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## Review

# Why children are not vaccinated: a review of the grey literature

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## ABSTRACT

In collaboration with WHO, IMMUNIZATIONbasics analyzed 126 documents from the global grey literature to identify reasons why eligible children had incomplete or no vaccinations.

The main reasons for under-vaccination were related to immunization services and to parental knowledge and attitudes. The most frequently cited factors were: access to services, health staff attitudes and practices, reliability of services, false contraindications, parents' practical knowledge of vaccination, fear of side effects, conflicting priorities and parental beliefs. Some family demographic characteristics were strong, but underlying, risk factors for under-vaccination.

Studies must be well designed to capture a complete picture of the simultaneous causes of under-vaccination and to avoid biased results. Although the grey literature contains studies of varying quality, it includes many well-designed studies.

Every immunization program should strive to provide quality services that are accessible, convenient, reliable, friendly, affordable and acceptable, and should solicit feedback from families and community leaders. Every program should monitor missed and under-vaccinated children and assess and address the causes. Although global reviews, such as this one, can play a useful role in identifying key questions for local study, local enquiry and follow-up remain essential.

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## 1. Introduction

At the request of its Strategic Advisory Group of Experts (SAGE), in 2009 WHO asked the IMMUNIZATIONbasics Project (<http://www.immunizationbasics.jsi.com/>) to review the grey literature on the epidemiology of the unimmunized child to learn which children had no or incomplete vaccinations and why. Simultaneously, the Swiss Tropical Institute analyzed demographic and health surveys and multi-indicator cluster surveys,<sup>1</sup> and CDC

analyzed peer-reviewed literature.<sup>2</sup> Findings from these reviews were presented at the October 2009 SAGE meeting. WHO is building on these reviews to further examine the influence of sex and gender on vaccination.

## 2. Materials and methods

IMMUNIZATIONbasics identified documents by posting a call for documents on the TechNet and CORE Group websites (<http://www.technet21.org/>; <http://www.coregroup.org/>), asking WHO headquarters to contact WHO field staff, searching personal files, networking, and searching several online databases.

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#### Box 1. Documents included in this review

##### When written:

24 from 1980–1989, 52 from 1990–1999, 50 from 2000–2009

##### Types of documents:

36.5% reports and other documents from international organizations, 27.9% journal articles, 25.4% field project reports, 10.2% other

##### Types of studies:

22 missed opportunities studies or synopses of them, 8 GAVI Alliance-funded 'barrier studies'; most others were formative research, assessments, and investigations of reasons for low coverage

##### Scope of studies:

44.3% national, 40.6% sub-national, 15.1% district or smaller

##### Projects by region:

53.9% Africa, 33.0% Asia, 7.8% Latin America, 3.5% Middle East, 1.7% Europe

##### Countries with the most projects:

India (18), Kenya (11), Bangladesh (10)

Researchers read approximately 160 documents, of which 126 contained relevant information on which children are under-immunized (have no or insufficient vaccinations for age) and what factors are associated with their status. Each document included in this review had to: address routine immunization services to young children in poor or middle-income countries, describe activities carried out since 1980, and report on systematically-collected information about children's vaccination.

Of the 126 documents (see Box 1), 111 were on immunization in one or a few countries; 15 documents were reviews of many country studies. Most documents were in English but some were in French or Spanish. The grey literature reviewed ranged from formally published documents to photocopies from personal files. Journal articles that were clearly peer-reviewed were excluded.

Two reviewers developed a format for summarizing relevant information, then separately reviewed several of the same documents to test both the summary format and inter-reader variability. They reviewed the summaries and counted the number of projects or programs for which documents identified particular factors as significant determinants of under-vaccination. As described below, they also carried out a more qualitative analysis of selected studies.

In agreement with CDC colleagues, this review used the 'Classification of Factors Affecting Receipt of Vaccines' in Hadler et al. to categorize findings.<sup>3</sup> The main clusters of factors are: Immunization System; Communication and Information; Family Characteristics; and Parental Attitudes/Knowledge. While this classification sufficed, IMMUNIZATIONbasics added new sub-factors under the main clusters.

### 3. Results

This section describes the key factors found to cause or be associated with under-vaccination of children in

developing countries. Table 1 displays the number of programs for which each factor was mentioned, plus the number of mentions as a major factor in documents that generalized about many programs. Factors mentioned fewer than 10 times are not included.

The numbers next to factors provide a general indication of importance but should not be considered as precise indicators, because: study methodology influences the types of factors found; coding required judgments on both what was significant and how to classify particular information; and factors are often inter-related and overlapping.

Service factors and parental attitudes and knowledge emerged as the most important categories. Although mentioned frequently, family characteristics appear to be more risk factors than determinants. For example, poverty increases the risk of mothers having competing priorities, being socially alienated, mistreated by health workers and encountering financial barriers. Lack of communication did not emerge as a major factor, in part because it often was classified under parental knowledge or poor health worker performance.

The complete report<sup>4</sup> discusses many more determinants of under-vaccination. The most frequently cited factors are discussed below.

#### 3.1. The most frequently cited factors

##### 3.1.1. Distance/travel conditions/access (49)

Numerous studies document service inaccessibility as an important cause of partial or under-vaccination. More than a third of mothers in a six-state survey in Nigeria claimed distance/access as a problem, as did 43% in Siaya, Kenya, and 30% in Liberia.<sup>5–7</sup> A 2003 Mozambique study found distance to services to be the major obstacle to vaccination.<sup>8</sup> A Senegal study found that 71% of children completely vaccinated lived less than 10 km from the nearest health center, while in remote villages only 10% of children were completely vaccinated.<sup>9</sup>

##### 3.1.2. Poor health staff motivation, performance/competence and attitudes (49)

Attitudes and behavior of health staff – treating mothers in an unfriendly, disrespectful, or even abusive manner – are frequently cited as discouraging children's vaccination. Health staff reportedly screamed at mothers who forgot the child's card, missed a scheduled vaccination appointment, or had a dirty, poorly dressed, or malnourished child. Mothers felt humiliated and discouraged from returning (e.g. in Ethiopia,<sup>10</sup> Zimbabwe,<sup>11</sup> Niger,<sup>12</sup> Kenya,<sup>13</sup> Bangladesh,<sup>14–16</sup> West Africa,<sup>17</sup> Uganda,<sup>18</sup> Benin,<sup>19</sup> Nigeria<sup>20</sup> and Syria<sup>21</sup>).

This factor was not prominent in all settings. In Uganda only 13% of over 1000 women interviewed complained about being treated rudely.<sup>18</sup> Over 90% of mothers in the Dominican Republic said that the staff treated them well, although the majority complained about waiting too long for service and wasting trips because the needed vaccine or vaccinator was absent.<sup>22</sup>

Even where extreme behavior is not normal, health workers commonly communicate little and poorly with mothers, so that some mothers leave not knowing when

**Table 1**  
Main factors associated with under-vaccination of children

Most mentioned factors	No. of mentions as a key factor
Immunization system	
Distance (travel conditions/access)	49
Poor health staff motivation and attitude (performance/competence, knowledge, ability to communicate with mothers)	49
Lack of resources/logistics (e.g., insufficient funding and stock outs which affect reliability, missed opportunities to immunize and cold chain)	48
False contraindications (particularly children sick, too old, under-weight) as factor for health workers and/or parents	47
Failure to use all opportunities (e.g., not screening; refusal to vaccinate eligible child due to false contraindications, fear of giving multiple antigens together, mother from another catchment area, mother forgot card and confusion about appropriate age for child to be immunized)	37
Unreliability (cancellation of sessions because provider absent, lack of supplies or fuel; other work priorities)	34
Inappropriate/limited service hours (limited days/hours; sessions begin late/end early)	30
Waiting time	29
Informal, illegal charges, indirect costs such as transportation	21
Lack of promotion/follow-up of routine immunization/health communication	13
Official fees and charges	10
Communication and Information	
Lack of promotion/follow-up of routine immunization/health communication	13
Family characteristics	
Low income/socioeconomic status	18
Recent/seasonal migrants	16
Low educational level (maternal and paternal)	15
Parental attitudes/knowledge	
Lack of parental knowledge on who, when, where	58
Fear of side effects	47
Conflicting priorities	43
Religious/cultural/social beliefs/norms and rumors	41
Low perceived importance of vaccination for child's health; attitude that it is better to treat illness (than prevent)	30
Lack of perceived efficacy of vaccine	27
Lack of interest/motivation	19
Lost/unavailable health cards	18
Low demand/acceptability of vaccination	15
Limited autonomy of women/father or mother-in-law pressuring against/husband refusal	15
Perceived lack of safety of vaccine/fear of multiple doses/of vaccination procedures/of dirty needles	13
Feeling of alienation because not in majority cultural/social group or otherwise unaccepted, embarrassed)	13
Perception that child is too sick, too weak/fatalism	13
Unpleasant experiences at health services (e.g., turned away, post-vaccination abscesses, verbally abused or publicly humiliated)	11
Mistrust of health staff	11

to return and what to do about side effects (e.g., in Liberia,<sup>7</sup> Niger,<sup>23</sup> Burkina Faso,<sup>23</sup> Somalia,<sup>24</sup> Guinea,<sup>9</sup> Malawi<sup>25</sup> and Benin<sup>26</sup>). In Mozambique, three quarters of health workers said they always wrote the return dates on the child's card, but only one quarter of the cards examined actually had the date written.<sup>8</sup> Better communication was reported in programs in Uganda,<sup>18</sup> Bangladesh<sup>16</sup> and Armenia.<sup>27</sup>

Some health workers also mistreat mothers by illicitly charging for vaccination, arriving late to start vaccination sessions, and ending sessions several hours early.<sup>16,20,28</sup>

Various documents indicate that mothers' and families' general experiences with health services affect their likelihood of bringing their children for vaccination. Availability of drugs, length of waiting times, and satisfaction with how they have been treated and treatments received are also considerations.<sup>24,29,30</sup>

The documents provide some indications of why health workers act in such ways. Some (e.g. in Gambia,<sup>31</sup> Guinea<sup>32</sup> and Nigeria<sup>20</sup>) view mothers' coming late for a return date or forgetting the child's card as irresponsible behavior that justifies scolding or humiliating the mother. There is also an issue of social distance, which causes some professionals to reinforce their own status by denigrating

others, particularly the poor, unwashed, uneducated, ethnic-minority mothers who don't speak the national language. As shown by in-depth interviews with health staff in Mozambique,<sup>8</sup> Kenya<sup>13</sup> and Somalia,<sup>24</sup> health staff themselves may feel unsupported by the health system, which may increase their tendency to treat mothers inconsiderately. A report on Benin claims that staff hostility towards clients increased along with declining resources for health services.<sup>19</sup>

### 3.1.3. Lack of resources/logistics (48)

Many studies<sup>18,21,22,33–43</sup> noted that vaccine stock-outs and/or cold chain problems caused unavailability of vaccination. When parents miss work, travel long distances, wait for long hours, and then are denied service, they are naturally less likely to return for vaccination.

Vaccine stock-outs are caused by lack of funding or storage capacity, or poor ordering and distribution skills and systems. One document reported a vicious cycle in Guinea<sup>28</sup> in which public facilities lacked drugs, driving most people to private providers, which reduced resources for immunization, since facilities gained a portion of their funding through providing curative care. People in Somalia<sup>24</sup> and Kenya<sup>44</sup> became less likely to seek



vaccination because of health facilities' frequent stock-outs of medicines or failure to offer curative and other services at the time and place of vaccination.

#### 3.1.4. False contraindications (47)

A major cause of missed opportunities is health workers' refusal to immunize eligible children. Behind this are various fears and false beliefs such as that a sick child should not be vaccinated, that a child should not receive multiple vaccinations on the same visit, that a child over 12 months is 'too old' for measles vaccination, or that underweight children should not be vaccinated. The most common false contraindication concerns immunizing a sick child, which is mentioned in many studies (e.g., in Kenya,<sup>13</sup> Nigeria<sup>20</sup> and Pakistan<sup>45</sup>). Various documents reported that health workers said they delayed vaccinating a sick child for fear that the vaccination would be blamed if the child's condition worsened. Others claimed they were only doing what the mother wanted, although there was consistent evidence that mothers rarely question providers' advice.<sup>24</sup>

#### 3.1.5. Lack of parental knowledge concerning which children, when, where (58)

Many studies assume that parents' good understanding of vaccine-preventable diseases, how vaccination works, and the vaccination schedule will lead to children being vaccinated. Although some studies did find strong correlations between scientific knowledge and good immunization status, many well-implemented studies found high immunization coverage among families with extremely low scientific understanding of immunization. The bulk of evidence indicates that scientific knowledge among parents is not essential.

This is shown clearly in studies on Mozambique,<sup>8</sup> Uganda,<sup>18</sup> Indonesia<sup>46</sup> and Rwanda,<sup>47</sup> among others. Bukenya found very low levels of community knowledge and understanding of the 'scientific' foundation of immunization in Uganda, but over 90% of parents 'believe immunization is important...[there is] massive good will in the midst of lack of knowledge.'<sup>18</sup> From a study in Rwanda, Habimana concluded that 'knowledge of vaccination on the part of parents is not an important factor in vaccination coverage.'<sup>47</sup> Leach reported that in the Gambia, '29% of urban and 48% of rural mothers could not correctly name any...vaccine-preventable diseases', yet reported national coverage was 90%.<sup>48</sup>

What does seem essential is a positive attitude towards immunization: parents' belief that vaccination is good for their child's health and prevents various diseases, and their practical knowledge about services; that multiple visits are required for protection and when and where the child needs to go.

#### 3.1.6. Fear of side effects (47)

Parents commonly mention fear of side effects as a reason for not vaccinating their children, e.g. in Liberia,<sup>7</sup> Somalia<sup>24</sup> and Armenia.<sup>43</sup> In some cases, if an older sibling or acquaintance's child had side effects, parents refused vaccinations for younger children. A few documents mention that side effects become an issue when fathers or

mothers-in-law become upset and refuse to allow further vaccination.

Depending on other factors, this discomfort may or may not be sufficient to cause under-vaccination. Some mothers stated that better health worker communication, e.g., warning caregivers about the side effects, what to expect, and what to do, would reduce this problem.

#### 3.1.7. Conflicting priorities (43)

It is difficult for poor parents to travel long distances and then wait for hours for vaccination, when they should be working to feed the family that day. In addition, weddings and funerals in some countries last up to a week and lead mothers to miss vaccination appointments. In many traditional cultures, families refuse to take the baby out for vaccination during a period of post-partum seclusion. Other conflicting priorities mentioned are taking care of sick or other children, not being able to leave older children while traveling to get the younger ones vaccinated, and mothers' illness.

One study reported that many mothers in Dhaka worked two or three jobs, were exhausted and overwhelmed, and depended on older children to care for young ones.<sup>14</sup> Studies on Kenya,<sup>49</sup> Bangladesh,<sup>50</sup> Somalia,<sup>24</sup> Guinea<sup>28</sup> and other countries cited mothers' conflicting priorities as a significant cause of under-immunization. Possibly some of these claims mask other factors, but clearly conflicting priorities are an obstacle for many mothers. Unfortunately, vaccination times and locations are rarely adjusted for mothers' convenience.

### 3.2. Findings for specific countries and areas

There were 18 projects in India, 11 in Kenya, and 10 in Bangladesh. Although the numbers should be considered as no more than general indicators of importance, Table 2 lists the key factors and number of times mentioned for all countries, the three countries with the most projects described, and the 20 urban projects.

It is noteworthy that many of the main factors are quite consistent across countries, although a few stand out in particular locations; e.g. demand and illicit charges in Bangladesh and unavailable health cards in Kenya.

A more detailed analysis of urban programs vs. all programs did reveal some general differences. Factors more important in urban areas were: inconvenient times of services, informal charges, low income, low education, migrant status, fear of side effects, conflicting priorities, and belief that the child was too sick or weak to be immunized. Determinants less important in urban areas included: distance/access and negative beliefs/rumors.

### 3.3. Findings by time period

An analysis by decade might find some certain differences, but it would be impossible to determine the extent to which such differences simply reflected the most prevalent types of studies at that time. For example, since most of the missed opportunity studies were conducted in the 1980s and early 1990s, missed opportunities would probably stand out more in those decades.

**Table 2**  
Key factors, by frequency mentioned, for all countries, specific countries and urban programs

All countries	India	Bangladesh	Kenya	Urban programs
Parental practice knowledge, 58	Parental practice knowledge, 9	Fear of side effects, 8	False contraindications, 8	Fear of side effects, 12
Geographical access, 49	Lack of resources/logistics, 7	Parental practice knowledge, 7	Staff motivation, attitude, performance, 7	Parental practice knowledge, 10
Staff motivation, attitude, performance, 49	Conflicting priorities, 6	Conflicting priorities, 6	Conflicting priorities, 6	Conflicting priorities, 9
Lack of resources/logistics, 48	False contraindications, 6	Demand/acceptability of immunization, 5	Religious/cultural beliefs, rumors, 6	Staff motivation, attitude, performance, 7
False contraindications, 47	Fear of side effects, 6	Illicit charges, 5	Appropriateness of service times, 6	Appropriateness of service times, 7
Fear of side effects, 43	Religious/cultural beliefs, rumors, 5	Appropriateness of service times, 5	Geographical access, 6	Lack of resources/logistics, 6
Conflicting priorities, 43	Geographical access, 5	Parents' perceptions of importance, 5	Lack of resources/logistics, 5	False contraindications, 6
Religious/cultural beliefs, rumors, 41	Staff motivation, attitude, performance, 4	Staff motivation, attitude, performance, 4	Lost/unavailable health cards, 5	Missed opportunities, 6
Missed opportunities, 37	Service reliability, 4	Lost/unavailable health cards, 4	Parental practical knowledge, 5	Service reliability, 5
Service reliability, 34	Parents' perceptions of importance, 3	Geographical access, 3	Parents' lack of interest/motivation, 5	Low income, 5
Parents' perceptions of importance, 30	Parental practice knowledge, 3	Gender issues, 3	Perceived efficacy of vaccination, 5	Low education, 5
Appropriateness of service times, 30	Low income; parents' lack of interest/motivation; lack of promotion; waiting time; illicit charges, 3 each	False contraindications; perception that child too sick/weak; religious/cultural beliefs, rumors; lack of resources; costs and regular charges, 3 each	Parents' perceptions of importance; waiting time; fear of side effects, 4 each	Parents' perceptions of importance, 5

The main factors in a specific time and location do not appear to be very predictable. For example, Blanchet described insulting treatment of mothers in urban Dhaka in 1991.<sup>14</sup> Although clearly there have been changes in Bangladesh in the last 20 years, Khan in 2005<sup>15</sup> and Perry et al. in 2007<sup>51</sup> reported similar behavior by health staff in Dhaka. Perry, in 1996,<sup>16</sup> however, reported that mothers in Dhaka considered providers in general to be knowledgeable and friendly.

### 3.4. Influence of sex and gender on vaccination

According to the WHO web page on Gender, Women and Health (<http://www.who.int/gender/whatisgender/en/>), gender refers to 'socially constructed roles, behaviours, activities and attributes that a given society considers appropriate for men and women,' and sex refers to the 'biological and physiological characteristics that define men and women, boys and girls.'

The grey literature reviewed indicates that sex differentials in vaccination coverage not widespread. However, particularly in south Asia, fewer girls parts of India and south Asia and are often modest. In some of these areas, more girls are not vaccinated or vaccinated later than boys, although often low income and rural residence are stronger predictors of under-vaccination than the child's sex.<sup>52</sup> Gender issues appear to be more widespread, but are not, in general, a major factor in under-vaccination. Some husbands either prohibit their wives from taking children for vaccination or women themselves are not comfortable being attended by unknown men.<sup>14</sup> Several sources mentioned that husbands might refuse permission for vaccination, particularly if the child previously had side effects.<sup>14,53,54</sup>

### 3.5. Analysis of the most complete studies

In addition to simply counting frequency of factors mentioned, IMMUNIZATIONbasics separately analyzed the most complete, reliable studies.<sup>8,10,13–16,18,22–24,28,29,33,44,54–56</sup> These selected studies:

- Sought to answer a limited number of clear questions
- Employed multiple information-gathering methods, both qualitative and quantitative
- Used qualitative methods to seek explanations, not just associations
- Used observations as well as questioning
- Interviewed both mothers/caregivers and health staff
- Linked determinants to children's vaccination status, i.e. fully immunized, partially immunized, and no vaccinations
- Reported findings from all methods and audiences on each key question in an integrated manner
- Took steps to encourage candid, unbiased answers, for example, and by avoiding use of health workers in uniform as interviewers; using earlier responses to open-ended questions and observations to construct survey questions, so that questions explored community and health worker, not just researchers', concepts and concerns

A review of these selected studies yielded nine primary and underlying factors. Interestingly, each factor has both a health system side and a family side. These key determinants of under-vaccination (not in order of importance) are shown in Figure 1. This intertwining of determinants of under-utilization too often leads to interpretations that under-immunization is the clients' fault ('insufficient demand'), when any 'fault' is truly a shared one.

The documents offered limited findings on reasons for non-vaccination versus incomplete vaccination. However, the evidence suggests that children having no vaccinations appears to be associated with: difficult access, inconvenient hours, negative beliefs/rumors/misinformation, and minority status; whereas the main reasons for incomplete vaccination appear to be: poor treatment/bad experiences, missed opportunities, fears (of side effects, abusive treatment), and lack of understanding of the need to return or when.

## 4. Discussion

### 4.1. Possible limitations of findings

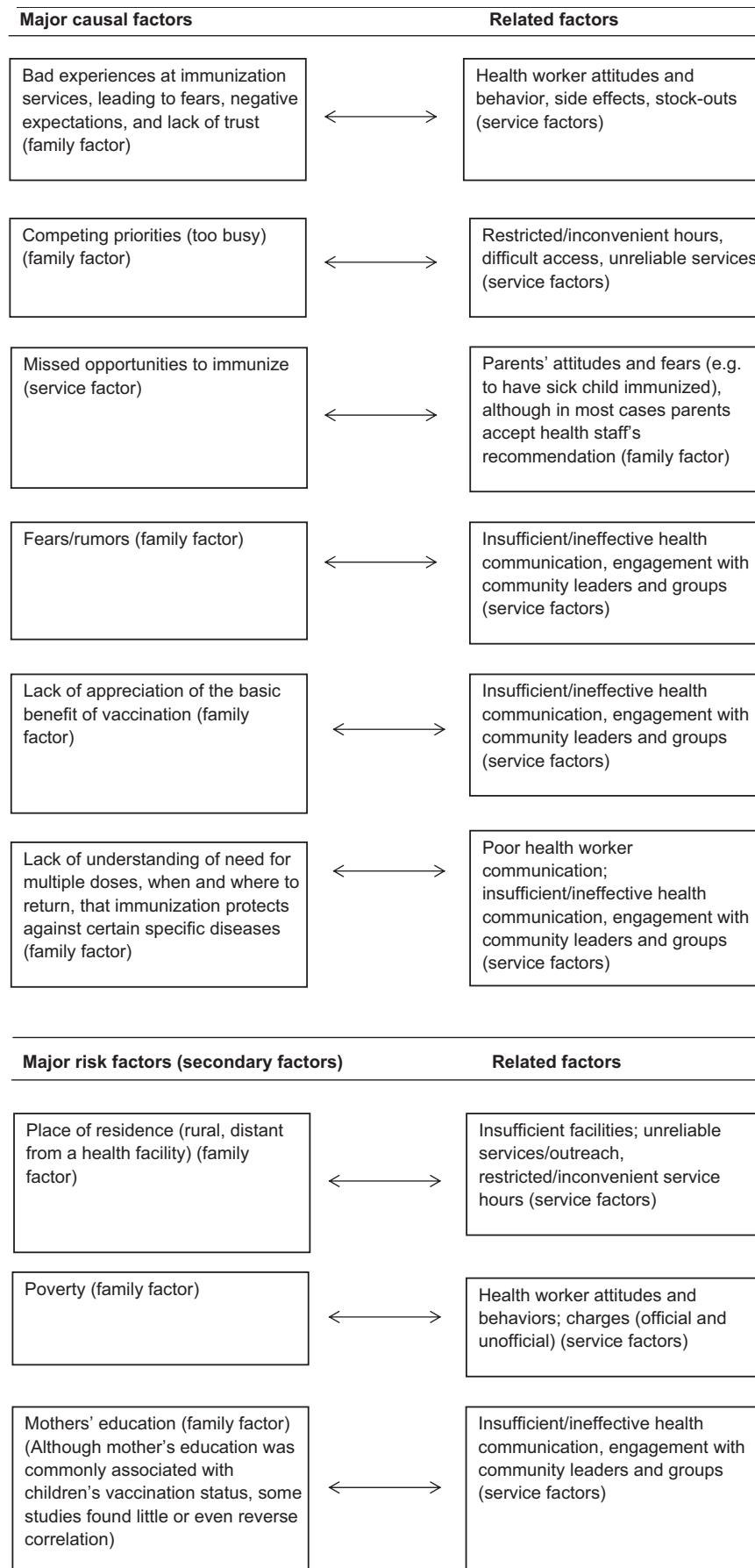
The situations, purposes, design and execution of the studies reported in the grey literature varied widely. Studies not designed and implemented with care can easily yield incomplete or unreliable information. As mentioned, the review team addressed this by emphasizing findings from the most complete and well-executed studies.

A study in Kenya illustrated the importance of meshing findings from multiple methods. The health facility assessment – consisting of observations and interviews with health staff and clients (carried out by health professionals) – found that staff carried out their vaccination tasks well and that most clients were satisfied.<sup>23</sup> 'However, focus group discussions with mothers painted an entirely different picture. Mothers described harassment and maltreatment by health workers, as well as practices contrary to KEPI (Kenya EPI) procedures, such as turning away a child who was sick or lacked a child health card.'<sup>23</sup>

The review team's search strategies are likely to have missed relevant literature in other languages as well as documents in files and on shelves of Ministries of Health and other organizations. While IMMUNIZATIONbasics does not believe that reviewing the more complete universe of evidence would change major conclusions, one cannot be certain.

Another potential limitation is the reviewers' accuracy in extracting key factors from documents. Although systematic, the process involved many judgments, so there is no guarantee that other reviewers would not reach slightly different conclusions.

Just as the best studies incorporated several methods and audiences, the grey-literature findings need to be consolidated with those from the peer-reviewed literature and analysis of surveys. It is encouraging that the CDC review of published documents, which employed much stricter criteria for inclusion, yielded very similar findings.<sup>2</sup> This supports IMMUNIZATIONbasics' contention that 'grey' does not necessarily imply poor quality.



**Figure 1.** Major determinants of child under-vaccination in developing countries.



**Box 2.** Main factors for under-vaccination and suggested program responses

Main factors	Suggested responses by health services
Parental practical knowledge	Improve quality of communication at time of vaccination (may involve training, supportive supervision, reducing crowding); disseminate practical information through community leaders/groups; provide community education/discussions
Geographical access	Analyze data to identify largest pockets of under-immunized children; map them; consult with local leaders; in micro-planning address the best mix of fixed, outreach, and mobile vaccination, reaching each area at least four times per year; plan for difficult seasonal access
Health staff knowledge, attitude, performance	Provide pre-service and in-service training (addressing attitudes specifically, if needed), supportive supervision, job aids and references, exchange visits; reward good performance; improve treatment of health staff (raise salaries, pay on time, provide sufficient resources, supportive supervision); employ more staff if justified by workloads
Lack of resources/logistics	Improve skills and performance in forecasting vaccine, supplies and equipment needs at all levels; improve efficiency of preventive maintenance and repairs; improve skills and performance in storage and transport of vaccine, supplies and equipment
False contraindications	Through training, job aids, and supportive supervision, ensure that all health staff know and accept the national contraindications policy; through supervision, assess extent and nature of false contraindications; ensure staff that their supervisors and health system support them should public doubts arise; inform community leaders, groups, and the public
Fear of side effects	Inform community leaders, groups, and the public about risks and benefits of vaccination, how to handle common side effects; improve counseling on side effects at vaccination sites
Conflicting priorities	Assess the extent to which conflicting priorities affect under-immunization; if needed, address employers through mass media or interpersonal contacts; organize special vaccination sessions at least quarterly, at a time when more people can attend
Religious/cultural/social beliefs + Parental low perceived importance + Parental lack of perceived efficacy	Consult with people (through individual or group discussions with leaders or the public) to understand their issues; work with leaders and the public to calm fears, motivate participation
Missed opportunities	At district and facility levels, hold staff discussions on how various health programs can support each other; offer vaccinations every day during facility hours and as part of integrated outreach; improve forecasting, management, and distribution of resources, including staff
Unreliable services + Inappropriate/limited hours	Make each facility director responsible for ensuring that vaccination is available every day and hour that it should be; have each facility director and appropriate district staff monitor this; post vaccination days and hours in facilities and, if possible, in communities; improve personnel policies as needed; ensure that vaccination is available when some staff are away at meetings or training; improve forecasting, management, and distribution of vaccine, supplies, and equipment; hold individual or group discussions with leaders or the public to learn if hours are inconvenient for many people, and if so, modify hours or schedule occasional special sessions
Waiting time	Make each facility director responsible for ensuring that vaccination is available every day and during hours that it should be; have each facility director and appropriate district staff monitor this; improve the conditions in the waiting area (shade, seats); use staff or community volunteers to facilitate health discussions in the waiting area (not lectures); through leaders and other means, encourage community members to come throughout the vaccination hours

While, the categories and factors used to explain non- or under-vaccination functioned adequately, individually they cannot capture the multi-causality of under-vaccination completely. Perhaps new scales and approaches might better describe both the multiple factors and the mirror-like relationship between health-service and family factors.

#### 4.2. Implications

The questions are simple – what children are unvaccinated, and why? – but the answers are complicated, often involving a multiplicity of interacting factors. Clearly, certain sociological factors put children at risk of under-vaccination – place of residence, mother's education, family income – but it is the interaction of multiple factors, in very personal ways, that leads to a particular family's decision

to have its children fully vaccinated or not. In some cases of under-vaccination, the explanation may have one simple cause, e.g., the father prohibited the mother to return after the child had a fever following vaccination, or the mother cannot miss work during vaccination hours. In other instances, the parents themselves may not be able to articulate the combination of beliefs, perceptions, knowledge and experiences.

The main factors in a specific setting cannot be predicted based on global information. The key issue in one place may be health workers' poor treatment of mothers (e.g. Nigeria<sup>20</sup> and Kenya<sup>23</sup>); while in another (e.g. Uganda<sup>18</sup>) it is that health workers stopped receiving their incentive for doing outreach; or in Cambodia<sup>57</sup> it is the health services failed to make sufficient accommodation for the Vietnamese minority. Missed opportunities were significant almost everywhere, but none were found in a

Zimbabwe study.<sup>58</sup> Thus, any one factor may range from extremely important to having no importance, which is the reason situation- and location-specific enquiry is needed, with great care taken to avoid bias, leading questions, and assumptions.

Clearly, the purpose of clarifying and assessing the magnitude of factors for under-immunization must be to enable programs to address the dominant factors in their setting. While IMMUNIZATIONbasics did not search for assessments of program responses, we can offer general suggestions based on experience and recommendations from WHO and others (Box 2).

**Authors' contributions:** MS and MF summarized and analyzed the grey literature and wrote the longer paper on which this article is based. RS, RF, and KB helped conceptualize the research. RS and RF participated in planning the research, provided source documents, and contributed many comments and suggestions on the original paper. RF summarized French documents. KB coordinated the umbrella project at WHO and provided guidance and feedback throughout the research and writing process. MF prepared the draft article and RS, RF, KB, and MS all offered comments and suggestions. All authors read and approved the final version of the paper. MF is guarantor of the paper.

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