions and behavior regarding seasonal influenza vaccination for their children: A survey in child-care centers in Sydney, Australia. Journal of Pediatric Infectious Diseases. 2012;7(2):89-96.

67. Garg R, Meraya A, Murray PJ, Kelly K. Illness representations of pertussis and predictors of child vaccination among mothers in a strict vaccination exemption state. Maternal and Child Health Journal. 2018;22(1):137-46.

68. Gaudino JA, Robison S. Risk factors associated with parents claiming personal-belief exemptions to school immunization requirements: Community and other influences on more skeptical parents in Oregon, 2006. Vaccine. 2012;30(6):1132-42.

69. Giambi C, Fabiani M, D’Ancona F, Ferrara L, Fiacchini D, Gallo T, et al. Parental vaccine hesitancy in Italy – results from a national survey. Vaccine. 2018;36(6):779-87.

70. Kelley CA, Velazco CS, Delaney TV, Bensimhon A, Huang K-N, Jarvis PR, et al. Factors contributing to suboptimal rates of childhood vaccinations in Vermont. Journal of Child Health Care. 2015;19(4):558-68.

71. Kettunen C, Nemecek J, Wenger O. Evaluation of low immunization coverage among the Amish population in rural Ohio. American Journal of Infection Control. 2017;45(6):630-4.
72. Liao QY, Lam WWT, Cowling BJ, Fielding R. Psychosocial influences on parental decision-making regarding vaccination against seasonal influenza for young children in Hong Kong: A longitudinal study, 2012-2013. International Journal of Behavioral Medicine. 2016;23(5):621-34.

73. Livni G, Wainstein A, Birk E, Chodick G, Levy I. Influenza vaccination rate and reasons for non-vaccination in children with cardiac disease. Pediatric Infectious Disease Journal. 2017;13.

74. MacDonald SE, Schopflocher DP, Vaudry W. Parental concern about vaccine safety in Canadian children partially immunized at age 2: A multivariable model including system level factors. Human Vaccines & Immunotherapeutics. 2014;10(9):2603-11.

75. McCauley MM, Kennedy A, Basket M, Sheedy K. Exploring the choice to refuse or delay vaccines: A national survey of parents of 6-through 23-month-olds. Academic Pediatrics. 2012;12(5):375-83.

76. Mollema L, Wijers N, Hahne SJM, Van Der Klis FRM, Boshuizen HC, De Melker HE. Participation in and attitude towards the national immunization program in the Netherlands: Data from population-based questionnaires. BMC Public Health. 2012;12(1).

77. Peleg N, Zevit N, Shamir R, Chodick G, Levy I. Seasonal influenza vaccination rates and reasons for non-vaccination in children with gastrointestinal disorders. Vaccine. 2015;33(1):182-6.

78. Perinet S, Kiely M, De Serres G, Gilbert NL. Delayed measles vaccination of toddlers in Canada: Associated socio-demographic factors and parental knowledge, attitudes and beliefs. Human Vaccines & Immunotherapeutics. 2018;14(4):868-74.

79. Rao S, Fischman V, Moss A, Ziniel SL, Torok MR, McNeely H, et al. Exploring provider and parental perceptions to influenza vaccination in the inpatient setting. Influenza and Other Respiratory Viruses. 2018;12(3):416-20.

80. Scheuerman O, Zilber E, Davidovits M, Chodick G, Levy I. Nephrologists need to play a key role in improving annual influenza vaccination rates in children with kidney disease. Acta Paediatrica. 2017;106(5):812-8.

81. Smith LE, Webster RK, Weinman J, Amlot R, Yiend J, Rubin GJ. Psychological factors associated with uptake of the childhood influenza vaccine and perception of post-vaccination side-effects: A cross-sectional survey in England. Vaccine. 2017;35(15):1936-45.

82. Tsuchiya Y, Shida N, Izumi S, Ogasawara M, Kakinuma W, Tsujiuchi T, et al. Factors associated with mothers not vaccinating their children against mumps in Japan. Public Health. 2016;137:95-105.

83. Weston D, Blackburn R, Potts HWW, Hayward AC. Predictors of self and parental vaccination decisions in England during the 2009 H1N1 pandemic: Analysis of the flu watch pandemic cohort data. Vaccine. 2017;35(31):3875-82.

84. Kalucka SK, Lopata E. Age-conditioned differences in parents’ attitudes towards compulsory vaccination. Family Medicine and Primary Care Review. 2016;18(4):425-8.

85. Lee C, Whetten K, Omer S, Pan W, Salmon D. Hurdles to herd immunity: Distrust of government and vaccine refusal in the US, 2002-2003. Vaccine. 2016;34(34):3972-8.

86. Low MSF, Tan H, Hartman M, Tam CC, Hoo C, Lim JQ, et al. Parental perceptions of childhood seasonal influenza vaccination in Singapore: A cross-sectional survey. Vaccine. 2017;35(45):6096-
87. Nowak GJ, Cacciatore MA. Parents’ confidence in recommended childhood vaccinations: Extending the assessment, expanding the context. Human Vaccines & Immunotherapeutics. 2017;13(3):687-700.

88. Ramprasad C, Zachariah R, Steinhoff M, Simon A. Parental attitudes towards influenza vaccination for children in south india. World Journal of Pediatrics. 2017;13(1):84-90.

89. Vezzosi L, Santagati G, Angelillo IF. Knowledge, attitudes, and behaviors of parents towards varicella and its vaccination. BMC Infectious Diseases. 2017;17.

90. Brewer NT, Chapman GB, Rothman AJ, Leask J, Kempe A. Increasing vaccination: Putting psychological science into action. Psychological Science in the Public Interest. 2017;18(3):149-207.

91. Larson HJ, Clarke RM, Jarrett C, Eckersberger E, Levine Z, Schulz WS, et al. Measuring trust in vaccination: A systematic review. Human Vaccines & Immunotherapeutics. 2018;14(7):1599-609.

92. Amin AB, Bednarczyk RA, Ray CE, Melchiori KJ, Graham J, Huntsinger JR, et al. Association of moral values with vaccine hesitancy. Nature Human Behaviour. 2017;1(12):873-80.

93. Luz PM, Brown HE, Struchiner CJ. Disgust as an emotional driver of vaccine attitudes and uptake? A mediation analysis. Epidemiology and Infection. 2019;147:e182-e.

94. Centers for Disease Control and Prevention. Measles cases and outbreaks. 2019.

95. Abu-rish EY, Elayeh ER, Mousa LA, Butanji YK, Albsoul-Younes AM. Knowledge, awareness and practices towards seasonal influenza and its vaccine: Implications for future vaccination campaigns in Jordan. Family Practice. 2016;33(6):690-7.

96. Bakhache P, Rodrigo C, Davie S, Ahuja A, Sudovar B, Crudup T, et al. Health care providers’ and parents’ attitudes toward administration of new infant vaccines-a multinational survey. European Journal of Pediatrics. 2013;172(4):485-92.

97. Bamatraf FF, Jawass MA. Knowledge and attitude towards childhood immunization among parents in Al-Mukalla, Yemen. World Family Medicine. 2018;16(2):24-31.

98. Bazzano A, Zeldin A, Schuster E, Barrett C, Lehrer D. Vaccine-related beliefs and practices of parents of children with autism spectrum disorders. American Journal on Intellectual & Developmental Disabilities.117(3):233-42.

99. Braczkowska B, Kowalska M, Barański K, Gajda M, Kurowski T, Zejda JE. Parental opinions and attitudes about children’s vaccination safety in silesian voivodeship, Poland. International Journal of Environmental Research and Public Health. 2018;15(4).

100. Bukhsh A, Rehman H, Mallhi TH, Ata H, Rehman IU, Lee LH, et al. Parents’ attitude, awareness and behaviour towards influenza vaccination in Pakistan. Human Vaccines & Immunotherapeutics [Internet]. 2018:1-6. Available from: http://cochranelibrary-wiley.com/o/cochrane/clcentral/articles/512/CN-01450512/frame.html.

101. Cacciatore MA, Nowak G, Evans NJ. Exploring the impact of the us measles outbreak on parental awareness of and support for vaccination. Health Affairs. 2016;35(2):334-40.
102. Campbell H, Edwards A, Letley L, Bedford H, Ramsay M, Yarwood J. Changing attitudes to childhood immunisation in English parents. Vaccine. 2017;35(22):2979-2985.

103. Esposito S, Cerutti M, Milani D, Menni F, Principi N. Vaccination coverage of children with rare genetic diseases and attitudes of their parents toward vaccines. Human Vaccines & Immunotherapeutics. 2016;12(3):801-5.

104. Frawley JE, Foley H, McIntyre E. The associations between medical, allied and complementary medicine practitioner visits and childhood vaccine uptake. Vaccine. 2018;36(6):866-72.

105. Garcia LDA, Velandia-Gonzalez M, Trumbo SP, Pedreira MC, Bravo-Alcantara P, Danovaro-Holliday MC. Understanding the main barriers to immunization in Colombia to better tailor communication strategies. BMC Public Health. 2014;14:669.

106. Gunduz S, Yuksel NC, Aktoprak HB, Canbal M, Kaya M. Attitudes towards influenza vaccination in high socioeconomic status Turkish parents. Turkish Journal of Medical Sciences.44(4):649-55.

107. Healy CM, Montesinos DP, Middleman AB. Parent and provider perspectives on immunization: Are providers overestimating parental concerns? Vaccine. 2014;32(5):579-84.

108. Hilyard KM, Quinn SC, Kim KH, Musa D, Freimuth VS. Determinants of parental acceptance of the H1N1 vaccine. Health Education & Behavior. 2014;41(3):307-14.

109. How CH, Chun PPS, Shafi F, Jakes RW. Parental knowledge, attitudes and perception of pneumococcal disease and pneumococcal conjugate vaccines in Singapore: A questionnaire-based assessment. BMC Public Health. 2016;16.

110. Idoko OT, Hampton LM, Mboizi RB, Agbla SC, Wallace AS, Harris JB, et al. Acceptance of multiple injectable vaccines in a single immunization visit in the gambia pre and post introduction of inactivated polio vaccine. Vaccine. 2016;34(41):5034-9.

111. Kaya A, Altinel N, Karakaya G, Çetinkaya F. Knowledge and attitudes among patients with asthma and parents and physicians towards influenza vaccination. Allergologia et Immunopathologia. 2017;45(3):240-3.

112. Kim IS, Seo YB, Hong KW, Noh JY, Choi WS, Song JY, et al. Perceptions of tetanus-diphteria-acellular pertussis (tdap) vaccination among Korean women of childbearing age. Infection and Chemotherapy. 2013;45(2):217-24.

113. Larson HJ, Schulz WS, Tucker JD, Smith DMD. Measuring vaccine confidence: Introducing a global vaccine confidence index. PLOS Currents Outbreaks. 2015;7.

114. Legesse E, Dechasa W. An assessment of child immunization coverage and its determinants in Sinana district, Southeast Ethiopia. BMC Pediatrics. 2015;15.

115. Lehmann BA, Melker HE, Timmermans DRM, Mollema L. Informed decision making in the context of childhood immunization. Patient Education and Counseling [Internet]. 2017. Available from: http://cochranelibrary-wiley.com/o/cochrane/clcentral/articles/325/CN-01396325/frame.html.

116. Masadeh MM, Alzoubi KH, Al-Azzam SI, Al-Agedi HS, Abu Rashid BE, Mukattash TL. Public awareness regarding children vaccination in Jordan. Human Vaccines & Immunotherapeutics. 2014;10(6):1762-6.
117. Michael CA, Ogbuanu IU, Storms AD, Ohuabunwo CJ, Corkum M, Ashenafi S, et al. An assessment of the reasons for oral poliovirus vaccine refusals in northern Nigeria. Journal of Infectious Diseases. 2014;210:S125-S30.

118. Moulsdale P, Grant A, Fletcher M, Finn A. Parents' perceptions of influenza and why they accept or decline the nasal vaccine for their child. Nursing Children and Young People. 2017;29(3):28-33.

119. Mrožek-Budzyn D, Kiełtyka A, Mróz E. Opinions about vaccination among mothers who delivered newborns in two hospitals in krakow and myślenice. Przeglad Epidemiologiczny. 2016;70(3):471-8.

120. Muhsen K, Abed El-Hai R, Amit-Aharon A, Nehama H, Gondia M, Davidovitch N, et al. Risk factors of underutilization of childhood immunizations in ultraorthodox jewish communities in Israel despite high access to health care services. Vaccine. 2012;30(12):2109-15.

121. My C, Danchin M, Willaby HW, Pemberton S, Leask J. Parental attitudes, beliefs, behaviours and concerns towards childhood vaccinations in Australia: A national online survey. Australian Family Physician. 2017;46(3):145-51.

122. Oskarsson Y, Gunason, Jonsdottir GA, Kristinsson KG, Briem H, Haraldsson A. Public opinion on childhood immunisations in Iceland. Vaccine.33(51):7211-6.

123. Preza I, Subaiya S, Harris JB, Ehlman DC, Wannemuehler K, Wallace AS, et al. Acceptance of the administration of multiple injectable vaccines in a single immunization visit in Albania. Journal of Infectious Diseases. 2017;216:S146-S51.

124. Rabinowitz M, Latella L, Stern C, Jost JT. Beliefs about childhood vaccination in the united states: Political ideology, false consensus, and the illusion of uniqueness. PLOS ONE. 2016;11(7).

125. Reavis RD, Ebbs JB, Onunkwo AK, Sage LM. A self-affirmation exercise does not improve intentions to vaccinate among parents with negative vaccine attitudes (and may decrease intentions to vaccinate). PLOS ONE [Internet]. 2017; 12(7):[e0181368]. Available from: http://cochranelibrary-wiley.com/o/cochrane/clcentral/articles/040/CN-01413040/frame.html.

126. Rogers C. Parents' vaccine beliefs: A study of experiences and attitudes among parents of children in private pre-schools. Rhode Island Medical Journal. 2014;97(4):27-30.

127. Sohail MM, Mahmood B, Asim M. Mother's knowledge, attitude and practices about child immunization: A study in district Faisalabad, Pakistan. Rawal Medical Journal. 2015;40(4):441-4.

128. Tam WWS, Chan J, Lo KKH, Lee A, Chan PKS, Chan D, et al. Parental attitudes and factors associated with varicella vaccination in preschool and schoolchildren in Hong Kong a cross-sectional study. Medicine. 2015;94(36).

129. Thors V, Moulsdale P, Finn A. Parental views on childhood influenza vaccination. Pediatric Infectious Disease Journal. 2014;33(3):334-5.

130. Van Lier A, Tostmann A, Harmsen IA, De Melker HE, Hautvast JLA, Ruijs WLM. Negative attitude and low intention to vaccinate universally against varicella among public health professionals and parents in the Netherlands: Two internet surveys. BMC Infectious Diseases. 2016;16.

131. Veldwijk J, Lambooij MS, Bruijning-Verhagen PC, Smit HA, de Wit GA. Parental preferences for rotavirus vaccination in young children: A discrete choice experiment. Vaccine. 2014;32(47):6277-83.
132. Wang LDL, Lam WWT, Fielding R. Hong kong chinese parental attitudes towards vaccination and associated socio-demographic disparities. Vaccine. 2016;34(12):1426-9.

133. Weiss C, Schröpfer D, Merten S. Parental attitudes towards measles vaccination in the canton of Aargau, Switzerland: A latent class analysis. BMC Infectious Diseases. 2016;16(1).

134. Wolff ER, Madlon-Kay DJ. Childhood vaccine beliefs reported by Somali and non-Somali parents. Journal of the American Board of Family Medicine. 2014;27(4):458-64.

135. Young AM, Elliston A, Ruble LA. Parents of children with autism: Issues surrounding childhood vaccination. International Journal of Public Health. 2015(7(3):331-341).

Tables

Table 1: Summary of included studies
| Article ID | Study design      | Sample size | Child age | Time period            | Country                  | Vaccine type                      |
|-----------|-------------------|-------------|-----------|------------------------|--------------------------|-----------------------------------|
| u-rish 16 (95) | Cross sectional | 317         | <5 years  | Dec 2015 - Apr 2016   | Jordon                   | Influenza                         |
| gadi 2013 3) | Cross sectional | 155         | 12-23 months | Oct-Nov 2011      | India                    | All childhood vaccines             |
| mitage 18 (30) | Cross sectional | 454         | N/S       | Aug-Sep 2017           | The Gambia                | Influenza                         |
| kinson 15 (31) | Cross sectional | 54          | <3 months | Nov 2013-Jul 2014     | Canada                    | All childhood vaccines             |
| khache 13 (96) | Cross sectional | 2460        | 0-23 months | Sep-Nov 2011        | Australia, Canada, France, Germany, Spain, Sweden, United Kingdom | All childhood vaccines             |
| matraf 18 (97) | Cross sectional | 400         | N/S       | Dec 2014 - Mar 2015   | Yemen                    | All childhood vaccines             |
| zzano 12 (98) | Cross sectional  | 197         | <18 years | Mar- Sep 2007         | United States             | All childhood vaccines             |
| n Natan 16 (32) | Cross sectional | 200         | <12 years | Jan-Mar 2015          | Israel                    | Influenza                         |
| the 2014 1) | Cross sectional  | 2576        | N/S       | Influenza seasons 2008-2012 | Australia                | Influenza                         |
| es 2017 9) | Cross sectional  | 518         | N/S       | May-June 2015         | Germany                  | Influenza                         |
| aczkowska 18 (99) | Cross sectional | 1239        | 6-13 years | 2016                 | Poland                   | All childhood vaccines             |
| own 2014 0) | Cross sectional  | 2065        | <14 yrs   | Jun-10                | United States             | Influenza                         |
| khsh 2018 0) | Cross sectional  | 532         | >6 months | N/S                   | Pakistan                 | Influenza                         |
| yuktiryaki 14 (65) | Cross sectional | 625         | 6-18 years | Apr-July 2010      | Turkey                   | A/H1N1 influenza                   |
| cciatore 16 (101) | Pre-post questionnaire | 1855 | <5 years | Nov-Dec 2014 & May-June 2015 | United States | All childhood vaccines             |
| mpbell 17 (102) | Cross sectional  | 1792        | 2 months-5 years | Jan-Apr 2015    | United Kingdom            | All childhood vaccines             |
| taldi 2016 1) | Cross sectional  | 351         | <1yr      | Apr-Jun 2015          | United States             | Measles, Mumps, Rubella            |
| en 2015 3) | Cross sectional  | 1300        | 6 months- | Jul-Aug 2011          | Taiwan                   |                                   |
| Study | Study Type | Sample Size | Age | Year(s) | Location | Disease |
|-------|------------|-------------|-----|---------|----------|---------|
| Heung 2015 | Cross sectional | 2755 | 5-13 years | Sep 2009 & Sep 2010 | United States | Influenza |
| Ow 2012 | Cross sectional | 431 | 6 months-5yrs | Nov-Dec 2009 | Australia | Influenza |
| Au 2017 | Cross sectional | 623 | N/S | May-Aug 2013 | China | influenza |
| Cunningham 18 (15) | Cross sectional | 648 | N/S | Jul 2014-Sep 2015 | United States | All childhood vaccines |
| Bé 2012 | Cross sectional | 413 | 0-6 weeks | 2008-2009 | Canada | Rotavirus |
| Bé 2014 | Cross sectional | 236 | 6 months & 17 years | Oct-Dec 2012 | Canada | Influenza |
| Bé 2018 | Cross sectional | 213 | 24-59 months | Mar-15 | Canada | All childhood vaccines |
| Posito 18 (103) | Cross sectional | 114 | N/S | Nov 2014-April 2015 | Italy | All childhood vaccines |
| Del 2017 | Prospective survey | 3268 | 2-6 months | 2011-2014 | United States | All childhood vaccines |
| Awley 18 (104) | Cross sectional | 429 | <6 years | N/S | Australia | All childhood vaccines |
| Arcia 2014 | Cross sectional | 4802 | <5 years | May-June 2010 | Colombia | All childhood vaccines |
| Rg 2018 | Cross sectional | 160 | <3 years | N/S | United States | All childhood vaccines |
| Udino 12 (68) | Retrospective cohort | 2900 | School aged | 2004-2005 | United States | All childhood vaccines |
| Ambi 2018 | Cross sectional | 3130 | 16-36 months | 2016 | Italy | All childhood vaccines |
| Ambuz 2014 | Cross sectional | 285 | 1-16 years | 2012 | Turkey | Influenza |
| Frumsen 12 (53) | Cross sectional | 906 | Newborn | N/S | Netherlands | Hepatitis B |
| 2015 (36) | Cross sectional | 335 | 6 months-3 years | 2013 | China | Influenza |
| Zaly 2014 | Cross sectional | 401 | <18 years | N/S | United States | All childhood vaccines |
| Eriksson 17 (16) | Follow up survey | 237 | 24 months | 2015 | United States | All childhood vaccines |
| Yard 2014 | Cross sectional | 684 | <18 years | 2010 | United States | H1N1 influenza |
| Ow 2016 | Cross sectional | 200 | <5 years | 2014 | Singapore | Pneumococcal |
| Vang 2017 | Cross sectional | 638 | 6-59 months | 2017 | South Korea | Influenza |
| Oko 2016 | Pre-post | 587 | ~4 | 2015 | The Gambia | Polio |
| Study | Survey Type     | Sample Size | Age/Time Period       | Country                      | Vaccines                                                                 |
|-------|-----------------|-------------|-----------------------|------------------------------|---------------------------------------------------------------------------|
| iks 2012 | Cross sectional | 149         | 4-7 years             | United Kingdom               | H1N1 influenza                                                            |
| lucka 16 (84) | Cross sectional | 78          | <7 years              | Poland                       | All childhood vaccines                                                    |
| ya 2017 (11) | Cross sectional | 81          | N/S                   | Turkey                       | Influenza                                                                 |
| Illey 2015 | Cross sectional | 379         | <5 years              | United States                | All childhood vaccines                                                    |
| mpe 2014 | Cross sectional | 699         | N/S                   | United States                | Influenza                                                                 |
| ttunen 17 (71) | Cross sectional | 84          | N/S                   | United States                | N/S                                                                       |
| n 2013 12) | Cross sectional | 500         | N/S                   | South Korea                  | Tetanus, diphtheria, and pertussis                                        |
| rson 2015 13) | Cross sectional | 5354        | <5 years              | United States, India,        | All childhood vaccines                                                    |
|         |                 |             |                      | Nigeria, Pakistan,          |                                                                           |
|         |                 |             |                      | United Kingdom               |                                                                           |
| u 2013 10) | Cross sectional | 401         | 6-23 months           | China                        | Influenza                                                                 |
| Vail 2013 2) | Cross sectional | 376         | <6 years              | United States                | All childhood vaccines                                                    |
| e 2016 5) | Case control study | 1253     | School age            | United States                | All childhood vaccines                                                    |
| gesse 2015 14) | Cross sectional | 591         | 12-23 months          | Ethiopia                     | All childhood vaccines                                                    |
| hmann 17 (115) | Cross sectional | 1615        | 3 months - 3.5 years  | Netherlands                  | All childhood vaccines                                                    |
| onard 17 (28) | Cross sectional | 243         | <6 years              | United States                | Measles, Mumps, Rubella                                                  |
| o 2016 2) | Longitudinal study | 1226        | 6 months - 6 years    | China                        | All childhood vaccines                                                    |
| mi 2017 3) | Cross sectional | 186         | <18 years             | Israel                       | Influenza                                                                 |
| w 2017 3) | Cross sectional | 332         | 6 months - 5 years    | Singapore                    | All childhood vaccines                                                    |
| thy 2013 3) | Cross sectional | 801         |                      | United States                | All childhood vaccines                                                    |
| icDonald 14 (74) | Case control study | 461        | 2 years               | Canada                       | All childhood vaccines                                                    |
| Authors | Study Type | Age | Year | Country | Vaccines Covered |
|---------|------------|-----|------|---------|------------------|
| Dougall et al. 2016 (54) | Before and After study | 722 & 709 | <18 years | 2010 | United States | Rotavirus |
| Alosh 2014 | Cross sectional | 778 | 2010 | Jordon | All childhood vaccines |
| Isadah 2014 (116) | Cross sectional | 506 | Jun-Aug 2012 | Jordon | All childhood vaccines |
| Cauley et al. 2012 (75) | Cross sectional | 1500 | 6-23 months | March-April 2010 | United States | All childhood vaccines |
| Grgler et al. 2013 (42) | Cross sectional | 1367 | School age | 2002-2003 & 2005 | United States | All childhood vaccines |
| chael 2014 (7) | Cross sectional | 148 | Oct 2012 | Nigeria | Polio |
| Asad 2014 | Cross sectional | 604 | <7 years | November-Dec 2016 | Malaysia | All childhood vaccines |
| llema 2012 (76) | Cross sectional (x2) | 7085 & 2934 | N/S | 1995-1996 & 2006-2007 | Netherlands | All childhood vaccines |
| rin 2012 | Cross sectional | 343 | N/S | Feb-11 | Canada | Rotavirus |
| ulsdale 2014 (118) | Cross sectional | 86 | 3-11 years | 2014 | United Kingdom | Influenza |
| ozek-dzyn 2016 (19) | Cross sectional | 154 | N/S | 2014-2015 | Poland | All childhood vaccines |
| hsen 2012 (20) | Case control study | 430 | 2-25 years & 2-5 years | 2007 | Israel | All childhood vaccines |
| 2017 (21) | Cross sectional | 452 | <18 years | 2012 | Australia | All childhood vaccines |
| wak 2017 (7) | Cross sectional | 1000 | <5 years | Nov-Dec 2014 | United States | All childhood vaccines |
| adejo 2016 (9) | Cross sectional | 1200 | <12 years | N/S | United States | All childhood vaccines |
| eary 2015 (4) | Cross sectional | 288 | 2-17 years | Apr-June 2012 | United States | Influenza |
| ia 2013 (3) | Before and After study | 5284 & 5755 | 6 months-10 years | Jun & Sep 2010 | Kenya | Influenza |
| r 2017 (3) | Cross sectional | 86 | 6 months-7 years | Oct-Nov 2015-2016 influenza season | United States | Influenza |
| karsson 2015 (122) | Cross sectional | 5584 | N/S | 2013-2014 | Iceland | All childhood vaccines |
| ek 2015 (5) | Cross sectional | 1017 | <12 years | 2014 | Korea | All childhood vaccines |
| leg 2015 (7) | Cross sectional | 273 | <18 years | Sep-Oct 2011 | Israel | Influenza |
| Reference | Study Type | Sample Size | Age Range | Time Period | Country | Vaccines |
|-----------|------------|-------------|-----------|-------------|---------|-----------|
| lullo 2014 | Cross sectional | 1039 | N/S | Jan-April 2013 | Italy | All childhood vaccines |
| rinet 2018 | Cross sectional | 3604 | 2 years | Mar-13 | Canada | Measles |
| eza 2017 | Cross sectional | 288 | 2-4 months | Dec 2014-July 2015 | Albania | All childhood vaccines |
| binowitz 16 (124) | Cross sectional | 367 | N/S | N/S | United States | All childhood vaccines |
| mprasad 17 (88) | Cross sectional | 456 | 6 months-15 years | Sep-Oct 2012 | India | Influenza |
| o 2018 | Cross sectional | 1001 | >6 months | Oct 2014-Mar 2015 | United States | Influenza |
| avis 2017 | Pre-post intervention | 585 | <18 years | Jun-14 | United States | All childhood vaccines |
| gers 2014 | Cross sectional | 51 | Preschool aged | N/S | United States | All childhood vaccines |
| itoh 2017 | Cluster-randomized controlled trial | 160 | <0 years | Sep 2014-Feb 2015 | Japan | All childhood vaccines |
| heuerman 17 (80) | Cross sectional | 217 | 6 months-18 years | Aug-Oct 2011 & Sept-Oct 2012 | Israel | Influenza |
| hoeppe 17 (20) | Pre-post survey | 460 & 238 | N/S | N/S | United States | All childhood vaccines |
| hollin 17 (61) | Cross sectional | 1063 | <12 weeks | Sep-Oct 2014 | Sweden | Rotavirus |
| honburger 12 (24) | Cross sectional | 3041 | <4 years | 2002-2005 | Germany | All childhood vaccines |
| restha 16 (25) | Case control study | 262 | 12-23 months | Sept-Nov 2014 | Nepal | All childhood vaccines |
| uith 2017 | Cross sectional | 1001 | 2-7 years | 2016-2017 flu season | United Kingdom | Influenza |
| uith 2015 | Cross sectional | 12259 | 19-35 months | 2010-2013 | United States | Measles |
| hail 2015 | Cross sectional | 200 | <16 months | n/s | Pakistan | All childhood vaccines |
| m 2015 | Cross sectional | 3484 | <12 years | Sep-Nov 2013 | Hong Kong | Varicella |
| orpe 2012 | Cross sectional | 124 | 0-18 years | May-10 | United States | All childhood vaccines |
| ors 2014 | Cross sectional | 253 | 2-11 years | 2012-2013 | United Kingdom | Influenza |
| uchiya 16 (82) | Cross sectional | 226 | N/S | 2011 | Japan | Mumps |
| uchiya | Cross | 220 | N/S | 2009-2010 | Japan | Influenza |
| Reference | Study Type | Study Size | Age | Year | Country | Vaccines |
|-----------|------------|------------|-----|------|---------|----------|
| Meh 2018 9) | Cross sectional | 396 | N/S | N/S | Nigeria | Polio |
| Lier 16 (130) | Cross sectional | 491 | 0-4 years | 2012 | Netherlands | Varicella |
| Idwijk 14 (131) | Cross sectional | 466 | 6 weeks | N/S | Netherlands | Rotavirus |
| Zzosi 2017 9) | Cross sectional | 414 | N/S | May-Jun 2015 | Italy | Varicella |
| Signer 2017 3) | Cross sectional | 619 | 8 months-7 years | May-Jun 2014 | China | Measles, Pneumonia, Meningitis |
| Ish 2015 7) | Case control study | 308 | 2 years | Jul-Sep 2001 | United Kingdom | Measles, Mumps, Rubella |
| Ang 2016 32) | Cross sectional | 1996 | 12-17 years | Feb-Nov 2014 | China | All childhood vaccines |
| Signer 2015 3) | Cross sectional | 200 | <0 years | Jun-Sep 2014 | United States | All childhood vaccines |
| Iss 2016 33) | Cross sectional | 189 | <36 months | 2011 | Switzerland | Measles |
| Eston 2017 3) | Cross sectional | 85 | 0-15 years | 2010 | United Kingdom | H1N1 influenza |
| Olff 2014 34) | Cross sectional | 99 | N/S | Aug 2012-Feb 2013 | United States | All childhood vaccines |
| Liu 2014 9) | Cross sectional | 118 | N/S | Jul-10 | China | H1N1 influenza |
| U 2014 35) | Cross sectional | 49 | N/S | N/S | United States | All childhood vaccines |

**Figures**
Figure 1

Summary of the search strategy results and set of included studies.
Figure 2

Among the set of 116 included studies, 34 countries were represented.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- App2.docx