



Review

Reasons related to non-vaccination and under-vaccination of children in low and middle income countries: Findings from a systematic review of the published literature, 1999–2009

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ABSTRACT

Objective: Despite increases in routine vaccination coverage during the past three decades, the percent of children completing the recommended vaccination schedule remains below expected targets in many low and middle income countries. In 2008, the World Health Organization Strategic Advisory Group of Experts on Immunization requested more information on the reasons that children were under-vaccinated (receiving at least one but not all recommended vaccinations) or not vaccinated in order to develop effective strategies and interventions to reach these children.

Methods: A systematic review of the peer-reviewed literature published from 1999 to 2009 was conducted to aggregate information on reasons and factors related to the under-vaccination and non-vaccination of children. A standardized form was used to abstract information from relevant articles identified from eight different medical, behavioural and social science literature databases.

Findings: Among 202 relevant articles, we abstracted 838 reasons associated with under-vaccination; 379 (45%) were related to immunization systems, 220 (26%) to family characteristics, 181 (22%) to parental attitudes and knowledge, and 58 (7%) to limitations in immunization-related communication and information. Of the 19 reasons abstracted from 11 identified articles describing the non-vaccinated child, 6 (32%) were related to immunization systems, 8 (42%) to parental attitudes and knowledge, 4 (21%) to family characteristics, and 1 (5%) to communication and information.

Conclusions: Multiple reasons for under-vaccination and non-vaccination were identified, indicating that a multi-faceted approach is needed to reach under-vaccinated and unvaccinated children. Immunization system issues can be addressed through improving outreach services, vaccine supply, and health worker training; however, under-vaccination and non-vaccination linked to parental attitudes and knowledge are more difficult to address and likely require local interventions.

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1. Introduction

Immunization is one of the most successful and cost-effective public health interventions for reducing infant and child morbidity and mortality globally [1]. Although the World Health Organization estimated that immunizations saved approximately 2.5 million lives in 2006, an estimated 1.4 million children died from vaccine preventable diseases (measles, *Haemophilus influenzae* type b, pertussis, tetanus, yellow fever, and poliomyelitis) during the same year because they were not fully vaccinated [2].

The Expanded Programme on Immunization (EPI) was launched in 1974 to provide free routine vaccinations to children. Operated by Ministries of Health with technical support from the World Health Organization, EPI has contributed to improvements in coverage towards the global goal of $\geq 90\%$ of children in each member country receiving the third dose of DTP vaccine (DTP3) and coverage of $\geq 80\%$ in all districts by 2010 [3]. Despite health worker training, targeted outreach services, and new strategies such as the Reaching Every District (RED) approach [4], the percent of children fully vaccinated has not reached these targets. Although global DTP3 coverage reached 82% in 2008, only 42 (27%) of the 157 WHO member states defined as low or middle income in 2006 had DTP3 coverage greater than 80% in all districts [2].

In 2008, the World Health Organization (WHO) Strategic Advisory Group of Experts on Immunization (SAGE) requested information on “the epidemiology of the non-vaccination” and under-vaccination of children with the basic routine immunizations in order to formulate strategies to decrease the number of children who are unvaccinated or only partially vaccinated [5]. Information was needed particularly for low and middle income countries, where vaccination coverage has been historically inadequate to prevent transmission of vaccine preventable diseases [1]. We conducted a systematic review of the peer-reviewed literature published between 1999 and 2009 with the objective to aggregate and summarize reasons that children in low and middle income countries remain under-vaccinated or unvaccinated with the EPI recommended vaccinations. We did not attempt to examine the merits of universal vaccination, assess country specific health systems, or quantify the impact of each reason on the number of unvaccinated or partially vaccinated children. Review findings can contribute to the development of local, national, and regional interventions to improve coverage of all EPI vaccinations. Country-level fact sheets containing relevant information on reasons for under-vaccination were developed and provided to Ministries of Health. The SAGE request also included a review of the grey literature (unpublished reports, meeting documents, and articles from non-peer reviewed journals) and an analysis of the Demographic and Health Survey (DHS) data. Results from these projects are reported separately [6,7].

2. Methods

2.1. Literature database search

Eight different medical, behavioural and social science literature databases were searched for relevant articles published from January 1, 1999 to March 31, 2009. These included Medline[®] (National Library of Medicine) and seven non-Medline databases: Embase[®] (Excerpta Medica Database, Elsevier), CSA Sociological Abstracts (ProQuest), Social Services Abstracts, Educational Resources Information Center (ERIC), Cochrane, Web of Science, and CINALH[®] (Cumulative Index to Nursing and Allied Health Literature). The initial search was performed by a reference librarian at the US Centers for Disease Control and Prevention (CDC) using the keywords ‘immunization’ or ‘vaccination’ (and derivatives including ‘vaccine’, ‘vaccinat’, ‘immuniz’, or ‘immunis’) and ‘low or middle income country’ (defined according to World Bank criteria in 2004) [8]. Animal studies and serologic investigations were excluded. Articles in all six official WHO languages (English, French, Spanish, Arabic, Chinese and Russian), and in Portuguese were eligible for inclusion. Duplicate results obtained from different databases were eliminated from the search findings.

Titles and abstracts of identified articles in the initial search were reviewed by one person and categorized as relevant if (1) the title included one or a combination of the following terms: routine immunization, infant (or child) health service utilization, immunization coverage (or survey), coverage of measles vaccine (or other specific EPI vaccine: BCG, polio, diphtheria, tetanus, pertussis, hepatitis B, *Haemophilus influenzae* type b or rubella), or (2) the abstract, if available, described routine immunization and reasons or factors related to a child’s vaccination status. Articles reporting findings related to immunogenicity studies, non-EPI vaccines, adult vaccination, immunization policies (e.g., optimal vaccination schedules), mass immunization campaigns, or the epidemiology of vaccine preventable diseases were excluded.

2.2. Article review

Full articles for titles and abstracts assessed as relevant were retrieved through internet searches, directly from PubMed, and the CDC library article request service. If the full article could not be obtained from one of these sources, it was categorized as ‘Not Found’. Additionally, 13 articles in press with the BioMed Central’s Journal supplement on International Health and Human Rights at the time of this review were received directly from the International Development Research Centre (IDRC), Canada. These articles were prepared with support from the Canadian International Immunization Initiative Phase 2 Operational Research Grants, specifically addressed reasons related to non-vaccination and under-vaccination in low income countries, and at the request of the World Health Organization were added to the

review of articles identified through Medline and non-Medline databases.

All articles were initially reviewed by one member of a team of CDC public health specialists to determine overall relevancy. If the article appeared relevant, the article was reviewed by two persons using a standardized abstraction form to obtain information on the article title, publication date, study type, country in which the study was conducted, and reasons related to non-vaccination and under-vaccination. Reviewers additionally assessed whether each article met the following 10 quality criteria: (1) study question/hypothesis/purpose of the project was defined, (2) target population was defined, (3) methods were described, (4) recruitment or sampling strategy was defined, (5) analysis was described, (6) source of vaccination information was described, (7) resulting data were presented, (8) findings were compared with other studies, (9) limitations were addressed, and (10) major conclusions were presented. Only articles meeting at least 7 of these 10 criteria were included in the final review. This cut-off level was used to maximize the number of articles included in the review while ensuring that reasons were abstracted only from high quality articles, regardless of study type (e.g., case-control study, coverage survey, or focus group).

Completed abstraction forms were reviewed by a third person for any differences and reconciled; an additional review of the article was conducted, if necessary. All study types were eligible for inclusion, including descriptive analyses, qualitative investigations, and intervention studies. “Interventions” tested in an intervention project were considered factors or reasons for the purpose of this review. Articles not written in a WHO language or Portuguese, not discussing an EPI vaccination, not published in a peer-reviewed journal, or not describing a reason related to a child being under-vaccinated or unvaccinated were excluded.

2.3. Analysis

Information from completed and reconciled abstraction forms were entered into an EZ-Text database (version 4, Atlanta, GA), a qualitative research software product developed by CDC [9]. An under-vaccinated child was defined as any child receiving at least one but not all recommended routine EPI vaccines. An unvaccinated child was defined as one who has not received any EPI vaccines. For both groups, reasons were categorized into one of four major themes according to the “Classification of Factors Affecting Receipt of Vaccines” from *Vaccines* (5th edition) and then further classified into sub-categories according to common keywords in the abstracted reasons [10]. Each reason was weighted equally regardless of study type or study sample size and placed into only one sub-category.

These included the following:

Immunization Systems: Poor access and distance from vaccination services, inadequate vaccine supply, health worker availability and knowledge, missed opportunity to vaccinate (including non-specified missed opportunities, misuse of contraindications, lacking vaccination card [i.e., a booklet for documenting receipt of EPI vaccinations provided to each child by the child’s health care facility], and no screening for vaccination during receipt of curative services), vaccinator absent at the scheduled time for vaccinations, direct and indirect costs associated with vaccination, place of residence (living in rural or certain urban settings such as slums), low political and financial support for health system, and lack of integration with maternal health services.

Communication and Information: Inaccurate or insensitive delivery of information from health workers, lack of interaction between vaccination program and community, lack of social connection or language barriers between caregivers and health workers, and lack of mass media messaging.

Family Characteristics: Low caregiver education or literacy level, low socio-economic status, family composition (including family size, birth order, and living with extended family members), ethnicity or minority religious group, family engaged in migrant work, age and marital status of mother, and other (family problems, HIV status of caregiver, access to day care, and father as head of household).

Parental Attitudes and Knowledge: Lack of knowledge regarding vaccinations and disease prevention, fear of adverse events, belief that vaccinations are ineffective or can cause harm, lack of caregiver motivation, being a female child, mistrust of health care system, social or cultural pressure against vaccinations, and lack of family discussions on vaccinations.

3. Results

3.1. Description of articles

The literature database search resulted in 9,480 articles from the Medline® database and 6,617 articles from the seven non-Medline databases (Table 1). The initial review of titles and abstracts identified 620 relevant articles (including articles received from IDRC); of these, 202 articles were determined to be highly relevant and of high quality following full review. Of 418 excluded articles, 180 (43%) were deemed not relevant, 108 (26%) were duplicates, 59 (14%) were not published in a peer-reviewed journal, 34 (8%) had a study quality score of < 7, 22 (5%) were not found, and 15 (4%) were not in an official WHO language or Portuguese.

Of the 202 highly relevant articles, 152 (75%) were reports of cross-sectional studies, or were based on a secondary analysis of cross-sectional surveys; 22 (11%) were reports of studies assessing impact of an intervention on vaccination status; 10 (5%) were reports of anthropological investigations or results from focus groups; and 8 (4%) were systematic reviews or articles describing lessons learned from the field. The remaining 10 (5%) articles included a combination of study types (e.g., cross-sectional survey with focus group interviews). None of the reviewed expert opinion or editorial articles met the minimum study quality score.

Projects and studies described in the highly relevant articles were conducted in 51 countries; including India (49 articles), Pakistan (12), Turkey (12), Bangladesh (11), Brazil (5), Nigeria (9), Burkina Faso (6), Uganda (6), China (5), Columbia (5), Cambodia (4), Kenya (4), and South Africa (4). One to three articles described projects or studies conducted in each of the remaining 38 countries (Appendix A). Eight articles included findings from multiple-countries. Eleven articles discussing reasons associated with non-vaccination were identified; 4 studies were conducted in India and one study was conducted in Bangladesh, Benin, China, Columbia, Nigeria, Turkey, and Uganda. There was an increasing number of highly relevant articles identified during the latter part of the review period, ranging from 12 in 1999 to 30 in 2008; however, articles published in 2009 were only included if they had been published by the end of the first quarter (with the exception of the articles received directly from IDRC). There were no detectable temporal trends for the 11 articles describing reasons related to a child being completely unvaccinated.

3.2. Reasons linked to under-vaccination

A total of 838 reasons linked to under-vaccination were abstracted from the 202 highly relevant articles. Of these, 379 (45%) were immunization systems related reasons, 220 (26%) addressed family characteristics, 181 (22%) were parental attitudes

Table 1
Relevant and excluded articles by literature database source, January 1, 1999–March 31, 2009.*

	Medline®	Non-Medline**	Other†	Total
Literature database search results	9,480	6,617	–	16,097
Relevant from title and abstract review	304	303	13	620
Included following full article review	144	47	11	202
Excluded articles				
Duplicates	20	88	0	108
Article not found	0	22	0	22
Not in WHO language***	11	4	0	15
Not EPI vaccine†	18	16	0	34
Not peer-reviewed journal	15	44	0	59
No reason described	63	46	2	111
Low study quality score (< 7/10)‡	20	14	0	34
Other factors#	13	22	0	35

* Articles in press at the time of the review received directly from International Development and Research Centre (Canada) and published in October 2009

** Non-Medline databases include: Embase® (Excerpta Medica Database, Elsevier), CSA Sociological Abstracts (ProQuest), Social Services Abstracts, Educational Resources Information Center (ERIC), Cochrane, Web of Science, and CINALH® (Cumulative Index to Nursing and Allied Health Literature).

*** Not in one of the five official languages of the World Health Organization (English, French, Russian, Spanish, Arabic, and Chinese) or in Portuguese.

† Expanded Programme on Immunizations (EPI) vaccines include oral polio vaccine, diphtheria, pertussis, and tetanus, hepatitis B, measles, rubella, and *Haemophilus influenzae* type b.

‡ Article had to meet 7 of following 10 quality criteria: (1) study question/hypothesis/purpose of the project was defined, (2) target population was defined, (3) methods were described, (4) recruitment or sampling strategy was defined, (5) analysis was described, (6) source of vaccination information was described, (7) resulting data were presented, (8) findings were compared with other studies, (9) limitations were addressed, and (10) major conclusions were presented.

Includes articles discussing campaign related activities and broad policy issues.

and knowledge related, and 58 (7%) were associated with limitations or weaknesses in immunization-related communication and information.

3.3. Immunization systems

The 379 reasons linked to immunization systems were grouped into eight subcategories (Table 2). The four most frequently reported sub-categories included access or distance to services ($n=86$), missed opportunities ($n=79$), low health worker knowledge ($n=43$), and cost for vaccinations ($n=43$) which included price of the vaccination card and of the vaccines (at private clinics) as well as indirect costs of transportation and time being away from work. Missed opportunities could be further sub-divided into non-specified missed opportunities ($n=29$), incorrectly applied contraindications ($n=25$), children receiving curative services only (i.e., the child's immunization status was not assessed) ($n=13$), and not having a vaccination card at the time of the clinic visit ($n=13$). Under-vaccination was also linked to mothers with limited access to prenatal or antenatal care, and to infants born at home ($n=28$).

3.4. Communication and information

The 58 reasons linked to communication and information were grouped into four subcategories. These included the incorrect or insensitive delivery of information by health workers ($n=42$), lack of interaction between the vaccination program and community (including lack of home visits by health educators) ($n=8$), lack of social connection or language barriers between caregivers and health workers ($n=5$), and inadequate or poorly targeted media or radio messaging regarding vaccination services ($n=3$). Although communication and information was the theme least frequently linked to under-vaccination in the reviewed articles, reasons from this theme were reported by countries in all WHO regions.

3.5. Family characteristics

The 220 reasons related to family characteristics were grouped into seven subcategories. The four most frequently reported sub-categories included low education level or illiteracy of caregivers ($n=70$), low socio-economic status ($n=61$), living in a large or combined family setting or having older siblings ($n=34$), and

belonging to a minority ethnic or religious group ($n=24$). Although the education level of both parents was assessed, a low educational level of the maternal caregiver was most commonly linked to under-vaccination ($n=47$). In Uganda, children living with a HIV-positive maternal caregiver were at greater risk of being under-vaccinated compared with children whose maternal caregiver was HIV-negative.

3.6. Parental attitudes and knowledge

The 181 reasons linked to parental attitudes and knowledge were grouped into eight sub-categories. The four most frequently reported sub-categories included caregivers' lack of knowledge about immunizations and disease prevention ($n=49$), fear of adverse events ($n=27$), belief that vaccinations are ineffective or cause harm ($n=26$), and lack of caregiver motivation to vaccinate his or her child ($n=23$). Additionally, strong social and cultural (e.g., religious or traditional) beliefs against vaccinations were reported from Pakistan, Nigeria, Benin, and in certain regions of India ($n=12$) and the belief that the health systems that provided them could or should not be trusted ($n=13$). Studies conducted in India, Pakistan, Bangladesh, Nigeria, and Turkey indicated that female children were more likely than their male counterparts to be under-vaccinated ($n=20$).

3.7. Reasons linked to non-vaccination

Nineteen reasons were abstracted from 11 articles describing completely unvaccinated children. Among these reasons, eight (42%) concerned parental attitudes and knowledge, six (32%) were related to immunization systems, four (21%) were related to family characteristics, and one (5%) was associated with limitations or weaknesses in immunization-related communication and information.

Of the eight parental attitude and knowledge related reasons, three were directly related to religious and cultural beliefs against vaccinations. In certain communities in Benin, for example, vaccinations were considered "a tool of the devil" and that "only God can protect his faithful". In India, being a female child was associated with non-vaccination. Access to vaccination services ($n=4$) due to a long travel distance, living in a remote area, and civil conflict were also linked to children being unvaccinated.

Table 2

Reasons related to under-vaccination* among children living in low and middle income countries, by theme and sub-category, identified from 202 peer-reviewed articles published between January 1, 1999 to March 31, 2009.**

Theme and sub-category	Frequency
Immunization systems	
Poor access and distance from vaccination services	86
Missed opportunity to vaccinate***	79
Limited availability and knowledge of health workers	43
Costs (direct and indirect)†	43
Location of residence and service delivery (rural or urban settings)	39
Limited support (political/financial) for health system	34
Lack of integration with maternal health care services‡	28
Inadequate vaccine supply	27
Total	379
Communication and information	
Inaccurate or insensitive delivery of information from health workers	42
Lack of interaction between vaccination program and community	8
Lack of social connection or language barriers with health workers	5
Inadequate or poorly targetted mass media messaging	3
Total	58
Family characteristics	
Low caregiver education or literacy level#	70
Low socio-economic status	61
Family composition§	34
Ethnicity or minority religious group	24
Family engaged in migrant work	16
Single or older maternal caregiver	6
Other¶	9
Total	220
Parental attitude or knowledge	
Lack of knowledge on role of vaccinations and disease prevention	49
Fear of adverse events	27
Belief that vaccinations are not beneficial or cause harm	26
Lack of motivation	23
Being a female child	20
Mistrust of health care system	13
Social or cultural pressure against vaccinations	12
Lack of family discussions regarding vaccinations	11
Total	181

* Under-vaccination defined as having received at least one but not all recommended EPI vaccines.

** 11 relevant articles received directly from International Development and Research Centre (Canada) in press at the time of the review and published in October 2009 were also included.

*** Missed opportunities include incorrectly applied contraindications, vaccinator absent at the scheduled time for vaccinations, child did not have vaccination card at time of services, and lack of screening for vaccinations during curative visits to health care facilities.

† Costs include direct costs of vaccination card, vaccines, and indirect costs of time away from work and transportation cost.

‡ Mother had limited or no prenatal care or child was born at home.

Includes either parental or maternal caregiver or both.

§ Includes family size, birth order, living with extended family members.

¶ Other includes family problems (HIV infection), lack of day care, father is head of household.

3.8. Changes in reasons/factors over time

The distribution of reasons for under-vaccination according to the four major themes remained relatively constant over time, except reasons abstracted from articles published in 2004 which tended to focus on immunization systems and family characteristics (Fig. 1). The percent of all reasons which were immunization systems-related ranged from 38% in 2009 to 59% in 2004, and the percent of reasons which were family characteristic-related ranged from 15% in 2009 to 37% in 2004. Communication and information related reasons were the least frequently reported reasons each year of the 10-year review period.

4. Discussion

A number of themes related to under-vaccination and non-vaccination emerged in this review, including weaknesses in the immunization delivery system, problems with communication or information delivery, family characteristics, and parental knowledge regarding vaccination. The multiplicity of causes that we identified suggests the complex nature of this issue, and calls for a multi-faceted approach to reaching under-vaccinated and unvaccinated children. While some of these factors, such as the lack of an adequate vaccine supply and inconsistent scheduling of vaccination outreach programs, are remediable with specific interventions such as strengthening supervision and management of vaccination service delivery at the local and regional levels, others, such as parents' educational level as well as cultural values and religious beliefs, are complex and more difficult to address, and require targeted interventions.

Some factors, such as limitations or weaknesses in the immunization system, geographic barriers to receipt of immunization services, and missed opportunities to vaccinate were consistently identified over the entire review period and across all regions, suggesting that it may be feasible to develop approaches that can be adapted to and implemented in a range of settings. On the other hand, determinants of health care seeking behaviour (including the demand for immunization services) that are linked to parental attitudes and knowledge, family characteristics, cultural values, and religious beliefs are likely to be country or region specific [10], and might present greater challenges to program managers and others charged with tailoring successful strategies for accessing hard-to-reach populations. In the majority of reviewed articles, low educational level and low socioeconomic status were often highly correlated, and were associated with under-vaccination; however, the underlying explanations for these associations were rarely investigated. Also, while parents' religious backgrounds were occasionally associated with low vaccine uptake, particularly in Pakistan, India, and Nigeria, it was not always clear whether this association was due to specific religious convictions opposing vaccination or rather to perceived barriers, such as belonging to a minority ethnic or linguistic group.

Factors associated with under-vaccination varied from those associated with being completely unvaccinated, and might demand different remedial strategies. Approximately 44% of the reasons linked to being under-vaccinated were related to immunization systems, and 28% to parental attitudes and knowledge. In contrast, roughly 32% of reasons associated with being unvaccinated were related to immunization systems; whereas 42% were linked to parental attitudes and knowledge. This suggests that caregivers are likely to bring their partially vaccinated children to a health center to obtain additional vaccinations, provided there is adequate access and minimal opportunity costs (i.e. time away from work, travel distance, and need for child care while away). However, being completely unvaccinated might reflect caregiver beliefs that are unrelated to access. These issues are more difficult to address, and will likely require locally developed, targeted strategies aimed at reaching these children. This interpretation is based only 11 articles and 19 abstracted reasons related to non-vaccination. Additional research or review of the non-published literature regarding reasons for non-vaccination is required to further assess this finding.

There were a few infrequently reported findings that merit further investigation. For example, children of HIV-positive caregivers were identified as being at risk for under-vaccination in Uganda. Understanding whether this is a factor in other locations could have important implications for improving vaccination coverage in countries and regions with high HIV prevalence rates. Similarly, the lack of female health workers was identified as a reason for low vaccine uptake among children in Pakistan. This finding was not

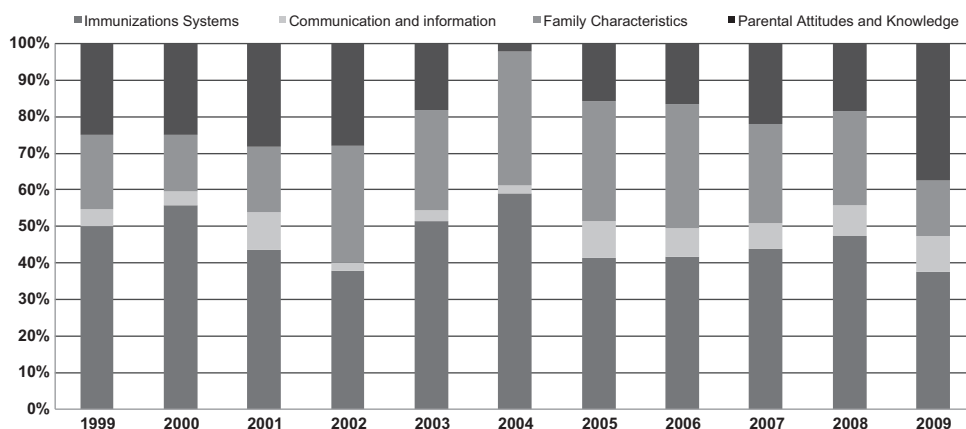


Fig. 1. Reasons* linked to under-vaccination** identified from peer-reviewed articles published from January 1, 1999 to March 31, 2009, by publication year. *Includes a total of 838 reasons from 202 articles, four themes defined in Vaccines, 5th edition. **Under-vaccination defined as a child receiving one or more but not all recommended routine vaccinations.

identified elsewhere, which could suggest a research bias, an artefact of the peer-reviewed literature, or a country-specific reason for low vaccine uptake. Finally, the association between under-vaccination and limited access to prenatal care suggests additional strategies that warrant exploration: expanding women's access to health care during pregnancy could improve prenatal care as well as provide opportunities for promotion of preventive health service for infants and children, including vaccination.

There were several limitations in this review. Although efforts were made to locate all relevant articles, the review methodology might have been unable to identify every relevant article published during the specified review period (January 1999 through March 2009). The literature database search used a broad filter to capture as many articles as possible and the review of titles and abstracts to identify likely relevant articles was conducted by one person (JJR). Due to the number and variability of articles identified by database search, some subjective judgment was employed in selecting relevant articles for full review. This subjectivity was minimized by using a set of pre-defined inclusion criteria. Nevertheless, certain titles and abstracts were not easily categorized, and a few potentially relevant articles could have been excluded during this phase of the review. Furthermore, due to time constraints, different groups of primary and secondary reviewers were responsible for the full article review and completion of the abstraction form. The use of standardized review instructions and the observed consistency of findings during the review period suggest that any potential methodological bias was likely to be minimal.

Because this review focused on qualitative reasons linked to under-vaccination from various study and project designs, assessing reasons identified through various methodologies was beyond the scope of this project. Therefore, despite different study designs and sample sizes, each reason or factor abstracted from relevant articles was weighted equally, and reasons from relatively small and large quantitative studies, as well as large and small qualitative projects contributed equally to review findings. This might have increased the relative importance of reasons that did not have a strong impact on a child's immunization status. Assessing the magnitude of such associations would be better conducted using standardized quantitative evaluations, such as the analysis of the DHS data conducted by the Swiss Tropical and Public Health Institute, another arm of this project, the results of which are described elsewhere [7].

Finally, classification of reasons into the four major themes was not always straightforward. Reasons were often complex and sometimes crossed over several categories. For example, a care-

giver who does not believe in vaccinations (a parental attitude and knowledge finding) may have received inaccurate information during a previous clinic visit (a communication and information problem). Findings reported here reflect the categorization of all reasons and factors in a standardized manner, according to the definitions provided. Overlap between the sub-categories and major themes probably occurred, but were not easily captured.

The findings from this systematic literature review only reflect the reasons and factors researched and published in peer-reviewed journals. Other reasons and factors might contribute to children being under-vaccinated or unvaccinated, but have not been researched or reported in peer-reviewed journals. As a consequence, the findings from this review should be interpreted in that light and compared with findings from quantitative analysis of immunization coverage data and information from the grey literature (e.g., unpublished reports). Collectively, information from these varied sources can be used to better understand the reasons for non-vaccination and under-vaccination, and enhance the development of effective strategies for improving vaccination coverage for all children.

5. Conclusions

The reasons for under-vaccination and non-vaccination are multi-factorial, and while no single intervention can address all identified barriers to timely childhood vaccination, some problems are more easily remedied than others. This review identified several patterns of reasons related to under-vaccination and non-vaccination of children in low and middle income countries. Many of those associated with under-vaccination were related to immunization system factors and access to services, and were consistent over time and across regions, and can be addressed by immunization program managers through known interventions: training of health workers to reduce missed opportunities, improve communication, and remove barriers by enhancing outreach services. However, other factors, such as parental education, cultural mores, the role of gender, and religious beliefs are complex, country- or region-specific, and difficult to interpret. Studies suggest that these factors might be associated more with non-vaccination than with under-vaccination. Reaching the most vulnerable populations will require innovative and targeted approaches. A more detailed investigation of the specific pathways through which certain family characteristics operate to influence vaccination behaviour would be informative and likely helpful in developing strategies to improve coverage.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.vaccine.2011.08.096.

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