# Childhood Vaccination Coverage Rates Among Military Dependents in the United States

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abstract

**BACKGROUND AND OBJECTIVES:** The Military Health System provides universal coverage of all recommended childhood vaccinations. Few studies have examined the effect that being insured by the Military Health System has on childhood vaccination coverage. The purpose of this study was to compare the coverage of the universally recommended vaccines among military dependents versus other insured and uninsured children using a nationwide sample of children.

**METHODS:** The National Immunization Survey is a multistage, random-digit dialing survey designed to measure vaccination coverage estimates of US children aged 19 to 35 months old. Data from 2007 through 2012 were combined to permit comparison of vaccination coverage among military dependent and all other children.

**RESULTS:** Among military dependents, 28.0% of children aged 19 to 35 months were not up to date on the 4:3:1:3:3:1 vaccination series excluding *Haemophilus influenzae* type b vaccine compared with 21.1% of all other children (odds ratio: 1.4; 95% confidence interval: 1.2–1.6). After controlling for sociodemographic characteristics, compared with all other US children, military dependent children were more likely to be incompletely vaccinated (odds ratio: 1.3; 95% confidence interval: 1.1–1.5).

**CONCLUSIONS:** Lower vaccination coverage rates among US military dependent children might be due to this population being highly mobile. However, the lack of a military-wide childhood immunization registry and incomplete documentation of vaccinations could contribute to the lower vaccination coverage rates seen in this study. These results suggest the need for further investigation to evaluate vaccination coverage of children with complete ascertainment of vaccination history, and if lower immunization rates are verified, assessment of reasons for lower vaccination coverage rates among military dependent children.

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**WHAT'S KNOWN ON THIS SUBJECT:** Current childhood vaccination coverage rates among military dependents in the United States are not known. Past studies on childhood vaccination coverage in military dependents have shown mixed results, with the majority showing lower than ideal coverage rates.

**WHAT THIS STUDY ADDS:** This study analyzes a national database with 6 years of data and provider-confirmed vaccination status to describe the current documented vaccination coverage rates among military dependents in the United States.

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Vaccines are considered 1 of the 10 greatest public health achievements of the 20th century. Each year, vaccinations save thousands of lives and result in substantial cost savings.[1,2] Although vaccination is an important cornerstone of routine pediatric care, a substantial proportion of US children remain susceptible to serious, vaccine-preventable diseases.

The US Department of Health and Human Services has established national objectives for select individual vaccinations and vaccination series in the Healthy People 2020 agenda. Most universally recommended vaccines (eg, diphtheria-tetanus-acellular pertussis [DTaP]; polio; measles, mumps, and rubella; *Haemophilus influenzae* type b [Hib]; hepatitis B; and varicella) have a target of 90% coverage by 2020 among young children. According to the 2011 National Immunization Survey (NIS) of children aged 19 to 35 months, >1 in 5 (22.4%) US children lack at least 1 recommended dose of DTaP, polio, measles antigen–containing vaccine, hepatitis B, or varicella.[3] Further efforts are needed to identify those at greatest risk of incomplete vaccination and to resolve health system factors impeding the attainment of the 2020 objectives.

A number of sociodemographic and health system factors have been identified as risk factors for incomplete vaccination. Sociodemographic characteristics associated with incomplete vaccination include nonwhite race/ethnicity, living in poverty, young maternal age, low maternal education, and large household size.[4–11] With respect to health system factors, barriers to primary care access, such as long waiting room times and difficulty making appointments, are also related to incomplete vaccination.[12,13] In addition, lack of an electronic health record system and errors in documentation have been associated with lower vaccination rates.[14–17] Type of health insurance can also play a role in vaccination coverage rates. Children with public insurance or uninsured children have a higher frequency of incomplete vaccination than those with private health insurance.[18,19]

Children of active-duty military members comprise 2.6% of the under-5 population in the United States[20] and represent a population of special interest because these children receive all well-child care and recommended immunizations free of charge with no copay, eliminating many financial barriers to attaining high coverage.[21] Despite the lack of such barriers, the 6 studies conducted to date on childhood vaccination coverage in military dependents have shown mixed results, with the majority showing lower than ideal vaccination coverage rates.[13,22–26] Several of these studies, however, have been limited by the potential biases introduced by the acute care clinic settings in which they were conducted.[23–25] Furthermore, most were performed in limited geographic settings and in single branches of the military,[13,22,24,25] and all were performed in the mid-1990s, which also limits their generalizability to the current situation.

As the United States seeks to achieve its vaccination objectives, it is important to understand the extent to which current financing and health care delivery systems, such as the universal care system for military dependents, are on track to reach the Healthy People 2020 targets and identify those systems that are particularly effective or which could benefit from further improvements. We therefore undertook a study to compare the coverage of the universally recommended vaccines among military dependents versus all other insured and uninsured children using a nationwide sample of children.

## METHODS

We used data from the 2007–2012 NIS, an annual random-digit-dial telephone survey designed to provide vaccination coverage estimates of children aged 19 to 35 months in the United States.[27] Until 2011, all NIS interviews were conducted via landline telephone. Beginning in 2012, interviews were conducted on landline and cellular telephones.[28] The survey has 2 components, a questionnaire administered to a parent or caregiver and a form mailed to the parent-identified vaccination providers. After ascertaining that there is an eligible child in the household and obtaining informed consent, sociodemographic information is collected and the name of the child's vaccination provider(s) is obtained. Informed consent is obtained from the person in the household most knowledgeable about the eligible child's immunization history. Informed consent to contact the child's vaccination provider(s) is obtained at the end of the interview. A form is then mailed to providers to obtain specific information on the vaccinations received and the dates of vaccination. The data collected in each year's NIS are weighted to represent the general US population of children aged 19 to 35 months.

In 2006, a module was added to the NIS questionnaire to gather information on health insurance coverage of the child, and starting in 2007 this information was added to the NIS public use files. If the parent or caregiver responded "yes" to the question, "Is child covered by Military Health Care, TRICARE, CHAMPUS, or CHAMP-VA?" the child was considered to be a military dependent for the purpose of this analysis. If the answer was "no," the child was considered to have other insurance coverage or to be uninsured. To obtain sufficient numbers of military dependent children, we combined data from the years 2007 through the

2012 NIS. We limited our study to those children for whom adequate provider data were available. Adequate provider data are defined and determined by the NIS to mean sufficient vaccination history information was obtained from the provider(s) to determine whether a child is up to date with respect to the recommended vaccination schedule. Inadequate provider data are defined as having at least 1 identified provider not respond and that completeness of provider immunization history cannot be determined. All other provider data are deemed adequate. Adequate and inadequate provider data definitions take into account responses from identified provider(s), shot card documentation, and the child's immunization history per the respondent.

Up-to-date vaccination is defined as a complete 4:3:1:3:3:1 vaccination series at the time of interview. This series includes at least 4 doses of DTaP; 3 doses of poliovirus vaccine; 1 dose of measles, mumps, and rubella vaccine (or any measles-containing vaccine); 3 doses of Hib vaccine; 3 doses of hepatitis B vaccine; and at least 1 varicella vaccine dose at or after 12 months. Because of the Hib vaccine shortage from December 2007 through September 2009, we used the modified 4:3:1:_:3:1 vaccination series, which excludes the Hib vaccine from the series.[29]

The NIS included data on child, maternal, and household covariates. Child data included the child's gender, age group at the time of survey (19–23, 24–29, or 30–35 months), and race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, or non-Hispanic other or mixed race). Available data on the mothers included education (≤12 years, >12 years non–college graduate, or college graduate), age (≤19 years, 20–29 years, or ≥30 years), and marital status (married or never married, widowed, divorced, or separated). Household information was also available for each child on poverty status as determined by federal poverty guidelines (below poverty or at or above poverty), the number of children <18 years in the household (1, 2–3, or ≥4), the number of vaccination providers identified by respondent (0, 1, or ≥2), and geographic mobility status (child moved states since birth or child has not moved states since birth). Because military families are concentrated in certain states and coverage levels vary widely between states, a state tertile variable was created on the basis of the combined 2007 through 2012 weighted vaccination coverage levels. Washington, DC, was considered its own state for the purposes of creating the state tertile variable. Children's state of residence was based on current location at the time of the survey.

In our analysis, we examined the sociodemographic characteristics and the coverage for individual vaccines as well as full 4:3:1:_:3:1 coverage for military dependents and for all others. We calculated odds ratios (ORs) and 95% confidence intervals (CIs) for not being up to date with the full series by each of the child characteristics, including military dependent status, maternal characteristics, and household characteristics. *P* values were calculated by using the $\chi^2$ test. A logistic regression model was developed that included those variables that were thought a priori to be associated with incomplete vaccination and could potentially confound the relationship between military dependent status and incomplete coverage. The NIS weighting assigned for children with adequate provider data was used in all analyses to provide nationally representative estimates.[30] All statistical analyses were performed by using SAS 9.2 (SAS Institute, Cary, NC) taking into account the complex survey design. Because of the large number of children in the study, findings were considered to be statistically significant only if the *P* value was ≤.01.

## RESULTS

The 2007–2012 NIS included data on 155 023 children, for whom 105 129 (67.8%) had adequate provider data. All children with adequate provider data were included in the description of risk factors for being not up to date. Children were excluded from analyses involving the military insurance variable if they had missing information for that variable (*n* = 1322; 1.3% of children with adequate provider data). Thus, the total population included in the final analyses was 103 807. There is no discernable trend in either increasing or decreasing undervaccination rates between 2007 and 2012.

Of the total study population, 3421 (weighted percentage: 2.8%) were military dependents. The characteristics of military dependents and all other children are depicted in Table 1. Except for child age group and gender, statistically significant differences were seen for all characteristics. The military dependent group was less likely to be Hispanic and more likely to be non-Hispanic white and to have mothers aged between 20 and 29 years, who had >12 years of education, and who were currently married. In addition, the households of military dependents were more likely to be at or above the poverty line and to have fewer children per household. Finally, a greater proportion of military dependents moved state residences since their birth or had ≥2 vaccination providers compared with those who were not military dependents.

Coverage estimates of individual vaccines and common vaccine series are shown in Table 2. Military dependents had lower levels of coverage for each of the individual vaccines, but differences were

**TABLE 1** Characteristics of Military Dependents and All Other Children Aged 19 to 35 Months: NIS, 2007–2012

| Characteristic | Military Dependents ($n$ = 342; 2.8%), $n$ (weighted %) | All Others ($n$ = 100 386; 97.2%), $n$ (weighted %) | Difference Between Military Dependents and All Others, $P$ |
|---|---|---|---|
| Child age group | | | .69 |
| 19–23 months | 1032 (30.6) | 29 245 (29.9) | |
| 24–29 months | 1143 (34.8) | 33 880 (34.1) | |
| 30–35 months | 1246 (34.6) | 37 261 (36.0) | |
| Race/ethnicity | | | <.01* |
| White, non-Hispanic | 2194 (57.4) | 61 903 (49.6) | |
| Black, non-Hispanic | 304 (12.3) | 9690 (12.9) | |
| Hispanic | 541 (19.6) | 18 460 (27.7) | |
| Other, non-Hispanic | 382 (10.8) | 10 333 (9.8) | |
| Gender | | | .18 |
| Male | 1760 (53.3) | 51 388 (51.1) | |
| Female | 1661 (46.7) | 48 998 (48.9) | |
| Maternal education | | | <.01* |
| ≤12 years | 633 (34.9) | 29 441 (49.3) | |
| >12 years, non–college graduate | 1376 (35.2) | 26 036 (20.0) | |
| College graduate | 1412 (29.9) | 44 909 (30.8) | |
| Maternal age group | | | <.01* |
| ≤19 years | 32 (1.2) | 1795 (2.9) | |
| 20–29 years | 1425 (50.1) | 32 793 (39.4) | |
| ≥30 years | 1964 (48.7) | 65 798 (57.8) | |
| Marital status | | | <.01* |
| Never/widowed/divorced/separated | 379 (15.3) | 25 179 (33.8) | |
| Currently married | 3042 (84.7) | 75 207 (66.2) | |
| Poverty level | | | <.01* |
| Below poverty | 325 (13.7) | 22 181 (33.9) | |
| At or above poverty | 2980 (86.3) | 74 697 (62.1) | |
| Vaccine coverage tertile in state of residence | | | <.01* |
| Highest | 1011 (28.8) | 28 870 (26.0) | |
| Middle | 1519 (54.0) | 41 019 (50.3) | |
| Lowest | 891 (17.2) | 30 497 (23.7) | |
| Number of children in household | | | <.01* |
| 1 | 832 (27.0) | 23 818 (24.2) | |
| 2–3 | 2137 (61.5) | 62 012 (60.0) | |
| ≥4 | 452 (11.5) | 14 556 (15.9) | |
| Currently living in a state other than birth state | | | <.01* |
| Yes | 1262 (39.1) | 7038 (6.9) | |
| No | 2159 (61.0) | 93 348 (93.1) | |
| Number of vaccination providers identified by respondent | | | <.01* |
| 0 | 4 (0.15) | 267 (0.18) | |
| 1 | 1663 (45.1) | 67 754 (65.6) | |
| ≥2 | 1754 (54.7) | 32 362 (34.3) | |

$N$ = 103 807. *Significant difference between military dependents and all others at $P \leq .01$.

statistically significant only for the DTaP and inactivated polio vaccine vaccines (77.9% vs 84.3%, $P < .01$, and 88.5% vs 93.3%, $P < .01$, respectively). In keeping with the findings for individual vaccines, military dependents also had lower coverage levels of the 4:3:1:_:3:1 series (72.0% vs 77.9%; $P < .01$).

The risk factors for being not up to date on the 4:3:1:_:3:1 vaccine series are presented in Table 3. Children who were military dependents, were non-Hispanic black, or who were younger than 30 months were at significantly higher risk of not being up to date, as were children whose mothers had less than a college education, were aged 20 to 29 years, or who were not currently married. Children who came from households below the poverty line, where there was >1 child in the household, who resided in a state in the lowest or middle tertile of vaccine coverage, who had moved states since birth, or who had ≥2 vaccine providers were also at significantly increased risk. Children who were non-Hispanic other race/ethnicity had a lower odds of incomplete vaccination compared with white children.

The results of the multivariable analysis are presented in Table 4. The odds of not being up to date on vaccination were 1.3-fold higher in military dependents compared with all others (95% CI: 1.1–1.5; $P < .01$). Having a mother with less than a college degree, maternal age 20 to 29 years, being younger than 30 months, having >1 child in the

**TABLE 2** Vaccine Coverage Levels Among Military Dependent and All Other Children Aged 19–35 Months, by Selected Vaccines: NIS, 2007–2012

| Vaccination | Military Dependents ($n$ = 3421; 2.8%), $n$ (weighted %; 95% CI) | All Others ($n$ = 100 386; 97.2%), $n$ (weighted %; 95% CI) |
|---|---|---|
| ≥ 4 doses DTaP[a] | 2679 (77.9; 75.3–80.4) | 85 813 (84.3; 83.9–84.7) |
| ≥ 3doses IPV | 3088 (88.5; 86.5–90.1) | 93 867 (93.3; 93.0–93.6) |
| ≥ 1 dose MCV | 3066 (90.2; 88.3–92.0) | 92 798 (92.4; 92.1–92.7) |
| ≥ 1 dose MMR | 3035 (89.1; 87.2–91.1) | 91 853 (91.4; 91.1–91.8) |
| ≥ 3doses hepatitis B vaccine | 3057 (89.0; 87.1–90.9) | 95 372 (91.9; 91.6–92.2) |
| ≥ 1 dose varicella vaccine | 2988 (87.8; 85.8–89.7) | 90 180 (90.3; 90.0–90.7) |
| Combined series 4:3:1:_:3:1[b] | 2476 (72.0; 69.3–74.8) | 78 550 (77.9; 77.4–78.3) |

$N$ = 103 807. IPV, inactivated poliovirus vaccine; MCV, measles-containing vaccine; measles, mumps, and rubella vaccine.
[a] Also includes children who might have been vaccinated with diphtheria-tetanus toxoids-pertussis vaccine, and diphtheria and tetanus toxoids vaccine.
[b] Four or more doses of DTaP, ≥3 doses of poliovirus vaccine, ≥1 doses of MCV, ≥3 doses of hepatitis B vaccine, and ≥1 doses of varicella vaccine.

household, residing in a state in the lowest or middle tertile of vaccine coverage, having ≥2 vaccination providers, and moving states since birth remained statistically significant. In the multivariate analysis, being Hispanic or non-Hispanic other race/ethnicity was associated with a lower odds of incomplete vaccination compared with white children.

The majority of these children (81.3%) received their vaccinations from solely civilian providers or a mix of military and civilian providers, whereas 18.7% of these children received their vaccinations from solely military providers. Although not statistically significant at the 0.01 level, children who saw solely military providers had significantly higher rates of incomplete vaccination compared with children who did not see military providers only (35.4% vs 26.3%; $P$ = 0.02). This finding remained true in a logistic regression model controlling for mobility; the odds of not being up to date on vaccination were 1.5-fold higher in military dependents who received vaccinations from solely military providers compared with those who did not see military providers only (95% CI: 1.1–2.1).

## DISCUSSION

Our study found that being a military dependent or seeing solely military providers were risk factors for being not up to date on the 4:3:1:_:3:1 vaccine series. This finding held true even after controlling for potential confounding variables. In multivariate analysis, being a military dependent was associated with a greater risk than low maternal education, younger maternal age, living below the poverty level, and having ≥2 vaccination providers.

Our study is the first in recent years to examine the vaccination coverage levels of a large national sample of military dependent children. Furthermore, it was based on provider-reported vaccination data over a 6-year period. Although the large sample size of this study provides high power, the difference in vaccination coverage between military dependents and others is clinically significant when some vaccine-preventable diseases require a very high coverage to achieve herd immunity (eg, measles). A difference in vaccination coverage of just a few percentage points can mean the difference in halting or not halting the spread of disease in a population.

Nonetheless, our study has limitations. First, vaccination coverage may have been underreported for some military dependents. Caregivers may not have reported all providers, especially if they had moved frequently or if multiple providers saw their child. Failure of caregivers to recall all vaccination providers would result in an underrepresentation of immunization status. Second, the NIS determined health insurance status at the time of the survey and it is possible that some children who were covered by the Military Health System when the survey was done may not have had such coverage previously and vice versa. Last, the NIS is a telephone survey and although data are weighted for nonresponse and nontelephone households and the percentage of military dependents in the NIS was similar to the percentage in the general population, some bias may remain.

Despite these limitations, our findings are in keeping with 2 previous population-based household studies that did not focus on the military but identified children covered by the Military Health System.[13,26] The smaller of the 2, which had a total study population of 749 children including 295 military dependents, was a door-to-door household survey conducted in the state of Virginia and which used provider records to verify vaccine status. After controlling for sociodemographic variables, military dependents had higher odds of not being up to date on recommended vaccinations at 12 months (OR: 5.2; 95% CI: 2.9–9.5).[13] Zhao et al[26] used National Health Information Survey data for the years from 1993 to 1996 and had a total study population of 7535. This survey, which relied on parental or caregiver report of vaccination history, revealed that being a military dependent was a risk factor for incomplete vaccination after controlling for parental or caregiver educational level and urbanicity; children with military health insurance had an OR of 0.41 (95% CI: 0.28–0.61) of being up to date on the 4:3:1:3 vaccine series. Both studies, however, were conducted in the 1990s and the applicability of findings to the current situation is not clear.

**TABLE 3** Risk Factors for Not Being Up to Date on the 4:3:1:_:3:1 Vaccination Series Among Children Aged 19 to 35 Months: NIS, 2007–2012

| Characteristic | *n* | Not Up to Date on 4:3:1:_:3:1 Series, *n* (weighted %; 95% CI) |
|---|---|---|
| Military dependent | | |
| Yes | 3421 | 945 (28.0; 25.2–30.7) |
| No | 100 386 | 21 836 (22.1; 21.7–22.6) |
| Child age group | | |
| 19–23 months | 30 683 | 8800 (29.5; 28.6–30.4) |
| 24–29 months | 35 475 | 7215 (20.6; 19.9–21.4) |
| 30–35 months | 38 971 | 7083 (17.9; 17.2–18.6) |
| Race/ethnicity | | |
| White, non-Hispanic | 64 579 | 14 135 (22.5; 21.9–23.1) |
| Black, non-Hispanic | 10 188 | 2445 (24.8; 23.5–26.1) |
| Hispanic | 19 444 | 4205 (21.7; 20.6–22.8) |
| Other, non-Hispanic | 8955 | 2313 (19.8; 18.5–21.2) |
| Gender | | |
| Male | 53 841 | 12 018 (22.4; 21.8–23.0) |
| Female | 51 288 | 11 080 (22.2; 21.5–22.9) |
| Maternal education | | |
| ≤12 years | 30 773 | 7624 (24.2; 23.4–24.9) |
| >12 years, non–college graduate | 27 688 | 6404 (22.8; 21.9–23.7) |
| College graduate | 46 668 | 9070 (18.9; 18.3–19.6) |
| Maternal age group | | |
| ≤19 years | 1880 | 459 (24.5; 21.2–27.8) |
| 20–29 years | 34 745 | 8436 (25.7; 23.9–25.4) |
| ≥30 years | 68 504 | 14 203 (20.6; 20.0–21.1) |
| Marital status | | |
| Never/widowed/divorced/separated | 26 072 | 6343 (24.2; 23.3–25.1) |
| Currently married | 79 057 | 16 755 (21.3; 20.8–21.9) |
| Poverty level | | |
| Below poverty level | 23 026 | 5789 (24.9; 24.0–25.9) |
| At or above poverty level | 78 329 | 16 474 (21.0; 20.5–21.6) |
| Vaccine coverage tertile in state of residence | | |
| Highest | 30 306 | 5587 (19.1; 18.3–19.8) |
| Middle | 43 083 | 9267 (22.2; 21.5–23.0) |
| Lowest | 31 740 | 8244 (26.1; 25.3–26.9) |
| Number of children in household | | |
| 1 | 24 924 | 4746 (19.1; 18.2–19.9) |
| 2–3 | 64 916 | 13 706 (21.7; 21.1–22.3) |
| ≥4 | 15 289 | 4646 (29.4; 28.1–30.7) |
| Currently living in a state other than birth state | | |
| Yes | 8402 | 2374 (29.4; 27.5–31.3) |
| No | 96 727 | 20 724 (21.7; 21.2–22.2) |
| Number of vaccination providers identified by respondent | | |
| 0 | 289 | 289 (100) |
| 1 | 70 319 | 14 689 (21.4; 20.9–22.0) |
| ≥2 | 34 518 | 8119 (23.5; 22.7–24.4) |

*N* = 103 807. The 4:3:1:_:3:1 vaccination series = ≥4 doses of DTaP, ≥3 doses of poliovirus vaccine, ≥1 doses of measles-containing vaccine, ≥3 doses of hepatitis B vaccine, and ≥1 doses of varicella vaccine.

By contrast, 4 studies showed coverage levels among military dependents to be greater than those obtained in the general population at the time the surveys were performed in the mid-1990s.[31] However, 3 of the studies were performed in acute care settings, resulting in limited generalizability to the overall US military dependent population.[23–25] The fourth study used the Defense Enrollment Eligibility Reporting System to identify the study population, but the data were collected from a single site with a small study population of 457 children.[22]

Reducing financial barriers to vaccinations has been shown to result in improvements in coverage. Initiated in 1994, the Vaccines for Children (VFC) Program was designed to reduce the financial barrier for children who were eligible for Medicaid, uninsured or underinsured, or American Indian/Alaska Native.[32] Vaccination coverage rates for the 4:3:1 vaccine series (at least 4 doses of diphtheria-tetanus-pertussis vaccine or diphtheria-tetanus toxoid, 3 doses of poliovirus vaccine, 1 dose of any measles-containing vaccine) increased from 75% of children aged 19 to 35 months in 1994 to 81% of children aged 19 to 35 months in 1998, 1 year after nearly all states had implemented the VFC program.[31,33] The VFC program may be in part responsible for the lack of association between coverage and type of health insurance (public, private, or uninsured) in the 2000 to 2003 NIS surveys, a finding that persisted after controlling for sociodemographic variables.[18,34]

It is not clear why military dependents have reported lower rates of vaccination coverage in this study given their universal access to all recommended vaccinations and well-child care visits, without copays or cost sharing.[21] Furthermore, military dependents exhibited some protective factors against incomplete vaccination. Compared with all other children in the study population, military dependents were more likely to live at or above the poverty level and to have mothers who had >12 years of education, were older than 19 years, or were currently married. However, military dependents were more likely to have moved cities since birth or have ≥2 health care providers, both risk factors for being not up to date on childhood vaccinations. Still, even after controlling for these risk factors, being a military dependent resulted in higher odds of being not up to date.

The military is a highly mobile population and such mobility is essentially a nonmodifiable risk factor in this population. Mobility can

**TABLE 4** Final Logistic Regression Model of Risk Factors for Not Being Up to Date on 4:3:1:_3:1 Vaccination Coverage of Military Dependent Children Aged 19 to 35 Months: NIS, 2007–2012

| Characteristic | OR (95% CI) |
|---|---|
| Military dependent | |
| Yes | 1.3 (1.1–1.5) |
| No | referent |
| Child age group | |
| 19–23 months | 2.0 (1.9–2.1) |
| 24–29 months | 1.2 (1.1–1.3) |
| 30–35 months | Referent |
| Race/ethnicity | |
| White, non-Hispanic | Referent |
| Black, non-Hispanic | 1.0 (0.9–1.1) |
| Hispanic | 0.8 (0.8–0.9) |
| Other, non-Hispanic | 0.8 (0.8–0.9) |
| Gender | |
| Male | Referent |
| Female | 1.0 (0.9–1.0) |
| Maternal education | |
| ≤ 2 years | 1.2 (1.1–1.3) |
| >12 years, non–college graduate | 1.1 (1.1–1.2) |
| College graduate | Referent |
| Maternal age group | |
| ≤19 years | 1.2 (0.9–1.5) |
| 20–29 years | 1.2 (1.1–1.3) |
| ≥30 years | Referent |
| Marital status | |
| Never/widowed/divorced/separated | 1.1 (1.0–1.2) |
| Currently married | Referent |
| Poverty level | |
| Below poverty level | 1.0 (0.9–1.1) |
| At or above poverty level | Referent |
| Vaccine coverage tertile in state of residence | |
| Highest | Referent |
| Middle | 1.3 (1.2–1.3) |
| Lowest | 1.5 (1.4–1.7) |
| Number of children in household | |
| 1 | Referent |
| 2–3 | 1.3 (1.2–1.4) |
| ≥4 | 1.9 (1.7–2.1) |
| Currently living in a state other than birth state | |
| Yes | 1.5 (1.3–1.7) |
| No | Referent |
| Number of vaccination providers identified by respondent | |
| 0 | N/A |
| 1 | Referent |
| ≥2 | 1.1 (1.0–1.2) |

*N* = 103 807. The 4:3:1:_:3:1 vaccination series = ≥4 doses of DTaP, ≥3 doses of poliovirus vaccine, ≥1 doses of measles-containing vaccine, ≥3 doses of hepatitis B vaccine, and ≥1 doses of varicella vaccine. N/A, not applicable.

be associated with children having multiple health care providers, which may relate to incomplete reporting of providers by caregivers, leading to an incomplete provider record check and record scattering. Record scattering can compromise the ability to accurately depict a population's vaccination coverage.[35,36] Barriers to establishing new primary care providers with each move may impact vaccination rates. In addition, providers may be relying on caregiver recall due to lack of documentation to determine a child's immunization status. The Military Health System does have electronic medical records, which, in theory, should lessen the risk associated with moving or having multiple providers. However, it does not have a comprehensive childhood immunization registry. Studies have shown that immunization registries allow for more accurate surveillance of vaccination coverage rates, rather than relying on medical record review.[37,38] Within the military system, routine entry of vaccination data into records is problematic because in military treatment facilities failure to capture such data does not have the economic consequences seen in other settings. In addition, children may receive vaccinations at nonmilitary facilities where information is not readily shared with the military treatment facilities. As mentioned in the study limitations, the extent to which the lack of accurate and complete records rather than lack of actual vaccinations may have affected the results of this study is not known.

In addition to issues around record-keeping in a highly mobile population, other barriers associated with low childhood vaccination rates among military dependents have been missed opportunities, long clinic waiting times, and difficulty making appointments.[13,39] Furthermore, in some military treatment facilities, vaccinations are performed in separate clinic areas, which may also present an additional barrier, especially if clinic waiting times to see the primary care provider are already prolonged. Many of these barriers have been addressed by the implementation of a primary care medical home model within the Military Health System. This new model of military health was designed to streamline the delivery of primary care in the military and continues to evolve. Still, currently existing system barriers need to be researched further and more fully described to begin understanding the reason for lower vaccination coverage rates among military dependent children and to find a solution to increase the coverage in this population.

As the United States seeks to reform its health care system, it is essential

that we understand how policies will affect health indicators. The Affordable Care Act mandates that all new health insurance plans offer all childhood vaccinations recommended by the Advisory Committee on Immunization Practices at no cost to the patient, including eliminating all copays and cost-sharing arrangements.[40] All risk factors associated with incomplete vaccination, including financial barriers, should be clearly identified and addressed to ensure adequate vaccination coverage and to minimize the morbidity and mortality due to vaccine-preventable diseases.

## CONCLUSIONS

Drawing from a database of provider-reported vaccination status, we show that compared with a national sample, children who are military dependents are less likely to be fully vaccinated. The reasons for this association are not clear and likely range from children being truly undervaccinated to lack of accurate and complete vaccination documentation. If the actual reason is the former, then a systematic process to identify individuals who are not up to date on vaccinations may be needed. If the latter is the cause, a more robust method of documenting vaccinations may be needed. The NIS relies on caregivers to recall all vaccination providers, and thus limits the use of the NIS to draw firm conclusions in the highly mobile military dependent population. Immunization registries can help document vaccinations and identify which vaccinations are necessary to ensure a child is up to date, which is especially important in populations with multiple providers.[41] Additional studies should be conducted to verify our findings and to further elucidate system factors associated with the reported incomplete vaccination within the Military Health System.

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