

Immunization Coverage of Children in Care of the  
Child Welfare System in High-Income Countries:  
A Systematic ReviewJennifer S. Hermann, MN,<sup>1</sup> Robin M. Featherstone, MLIS,<sup>2</sup> Margaret L. Russell, PhD,<sup>3</sup>  
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**Context:** Children in care of the child welfare system tend to underutilize preventive health services compared with other children. The purpose of this systematic review was to assess current knowledge regarding immunization coverage levels for children in the child welfare system and to determine barriers and supports to them utilizing immunization services.

**Evidence acquisition:** Articles published in Medline, Embase, Cochrane Library, CINAHL, SocINDEX, and ERIC from January 1, 2000 to October 13, 2017 were searched. Thesis and conference databases and relevant websites were also examined. Studies were included if written in English, from high-income countries, and addressed immunizations for children in the child welfare system. Independent dual screening, extraction, and quality appraisal were conducted between October 2016 and December 2017, followed by narrative synthesis.

**Evidence synthesis:** Of 2,906 records identified, 33 met inclusion criteria: 21 studied coverage, two studied barriers/supports, and ten studied both. Nineteen studies were moderate or high quality and thus included in the narrative synthesis; 15 studied coverage, one studied barriers/supports, and three studied both. Most studies found lower coverage among children in child welfare. The few studies that explicitly studied barriers/supports to immunization identified that a collaborative and coordinated approach between health and social services was key to service delivery to this population.

**Conclusions:** This review highlights that children in care of the child welfare system are at risk of poor immunization coverage. There is a need for high-quality studies on this issue, with a focus on assessing supports/barriers to immunization in this population.

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## CONTEXT

The child welfare system offers supports and interventions to children and families when there is concern for the child's safety and well-being.<sup>1</sup> Children in care of the child welfare system ("children in care") may reside in various settings, including the family home and out-of-home care (e.g., foster care and kinship care). This population often has greater developmental, physical, and psychosocial needs than children not in care.<sup>2–6</sup> Preventive health services are a key component of ensuring the well-being of all

children, but children in care may face particular challenges in accessing preventive health care because of

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unstable living circumstances and inconsistent care providers.<sup>4</sup> This may be especially true for access to immunization services, as obtaining all the requisite vaccine doses to achieve adequate protection requires attendance at multiple appointments over a period of time.

Given the critical role of immunizations in the protection of individual and public health,<sup>7</sup> it is important to understand whether disparities in immunization coverage are present in this vulnerable population. A recent review that focused on immunizations among children in care in the United Kingdom found that these children are less likely to be immunized than their counterparts.<sup>8</sup> To understand the extent of the problem for children in care across all high-income countries, a systematic review was conducted to (1) assess the state of knowledge regarding vaccine coverage and barriers/supports to immunization for routine childhood vaccines in high-income countries (as defined by the World Bank<sup>9</sup>), and (2) synthesize the literature to identify trends in coverage, barriers, and supports, in order to guide future policy and practice recommendations.

## EVIDENCE ACQUISITION

This systematic review followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines<sup>10</sup> and was guided by a published protocol<sup>11</sup> that was registered with PROSPERO (CRD42016047319). A brief summary of the methods and analysis plan are provided below. The detailed protocol, including search terms, can be found in the published protocol.<sup>11</sup> No ethics approval was necessary for this study.

This search sought out published and unpublished, English language, original research of any study design produced between January 1, 2000 and October 13, 2017. Published peer-reviewed articles indexed in MEDLINE, Embase, Wiley Cochrane Library, CINAHL, SocINDEX, or ERIC were searched, as well as unpublished works through searches of Conference Proceedings Citation Indices, and websites of key international, national, and provincial organizations in high-income countries. The reference lists of included studies were also searched for additional eligible articles. Articles were screened for inclusion in two stages, titles and abstracts followed by full-text review. Both stages were conducted in duplicate by two reviewers. Discrepancies in screening decisions were resolved through discussion, or adjudication by a third reviewer if necessary. To be included articles needed to meet the following criteria: (1) assess coverage, barriers, and/or supports for routine immunizations for children receiving child welfare services of any kind; (2) focus on children aged  $\leq 17$  years; and (3) be based in a high-income country, as defined by the World Bank.<sup>9</sup> For the purpose of this review, immunization coverage is the proportion of eligible children in the study population who received the vaccines being studied. Routine immunizations were based on the recommended immunization schedule from the study setting, as defined by the author. Duplicate data extraction of relevant content was conducted by two team members. Variables that were extracted are listed in the published protocol.<sup>11</sup>

Study authors were contacted by e-mail to seek any relevant information missing from the publication.

Quality/risk of bias was assessed for each included study using tools specific to the study design (Newcastle-Ottawa Scale<sup>12</sup> for case-control and cohort studies, adapted Newcastle-Ottawa Scale for cross-sectional studies,<sup>13</sup> and Mixed Methods Appraisal Tool<sup>14</sup> for qualitative and mixed-method studies). To produce a standardized measure of quality appraisal, regardless of the tool used, the numerator was divided by the denominator. Quality assessments were conducted in duplicate, with discrepancies resolved through discussion or adjudication by a third reviewer, if necessary. When missing data were obtained from study authors, the quality assessment score was revised to reflect the quality of the study (versus the quality of reporting). Publication bias was assessed by including a grey literature search for unpublished works in the field.

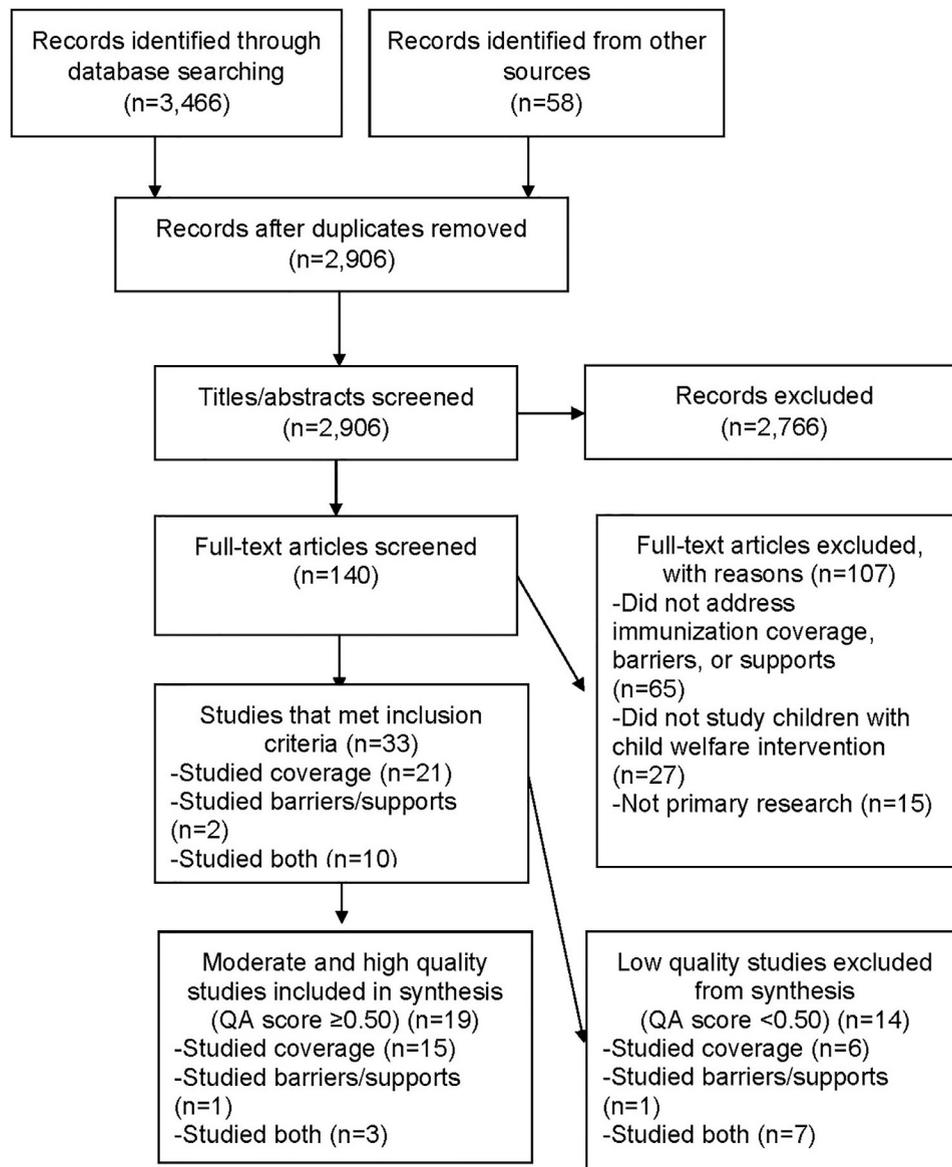
The search and screening results were presented per PRISMA guidelines. The characteristics and findings of all included studies were reported in tabular format. Only the findings from moderate- and high-quality studies were analyzed through narrative synthesis. The outcomes (coverage and barriers/supports) were assessed relative to data source, publication type, and presence/absence of comparison group. For the purpose of synthesis, studies that did not have a comparison group were divided into two groups based on calculated coverage levels for children in care:  $\geq 80\%$  vs  $< 80\%$ . This cut off was chosen based on WHO statements that 80% is considered “high immunization coverage”<sup>15</sup> and is the target minimum coverage for children aged  $< 5$  years in each district in a nation.<sup>16</sup> Identified barriers and supports, including the effectiveness of interventions, were described.

## EVIDENCE SYNTHESIS

There were 33 studies that met inclusion criteria (Figure 1). Of these, 21 measured immunization coverage,<sup>17–37</sup> ten studied both coverage and barriers/supports to immunization,<sup>38–47</sup> and two studied only barriers/supports.<sup>48,49</sup> The heterogeneity in the study design, data sources, inclusion of comparison group, type of care settings, and period of time children were in care precluded meta-analysis of results. Instead, a narrative synthesis of the findings is presented.

### Characteristics of Studies

The characteristics of included studies are presented in Appendix Table 1, (available online). The studies primarily came from the United Kingdom ( $n=15$ ),<sup>18,20,24,26,28,30–33,36,38,39,41,43,46</sup> the U.S. ( $n=9$ ),<sup>19,22,23,29,37,40,42,48,49</sup> and Australia ( $n=6$ ),<sup>17,27,35,44,45,47</sup> with a smaller number from Italy ( $n=1$ ),<sup>21</sup> and Sweden ( $n=2$ ).<sup>25,34</sup> They included 29 peer-reviewed journal publications, three government reports, and one thesis. Study designs included cross-sectional ( $n=22$ ),<sup>17–22,24–28,30–37,44,47,49</sup> case-control ( $n=1$ ),<sup>23</sup> prospective and retrospective cohort ( $n=2$ ),<sup>29,40</sup> retrospective cohort with pre-/post-intervention assessments ( $n=3$ ),<sup>38,41,43</sup> mixed methods ( $n=3$ ),<sup>42,45,46</sup> mixed methods



**Figure 1.** PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram. QA, quality appraisal.

with pre-/post-intervention ( $n=1$ ),<sup>39</sup> and qualitative ( $n=1$ ).<sup>48</sup> A variety of data sources were used to determine immunization status of children, including caregiver or self-report ( $n=5$ ),<sup>19,29,31,32,37</sup> caregiver or self-held record ( $n=1$ ),<sup>42</sup> child welfare data ( $n=6$ ),<sup>17,28,36,39,43,47</sup> community health records ( $n=2$ ),<sup>25,38</sup> electronic health database ( $n=5$ ),<sup>18,20,23,40,46</sup> medical records ( $n=4$ ),<sup>21,22,27,34</sup> electronic immunization databases ( $n=1$ ),<sup>24</sup> and mixed data sources ( $n=7$ ).<sup>26,30,33,35,41,44,45</sup> Very few studies ( $n=7$ )<sup>18,21,24,26,33,38,46</sup> reported on coverage for specific vaccines, whereas the remainder did not specify or reported more broadly on “age appropriate” or “recommended vaccines.”

Terminology, setting, and time in care varied by study. Included studies used various terms to describe immunization coverage, such as “up-to-date immunizations,” “fully immunized,” or “incomplete immunizations.” In some cases, authors did not define these terms, making it unclear whether they meant that the child had received all age-appropriate immunizations and whether these terms encompassed timeliness of immunization. Authors from different countries used different terminology for children in care (e.g., “looked-after children” is typically used in the United Kingdom, “out-of-home care” is more common in Australia, and “foster care” is common in the U.S. and the United Kingdom). It was

not always clear from the article whether these terms captured comparable types of care status, especially as many studies also used specific terms (e.g., foster care and kinship care) to identify subsets of children in care. Some studies specified that they studied children in more than one type of care setting (e.g., foster care, residential care), whereas others did not describe the type of care setting beyond the broad terms of looked-after or out-of-home care. Four studies compared coverage between groups of children in different care settings within the child welfare system.<sup>19,27,29,37</sup> The majority of studies ( $n=15$ )<sup>17,19,20,23,24,26,27,29,37–40,42,44,46</sup> did not describe how long the children had been in care before the study period, whereas others included children who had been in care varying lengths of time ( $n=4$ ).<sup>21,32,33,35</sup> Others studies looked at more defined periods of time in care, including in care  $\geq 3$  months ( $n=1$ ),<sup>25</sup>  $\geq 6$  months ( $n=2$ ),<sup>18,31</sup> or  $\geq 12$  months ( $n=2$ ).<sup>28,36</sup> Yet, others looked at children who had recently entered care ( $n=7$ ),<sup>22,30,34,41,43,45,47</sup> with two of these studies comparing coverage upon entry into care to coverage after children were established in care.<sup>41,43</sup> Two of the studies assessing barriers/supports to immunization did not study any children in care, instead focusing on nurses<sup>49</sup> or foster caregivers.<sup>48</sup>

Fourteen of the included studies were of low quality (score  $< 0.50$ ),<sup>32–37,41–47,49</sup> 12 were moderate quality (score  $\geq 0.50$  to  $< 0.75$ ),<sup>17–21,26–31,39</sup> and seven were high quality ( $\geq 0.75$ ).<sup>22–25,38,40,48</sup> The most common reasons for a study being assessed as low quality were lack of a comparison group or the study not being focused specifically on immunization (i.e., it focused more broadly on child health and thus lacked the necessary information specific to immunization, even after follow-up with authors). In order to ensure that recommendations for policy and practice are guided by the best evidence available, the findings of only moderate- and high-quality studies were synthesized and presented.

## Immunization Coverage

Appendix Table 2, (available online) presents the study findings from all articles, with moderate- and high-quality studies presented first. Of the 31 studies that measured immunization coverage, 18 were moderate or high quality.<sup>17–31,38–40</sup> Of these, ten had a comparison group<sup>18,21–26,31,38,40</sup> of the general population or children not in care. Nine of these found children in the child welfare system to have lower coverage than other children<sup>18,21–26,31,38</sup> and one found higher coverage.<sup>40</sup> Of the other eight studies (including all the government reports<sup>19,28</sup>) that did not have a comparison group of children in the general population or not in care, the

majority ( $n=5$ ) found  $\geq 80\%$  immunization coverage among children in the child welfare system<sup>17,19,20,28,29</sup>; the remaining three found  $< 80\%$  coverage.<sup>27,30,39</sup> Of these eight studies without a comparison group, three compared immunization coverage between groups of children in care by type of care setting.<sup>19,27,29</sup> One of these found no statistical difference in immunization coverage between those in foster care and parental care<sup>27</sup> and another found no significant difference in immunization coverage between foster care and kinship care.<sup>29</sup> The third study found that children living in the parental home were significantly less likely to be immunized than those in kinship care, foster homes, and residential care, though the difference in coverage was minimal.<sup>19</sup> Studies that reported immunization coverage by age found that older children in care were less likely to have received the recommended immunizations for their age than younger children.<sup>17,24,31,38</sup>

Of the five high-quality studies that reported coverage for specific vaccines, the vaccines assessed included: diphtheria, tetanus, pertussis, and polio<sup>18,21,26,38</sup>; *Haemophilus influenzae* type b<sup>18,21,38</sup>; pneumococcal<sup>21</sup>; meningococcal<sup>21,24</sup>; tuberculosis<sup>21,38</sup>; varicella<sup>21</sup>; and measles, mumps, and rubella.<sup>18,21,26,38</sup> All five studies had a comparison group or comparable data from the general population, and all were published in the United Kingdom between 2003 and 2005, except for one<sup>21</sup> that was published in Italy in 2016. The vaccines most consistently assessed in these five studies were diphtheria, tetanus, pertussis, and polio (coverage of 80%–91% among children in care compared with 95%–100% for children in the comparison group/general population) and measles, mumps, and rubella (coverage of 75%–87% compared with 80%–100% for children in the comparison group/general population). Vaccine coverage for children in care was consistently lower than the comparison group/general population, with only one exception (in which measles, mumps, and rubella coverage was the same in both groups).<sup>18</sup>

## Immunization Barriers and Supports

Of the 12 studies that assessed barriers/supports to immunization,<sup>38–49</sup> only four were of moderate or high quality.<sup>38–40,48</sup> Of these, three studies identified barriers/supports that arose during specific program evaluations<sup>39,40</sup> or interventions<sup>38</sup> aimed at improving immunization services to children in care. Only one was a qualitative study, which conducted interviews of foster caregivers to identify barriers and supports to accessing immunization services.<sup>48</sup>

Of the few moderate-/high-quality studies that explicitly studied barriers/supports to immunization, a common barrier identified was discontinuity of care ( $n=3$ ).<sup>38–40</sup>

Placement moves and changes in social workers were factors identified as contributing to this issue ( $n=1$ ).<sup>38</sup> Other identified barriers were the needs of children being seen as someone else's responsibility ( $n=1$ )<sup>39</sup> and lack of coordinated care ( $n=1$ ).<sup>40</sup> One study found, contrary to the authors' expectation, that identifying missing vaccines to social services did not bring children up-to-date in their immunizations.<sup>38</sup> Incomplete or lack of immunization history was also identified as a barrier ( $n=1$ ).<sup>39</sup> Interviews with foster caregivers found that forgetting appointments and hectic home lives were barriers to attending medical appointments.<sup>48</sup>

Identified supports included services designed to improve continuity of care, such as a specialized nursing service<sup>39</sup> and an Expanded Medical Home Model.<sup>40</sup> These programs were found to be successful in improving immunization status for children in care, as they addressed inter-agency partnership and a lack of coordinated care. Foster caregivers stated that they were more likely to bring children to medical appointments when they had a positive healthcare experience, had a system in place for remembering appointments, and viewed the appointment as necessary.<sup>48</sup>

There were additional studies that did not explicitly study barriers/supports, but noted them based on the study context and experiences.<sup>17,18,24,26,30</sup> These suggest barriers to immunization included: a lack of coordination and communication,<sup>17,24</sup> discontinuity of care,<sup>24</sup> poor record keeping,<sup>17,18,30</sup> greater number of placement moves,<sup>24,38</sup> and social workers not prioritizing medical needs of children.<sup>26</sup>

## DISCUSSION

This systematic review identified 19 moderate- or high-quality studies that focused on immunization coverage and barriers and supports to immunization for children in care. There was much variability in the study design, data sources, inclusion of comparison group, type of care settings, and period of time children were in care. The majority ( $n=12$ ) of moderate-/high-quality studies found that immunization coverage among children in care was less than 80% (when no comparison group) or less than children not in care.<sup>18,21–27,30,31,38,39</sup> Few studies explicitly studied barriers and supports to immunization. Of those that did, discontinuity of care<sup>38–40</sup> was the most common barrier identified, and programs that support collaboration and coordination were found to promote immunization coverage.

### Immunization Coverage for Children in Care

**Influence of placement type on immunization status.** Most studies did not clearly describe the type of care

settings. In addition, the variability of terms used for children in care across countries made it difficult to assume that study populations were comparable. For those studies that did explicitly identify care placement, there was no apparent association between type of care and children's immunization coverage. A small subset of studies<sup>19,27,29</sup> compared immunization coverage among different types of care settings. One of these found that children living at home with their parents were less likely to be immunized than those in formal/informal kinship care or foster care/group homes.<sup>19</sup> However, immunization status in that study was self-reported, and though a statistically significant result was found, the small difference likely lacked clinical significance. Two smaller studies found no statistically significant differences in coverage for different types of care setting,<sup>27,29</sup> although the small sample sizes may have limited the power to find existing differences. Further research with larger sample sizes and reliable sources of immunization data is needed to identify whether specific placement types influence immunization coverage.

### Influence of time in care on immunization status.

One might anticipate that immunization coverage increases with amount of time children spend in care, as the welfare system could intervene to improve care to this vulnerable population. However, there is no evidence to support this hypothesis. In fact, most ( $n=11$ ) of the moderate-/high-quality studies did not even report time in care for their study population.<sup>17,19,20,23,24,26,27,29,38–40</sup> Of note, two low-quality studies looked at statutory assessments that occur once a child is in care and their impact on immunization coverage among a small sample of children, and neither found a significant increase in coverage.<sup>41,43</sup> It would be important in future research to look at immunization at the time children are taken into care and compare this to immunization coverage once the child is established in care. This would discern whether the contributors to low coverage are a result of circumstances prior to entry in care or due to a failure of the welfare system to improve immunization service delivery.

**Influence of study design and data sources on validity of study findings.** Although characteristics of children in care (e.g., placement type and time in care) may influence actual immunization coverage, other attributes of the study itself (e.g., data sources and study design) may influence the validity of immunization coverage measurement. For instance, the level/adequacy of immunization coverage appeared to be related to the immunization data sources used, suggesting that data source may introduce some bias in measurement and thus influence validity of study findings. For instance, of studies that used health records, medical records, immunization databases, or health databases ( $n=10$ ),<sup>18,20–25,27,38,40</sup>

all but two<sup>20,40</sup> found coverage was lower among children in care ( $n=7$ ) or less than 80% (when there was no comparison group;  $n=1$ ). The two exceptions looked at groups of children who may experience higher coverage than other children in care: those considered for adoption<sup>20</sup> and those participating in an Expanded Medical Home Model.<sup>40</sup> By contrast, two of the three studies<sup>19,29,31</sup> that obtained immunization data from caregiver- or self-report<sup>19,29,31</sup> and two of the three studies<sup>17,28,39</sup> that used data from child welfare found immunization coverage of 80% or more.<sup>17,19,28,29</sup> This is not altogether surprising, as self-/caregiver-report has been shown previously to overestimate immunizations received.<sup>50</sup> Immunization data obtained from child welfare sources may also be of questionable accuracy, although difficult to confirm, as it is unclear from the study reports where child welfare obtained their immunization data. It is noted that multiple studies reported that poor sharing of information between health services and child welfare services was a concern.<sup>17,33,39–41,46</sup>

Other factors, such as presence/absence of a comparison group, may also have influenced study findings. For instance, the majority of moderate-/high-quality studies found low-immunization coverage for children in care<sup>18,21–27,30,31,38,39</sup> and most of these studies included a comparison group of children in the general population or not in care.<sup>18,21–26,31,38</sup> By contrast, all but one<sup>40</sup> of the studies that found higher/equal coverage in children in care<sup>17,19,20,28,29</sup> did not have a comparison group. The one study that did have a comparison group occurred where an Expanded Medical Home Model was put in place to improve health outcomes of children in care.<sup>40</sup> The majority of studies without comparison groups found coverage of 80% or more.<sup>17,19,20,28,29</sup> However, one of these studies looked specifically at children considered for adoption<sup>20</sup> who may receive services to improve their immunization coverage. Two other studies were government reports<sup>19,28</sup> and another used government data.<sup>29</sup> These sources may overestimate immunization coverage, as outcome-reporting bias has been known to occur in government reporting.<sup>51</sup>

**Study country.** There was no pattern in immunization coverage levels depending on country of study. Even multiple studies conducted in a single country lacked consistent results. This may be reflective of different models of healthcare service provision between regions in some countries, or may reflect other factors, such as differences in study design, immunization data source, type of publication, or changes in service delivery over time. For example, older publications from the United Kingdom<sup>26,31</sup> found lower coverage among children in care, whereas newer research found higher coverage.<sup>30,36</sup> This could be because of action taken over

time, or may reflect the fact that the high coverage reporting was from a government report that used social service data and only included looked-after children who had been in care continuously for at least one year. A previous systematic review of the literature that focused on UK studies suggests that the immunization status of children in care is improving,<sup>8</sup> and that immunization coverage varies by region, with certain regions changing their practice to improve immunization rates. They also note that Northern Ireland, which has integrated health and social services, reports higher rates of immunization for children in care.<sup>8</sup>

### Barriers and Supports to Immunization

There is a paucity of literature explicitly examining barriers and supports for immunization among children in care. Only three studies assessed whether specific interventions and factors were associated with higher/lower immunization among these children.<sup>38–40</sup> One found that providing social services with information on missing vaccines ( $n=54$ ) was not successful; none of the children's immunizations were brought up-to-date post-intervention.<sup>38</sup> The other two studies suggest that the most promising interventions are those that seek to bridge inter-agency silos and address discontinuity of care. One U.S. state with an Expanded Medical Home Model was found to have higher immunization coverage for children in care than other states.<sup>40</sup> In this context, there are 20 "lead agencies" that aggressively search, gather, and coordinate medical records for children entering care. This information is passed to the primary care physician (who has received training on the unique needs of children in care) before the comprehensive health evaluation. Lead agencies ensure health history and medical records are passed to new lead agencies/physicians when a child moves placements. Further, case management agencies and local health departments collaborate with the primary care physician to create an individualized service plan for all children under age 6 years to identify primary care referrals and ensure appointment attendance. These agencies also ensure and document that children in care are current for well-child exams and immunizations. Another effective intervention, a specialized nursing service in Scotland, found that linking health and social services improved immunization rates.<sup>39</sup> This service included nurses who mapped existing services for children in care, responded to health requests, provided health promotion teaching and activities, acted as a liaison between health professionals and social care to ensure children's needs were met, identified local healthcare needs, and ensured health recommendations and documentation were followed. In both of these studies,<sup>39,40</sup> a healthcare

member/team took responsibility for appointments, documentation, and information sharing. The tenets of these programs are promising and could be implemented and evaluated in other settings.

The one qualitative study of foster caregivers' perceived barriers/supports provides potentially important information.<sup>48</sup> This study emphasized the need to make the clinic setting and organization easily accessible to foster families with hectic lifestyles, including ensuring flexibility in appointment scheduling/rescheduling and use of reminder systems.

In addition to studies that explicitly studied barriers/supports, some study authors noted barriers to achieving high immunization coverage that arose from their study experiences. These included inadequate/missing records,<sup>30</sup> change of caregivers,<sup>18</sup> and discontinuity in care because of placement moves.<sup>24,38</sup> One study assessed whether general healthcare recommendations were addressed after statutory health assessments and found no association between number of placements and completion of the healthcare plan.<sup>43</sup> However, no studies have specifically assessed the association between number of placements and immunization coverage. These issues warrant further focused examination to determine their role in influencing immunization coverage.

### Limitations

The heterogeneity in study designs necessitated use of different quality appraisal tools with varying criteria and range of scores. This was addressed to some degree by standardizing the quality appraisal scores to enable comparison across study designs. Also, the search may have missed articles that studied relevant barriers and supports, if the article did not explicitly mention immunization (e.g., if an article studied barriers to accessing child preventive services in general). Finally, as studies came from a relatively limited number of countries, readers should be cautious about generalizing findings beyond comparable settings.

### CONCLUSIONS

In most contexts studied, children in care of the child welfare system experience inadequate and lower coverage than children who have not been in care. More than half of the studies identified were of lower quality, did not include a comparison group, or did not have immunization as the primary focus of study. Only five high-quality studies assessed coverage for specific vaccines, whereas the remainder looked at the immunization schedule as a whole, making it difficult to ascertain whether a specific vaccine or dose was responsible for

the poor immunization coverage. There is also limited research on the barriers and supports to immunization coverage among children in care, though key supports appear to be continuity of care, coordinated care, and inter-agency collaboration. Further research and action, including more qualitative research, should be undertaken to better understand the factors affecting immunization in this population and to determine how this vulnerable group of children can be supported in achieving optimal immunization levels.

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### SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at <https://doi.org/10.1016/j.amepre.2018.07.026>.

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