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# Safeguarding the Future: Pediatric Vaccination in the Military Health System

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- Dr. Nanda Ramchandrar has no relevant financial or non-financial relationships to disclose relating to the content of this activity.
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- The study protocol was approved by the Naval Health Research Center Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects. Research data were derived from an approved Naval Health Research Center Institutional Review Board protocol, number NHRC.1999.0003.



# Learning Objectives

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1. Review vaccination adherence in the MHS
2. Identify barriers to completion
3. Evaluate implications for care and future areas of research



# First, let's just acknowledge that vaccines save lives



Vaccine programs prevent more than 2 million deaths a year in children under age 5

Potential for 1.5 million more lives saved per year

Frieden, Thomas R. "The future of public health." *New England Journal of Medicine* 373.18 (2015): 1748-1754.



# Vaccines have yielded a net total \$2.7 trillion public benefit

**TABLE 2. Lifetime health and economic outcomes in 30 cohorts of children — United States, 1994–2023**

Outcome	All children born 1994–2023
Total illnesses prevented (x 1,000)	507,683
Total hospitalizations prevented (x 1,000)	31,955
Total deaths prevented (x 1,000)	1,129
Direct cost of immunization (billion, \$)	240
Societal cost of immunization (billion, \$)	268
Benefits in direct costs (billion, \$)	780
Benefits in societal costs (billion, \$)	2,931
Direct net savings (billion, \$)	540
Societal net savings (billion, \$)	2,663
Payer benefit-cost ratio*	3.3
Societal benefit-cost ratio†	10.9

\* Payer benefit-cost ratio = benefits in direct costs / direct cost of immunization.

† Societal benefit-cost ratio = benefits in societal costs / societal cost of immunization.

Zhou, Fangjun. "Health and economic benefits of routine childhood immunizations in the era of the Vaccines for Children program—United States, 1994–2023." *MMWR. Morbidity and Mortality Weekly Report* 73 (2024).

**TABLE 1. Estimated number of illnesses, hospitalizations, and deaths prevented by routine childhood immunization against selected vaccine-preventable diseases in 30 cohorts of children — United States, 1994–2023**

Vaccine-preventable disease	Illnesses prevented (x 1,000)	Hospitalizations prevented (x 1,000)	Deaths prevented (x 1,000)
Diphtheria	7,528	7,528	752.8
Tetanus	5	5	0.7
Pertussis	80,738	3,646	28.4
<i>Haemophilus influenzae</i> type b	536	495	20.3
Polio	1,847	786	21.9
Measles	104,984	13,172	85.0
Mumps	63,355	2,020	0.3
Rubella	54,225	199	0.4
Congenital rubella syndrome	17	26	1.9
Hepatitis B	6,061	940	90.1
Varicella*	106,270	272	1.9
Hepatitis A*	4,048	78	1.5
Pneumococcus-related diseases*,†	47,804	1,969	123.2
Rotavirus*	30,265	819	0.4
<b>Total</b>	<b>507,683</b>	<b>31,955</b>	<b>1,128.8</b>

\* Varicella vaccine for 1996–2023 cohorts, hepatitis A vaccine for 2006–2023, pneumococcal conjugate vaccine for 2001–2023, and rotavirus vaccine for 2007–2023.

† Includes invasive pneumococcal disease, otitis media, and pneumonia.



## That message is buttressed by trends over time

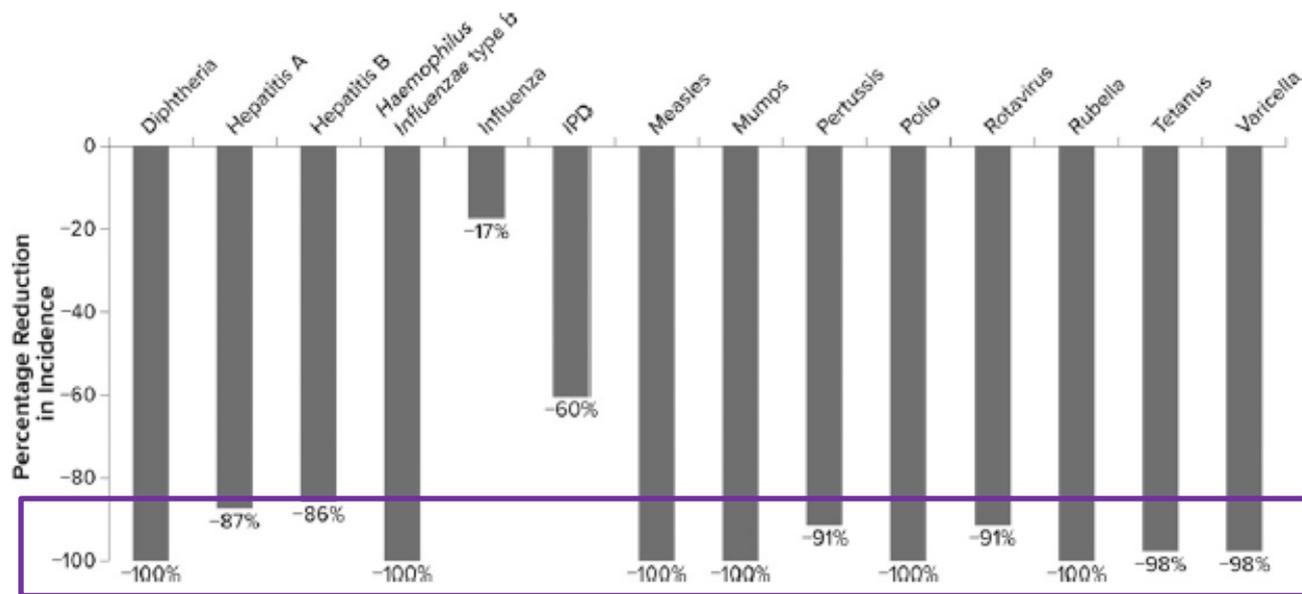
Vaccine-Preventable Disease	Vaccine Date(s), y <sup>f</sup>	Most Recent Postvaccine Reported No.		Prevaccine Estimated Annual No. vs Most Recent Reported No. (% Reduction)	
		Cases, 2006 <sup>g</sup>	Deaths, 2004 <sup>h</sup>	Cases	Deaths
Diphtheria	1928-1943	0	0	21 053 (100)	1822 (100)
Measles	1963, 1967, 1968	55	0	530 162 (99.9)	440 (100)
Mumps	1940s, 1967	6584	0	155 760 (95.9)	39 (100)
Pertussis	1914-1941	15 632	27	185 120 (92.2)	4007 (99.3)
Poliomyelitis, acute	1955, 1961-1963, 1987	0	0	19 794 (100)	1393 (100)
Poliomyelitis, paralytic	1955, 1961-1963, 1987	0	0	16 316 (100)	1879 (100)
Rubella	1969	11	0	47 734 (99.9)	17 (100)
Congenital rubella syndrome	1969	1	0	151 (99.3)	Not available
Smallpox	1798	0	0	29 005 (100)	337 (100)
Tetanus	1933-1949	41	4	539 (92.9)	468 (99.2)

Roush SW, Murphy TV, Vaccine-Preventable Disease Table Working Group AT. Historical Comparisons of Morbidity and Mortality for Vaccine-Preventable Diseases in the United States. *JAMA*. 2007;298(18):2155–2163. doi:10.1001/jama.298.18.2155



Vaccine-Preventable Disease	Vaccine Date(s), y <sup>g</sup>	Most Recent Postvaccine No., 2006				Prevaccine Estimated Annual No. vs Most Recent Estimated No. (% Reduction)		
		Reported Cases <sup>h</sup>	Estimated Cases <sup>i</sup>	Estimated Hospitalizations <sup>j</sup>	Deaths <sup>k</sup>	Cases	Hospitalizations	Deaths
Hepatitis A	1995	3579	15 298	895	18	102 035 (87.0)	5968 (87.0)	119 (86.9)
Acute hepatitis B	1981, 1986	4713	13 169	1461	47	53 063 (80.1)	5887 (80.1)	190 (80.2)
Invasive <i>Haemophilus influenzae</i> type b	1985, 1987, 1990	208 (29 type b; 179 type unknown)	< 50 (2005)	Not available	<5 (2005)	19 950 (≥ 99.8)	Not available	995 (≥ 99.5)
Invasive pneumococcal disease	2000	5169	41 550 (2005)	Not available	4850 (2005)	21 517 (34.1)	Not available	1650 (25.4)
Varicella	1995	48 445	612 768	1276	19 (2004)	3 472 352 (85.0)	9356 (88.0)	86 (81.9)

Roush SW, Murphy TV, Vaccine-Preventable Disease Table Working Group AT. Historical Comparisons of Morbidity and Mortality for Vaccine-Preventable Diseases in the United States. *JAMA*. 2007;298(18):2155–2163. doi:10.1001/jama.298.18.2155



Talbird, Sandra E., et al. "Impact of routine childhood immunization in reducing vaccine-preventable diseases in the United States." *Pediatrics* 150.3 (2022): e2021056013.



Disease	Without Immunization		With Immunization		Cases Averted (2019)
	Prevaccine Disease Incidence per 100 000 <sup>a</sup>	Annual Cases (2019) <sup>b</sup>	Vaccine-Era Disease Incidence per 100 000 <sup>a</sup>	Annual Cases (2019) <sup>b</sup>	
Diphtheria	600	263 000	<1	<1	263 000
Hepatitis A	17	56 000	2	7 000	49 000
Hepatitis B	46	150 000	7	22 000	128 000
<i>Haemophilus influenzae</i> type b	92	18 000	<1	<100	18 000
Influenza	1 252	7 115 000	13 412	5 879 000	1 236 000
Measles	2 129	3 639 000	<1	<1000	3 639 000
Mumps	1 312	2 243 000	2	3 000	2 240 000
Pertussis	744	2 442 000	66	217 000	2 225 000
<i>Streptococcus pneumoniae</i>					
IPD	24	79 000	10	31 000	48 000
Pneumonia hospitalizations <sup>c</sup>	152	500 000	24	78 000	422 000
Pneumonia outpatient visits <sup>c</sup>	282	927 000	88	289 000	638 000
ADM <sup>c</sup>	11 141	8 138 000	2 756	2 013 000	6 124 000 <sup>d</sup>
Polio	21	70 000	0	0	70 000
Rotavirus <sup>e</sup>					
Hospitalizations	340	67 000	29	6 000	61 000
ED visits	1 072	210 000	420	82 000	128 000
Outpatient visits	2 228	436 000	1 222	239 000	197 000
Rubella	1 124	1 921 000	<1	<10	1 921 000
Tetanus	<1	1 000	<1	<100	1 000
Varicella	1 328	4 359 000	30	97 000	4 262 000

Talbird, Sandra E., et al. "Impact of routine childhood immunization in reducing vaccine-preventable diseases in the United States." *Pediatrics* 150.3 (2022): e2021056013.



CDC ACIP recommends routine and timely vaccination against 15 childhood illnesses by age 24 months

DISEASE	VACCINE
<b>Hepatitis B</b>	<b>HepB</b> vaccine protects against hepatitis B.
<b>Rotavirus</b>	<b>RV</b> vaccine protects against rotavirus.
<b>Diphtheria</b>	<b>DTaP*</b> vaccine protects against diphtheria.
<b>Pertussis</b> (whooping cough)	<b>DTaP*</b> vaccine protects against pertussis (whooping cough).
<b>Tetanus</b>	<b>DTaP*</b> vaccine protects against tetanus.
<b>Haemophilus influenzae type b</b> (Hib)	<b>Hib</b> vaccine protects against <i>Haemophilus influenzae</i> type b.
<b>Pneumococcal disease</b> (PCV13, PCV15)	<b>PCV</b> vaccine protects against pneumococcal disease.
<b>Polio</b>	<b>IPV</b> vaccine protects against polio.
<b>Coronavirus disease 2019</b> (COVID-19)	<b>COVID-19</b> vaccine protects against severe complications from coronavirus disease 2019.
<b>Influenza (Flu)</b>	<b>Flu</b> vaccine protects against influenza.
<b>Measles</b>	<b>MMR**</b> vaccine protects against measles.
<b>Mumps</b>	<b>MMR**</b> vaccine protects against mumps.
<b>Rubella</b>	<b>MMR**</b> vaccine protects against rubella.
<b>Chickenpox</b>	<b>Varicella</b> vaccine protects against chickenpox.
<b>Hepatitis A</b>	<b>HepA</b> vaccine protects against hepatitis A.



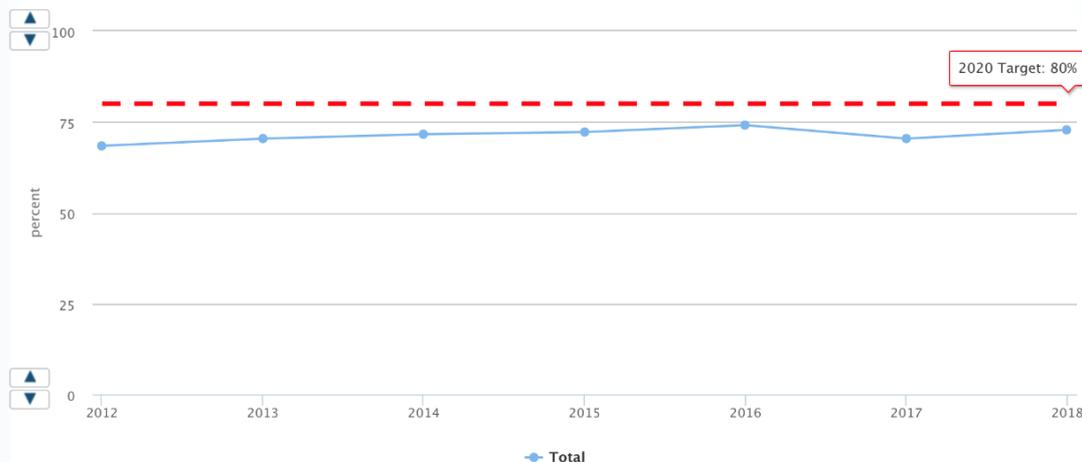
# HHS set national goals, but we never got there



## Children receiving the recommended doses of DTaP, polio, MMR, Hib, HepB, varicella and PCV vaccines by age 19–35 months (percent) By Total

2020 Baseline (year): 68.4 (2012) --- 2020 Target: 80.0 Desired Direction: ↑ Increase desired

Auto Scale



**Data Source:** National Immunization Survey (NIS); Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases and National Center for Health Statistics (CDC/NCIRD and CDC/NCHS)  
Additional footnotes may apply to these data. Please refer to footnotes below the data table for further information.

- Health people 2020: Target of 80% for a combined 7-vaccine series (IID8), and 90 percent for each individual vaccine series
- Only Hep B, MMR, IPV, and VZV exceeded the target goal by 2018

1. Koh HK. A 2020 vision for healthy people. N Engl J Med. 2010 May 6;362(18):1653-6. doi: 10.1056/NEJMp1001601. PMID: 20445177.
2. <https://wayback.archive-it.org/5774/20220414033335/https://www.healthypeople.gov/2020/topics-objectives/topic/immunization-and-infectious-diseases/objectives>
3. <https://health.gov/sites/default/files/2021-03/21%20HP2020EndofDecadeSnapshot2.pdf>
4. <https://health.gov/healthypeople/objectives-and-data/browse-objectives/children>



# Healthy People 2030 tried to reevaluate and set realistic goals



Healthy People  
2030, removed  
IID8

## Vaccination

Reduce the proportion of children who get no recommended vaccines by age 2 years — IID-02



Target met or exceeded

Maintain the vaccination coverage level of 1 dose of the MMR vaccine in children by age 2 years — IID-03



Little or no detectable change

Maintain the vaccination coverage level of 2 doses of the MMR vaccine for children in kindergarten — IID-04



Little or no detectable change

Increase the coverage level of 4 doses of the DTaP vaccine in children by age 2 years — IID-06



Little or no detectable change

1. Koh HK. A 2020 vision for healthy people. N Engl J Med. 2010 May 6;362(18):1653-6. doi: 10.1056/NEJMp1001601. PMID: 20445177.
2. <https://health.gov/healthypeople/objectives-and-data/browse-objectives/children>



# Reduce the proportion of children who get no recommended vaccines by age 2 years — IID-02



Status: Target met or exceeded 

[Learn more about our data release schedule](#)



Most Recent Data:  
**1.1** percent (2017)



Target:  
**1.3** percent



Desired Direction:  
**Decrease desired**



Baseline:  
**1.3** percent of children born in 2015 had received 0 doses of recommended vaccinations by their 2nd birthday

<https://health.gov/healthypeople/objectives-and-data/browse-objectives/vaccination/reduce-proportion-children-who-get-no-recommended-vaccines-age-2-years-iid-02>



# Maintain the vaccination coverage level of 1 dose of the MMR vaccine in children by age 2 years — IID-03



Status: Little or no detectable change 

[Learn more about our data release schedule](#)



Most Recent Data:  
**90.4** percent (2017)



Target:  
**90.8** percent



Desired Direction:  
**Increase desired**



Baseline:  
**90.8** percent of children born in 2015 received at least 1 dose of MMR by their 2nd birthday

[See detailed data for this objective](#)

**Maintain the vaccination coverage level of 1 dose of the measles-mumps-rubella (MMR) vaccine among children by age 2 years**

<https://health.gov/healthypeople/objectives-and-data/browse-objectives/vaccination/maintain-vaccination-coverage-level-1-dose-mmr-vaccine-children-age-2-years-iid-03>



# Maintain the vaccination coverage level of 2 doses of the MMR vaccine for children in kindergarten — IID-04



Status: Little or no detectable change 

[Learn more about our data release schedule](#)



Most Recent Data:

**93.0** percent (2021-22)



Target:

**95.0** percent



Desired Direction:

**Increase desired**



Baseline:

**94.7** percent of children enrolled in kindergarten received 2 or more doses of MMR for the 2018-19 school year

<https://health.gov/healthypeople/objectives-and-data/browse-objectives/vaccination/maintain-vaccination-coverage-level-2-doses-mmr-vaccine-children-kindergarten-iid-04>



# Increase the coverage level of 4 doses of the DTaP vaccine in children by age 2 years — IID-06



Status: Little or no detectable change 

[Learn more about our data release schedule](#)



Most Recent Data:  
**80.9** percent (2017)



Target:  
**90.0** percent



Desired Direction:  
**Increase desired**



Baseline:  
**80.7** percent of children born in 2015 received 4 or more doses of DTaP by their 2nd birthday

<https://health.gov/healthypeople/objectives-and-data/browse-objectives/vaccination/increase-coverage-level-4-doses-dtap-vaccine-children-age-2-years-iid-06>



# It is critical to understand why this is such a challenge

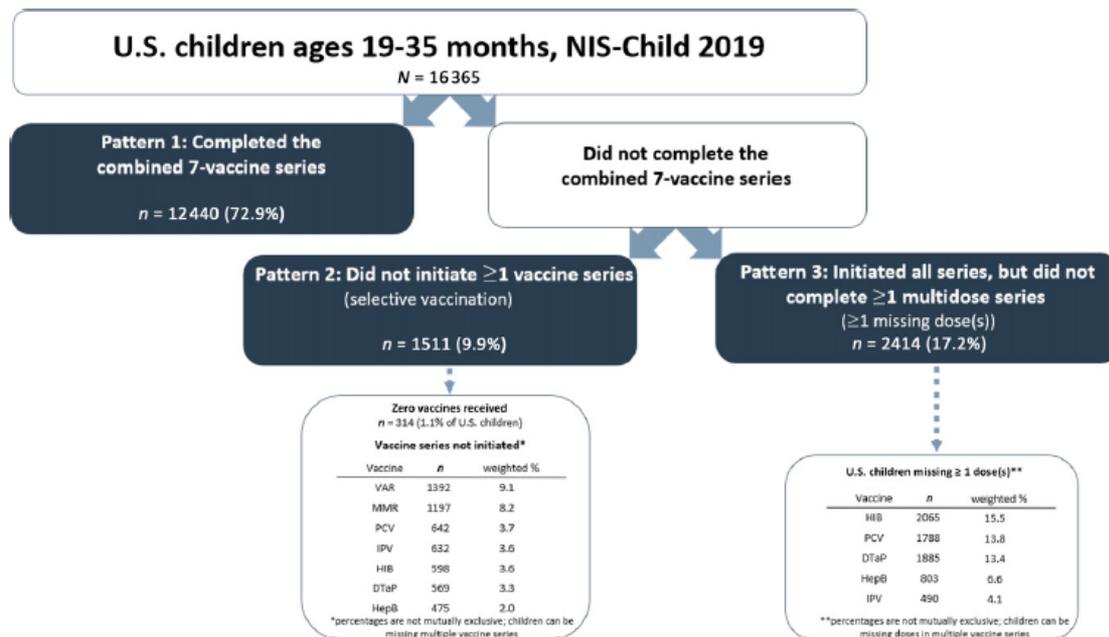


## Failure to Complete Multidose Vaccine Series in Early Childhood

Sarah Y. Michels, MPH,<sup>a,b</sup> Linda M. Niccolai, PhD,<sup>a</sup> James L. Hadler, MD, MPH,<sup>a</sup> Rain E. Freeman, MPH,<sup>b</sup> Alexandria N. Albers, MPH, MS,<sup>b,c</sup> Jason M. Glanz, PhD,<sup>d,e</sup> Matthew F. Daley, MD,<sup>d,f</sup> Sophia R. Newcomer, PhD, MPH<sup>c</sup>

- National Immunization Survey-Child data, US children ages 19 to 35 months
- Classified in 1 of 3 vaccination patterns: (1) completed the combined 7-vaccine series, (2) did not initiate  $\geq 1$  of the 7-vaccine series, or (3) initiated all series, but did not complete  $\geq 1$  multidose series
- Among 16 365 children, 72.9% completed the combined 7-vaccine series

Michels, Sarah Y., et al. "Failure to Complete Multidose Vaccine Series in Early Childhood." *Pediatrics* 152.2 (2023).





# How does that look in the Military Health System?



**TABLE 2.** Percent of Children With Health Care Coverage and Parent-reported Barriers to Obtaining Immunizations by Type of Usual Immunization Provider

Health System Factor	Usual Immunization Provider					Total N = 749*	P
	Private Offices n = 252	Public Clinics n = 148	Hospital Clinics/ Community Center n = 89	Military Clinics n = 177	Military Contract n = 77		
	%	%	%	%	%	%	
Health care coverage†							
CHAMPUS	16	10	10	97	99	42	<.001
Medicaid	31	60	76	2	1	32	<.001
Private fee-for-service/HMO	49	21	10	3	3	23	<.001
Uninsured	6	10	8	0	1	5	.003
Parent-reported problem obtaining immunizations‡							
At least one problem reported	29	33	34	41	46	35	.049
Waiting time a problem	5	17	11	14	22	12	<.001
Appointment system inadequate	4	4	6	18	24	10	<.001
Taking time away from work a problem	5	5	6	12	7	7	.080
Cost problem	12	5	6	5	0	7	.002
Transportation lacking	3	12	7	2	1	5	<.001
Clinic/office hours too limited	3	3	5	10	6	5	.011
Illness of child	3	<1	5	3	12	4	<.001
Waiting time >1 hour‡	9	23	27	16	30	17	<.001

System barriers, frequent work-related moves and strict workplace schedules may limit vaccination opportunities

Morrow AL, Rosenthal J, Lakkis HD, et al. A population-based study of access to immunization among urban Virginia children served by public, private, and military health care systems. *Pediatrics*. Feb 1998;101(2):E5.

# Assessment of Immunization Compliance Among Children in the Department of Defense Health Care System

J. O. Lopreiato, MD; and M. C. Ottolini, MD, MPH

- Cross sectional survey of vaccination status (4:3:1:1 schedule) of military children at 7 military health care facilities from May 1992-April 1993
- 1555 of 1857 (84%) of children were up to date

Lopreiato JO, Ottolini MC. Assessment of immunization compliance among children in the Department of Defense health care system. *Pediatrics*. 1996 Mar;97(3):308-11. PMID: 8604262.

**TABLE 1.** Percentage of Children Up-to-Date in Immunizations by Age

Age	Up-to-Date	Total	Percent
2-12 mo	333	370	90.0
13-24 mo	257	309	83.2
25-35 mo	156	182	85.7
36-48 mo	120	141	85.1
49-71 mo	219	246	89.0
6-8 y	224	258	86.8
9-11 y	152	164	92.7
12-14 y	62	115	53.9
≥15 y	32	72	44.4
<b>Totals</b>	<b>1555</b>	<b>1857</b>	<b>83.7</b>



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

Angela C. Dunn, MD, MPH<sup>a,b</sup>, Carla L. Black, PhD, MPH<sup>c</sup>, John Arnold, MD<sup>d</sup>, Stephanie Brodine, MD<sup>b</sup>, Jill Waalen, MD, MPH<sup>a,b</sup>, Nancy Binkin, MD, MPH<sup>b</sup>

Vaccination	Military Dependents ( <i>n</i> = 3421; 2.8%), <i>n</i> (weighted %; 95% CI)	All Others ( <i>n</i> = 100 386; 97.2%), <i>n</i> (weighted %; 95% CI)
≥ 4 doses DTaP <sup>a</sup>	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)
<b>Combined series</b>		
4:3:1:~3:1 <sup>b</sup>	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.

<sup>a</sup> Also includes children who might have been vaccinated with diphtheria-tetanus toxoids-pertussis vaccine, and diphtheria and tetanus toxoids vaccine.

<sup>b</sup> 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.

Dunn AC, Black CL, Arnold J, Brodine S, Waalen J, Binkin N. Childhood vaccination coverage rates among military dependents in the United States. *Pediatrics*. 2015 May;135(5):e1148-56. doi: 10.1542/peds.2014-2101. Epub 2015 Apr 13. PMID: 25869378.

- National Immunization Survey data used to measure vaccination coverage estimates of US children aged 19 to 35 months old from 2007 through 2012
  - Using the 4:3:1:3:3:1 vaccination schedule
- 28.0% of military children were not up to date on the 4:3:1:3:3:1 vaccination series compared with 21.1% of all other children (odds ratio 1.4; 95% confidence interval: 1.2–1.6)
- After adjusting, military children were still more likely to be incompletely vaccinated (odds ratio 1.3; 95% confidence interval: 1.1–1.5)

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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.

Dunn AC, Black CL, Arnold J, Brodine S, Waalen J, Binkin N. Childhood vaccination coverage rates among military dependents in the United States. Pediatrics. 2015 May;135(5):e1148-56. doi: 10.1542/peds.2014-2101. Epub 2015 Apr 13. PMID: 25869378.



# Are there other ways to look at the MHS?



- Nestander et al, JPIDS 2018: Retrospective cohort using MDR of infants born between 2008 and 2011
  - Primary objective was to assess whether low birthweight infants were at risk for underimmunization at 2 years of age
  - Immunization status was evaluated for completeness at 2 years of age and was defined by the 4:3:1:3:3:1 immunization schedule
  - Immunization rate among 135, 964 infants was 85.7%

Nestander M, Dintaman J, Susi A, Gorman G, Hisle-Gorman E. Immunization Completion in Infants Born at Low Birth Weight. J Pediatric Infect Dis Soc. 2018 Aug 17;7(3):e58-e64. doi: 10.1093/jpids/pix079. PMID: 29036471.



# My partners at the Naval Health Research Center



- DoD Birth and Infant Health Research (BIHR) program was established in 1998 to be a repository for health information for DoD beneficiary infants and their parents
- BIHR data include administrative healthcare encounter records for all direct and purchased care received from MTFs and TRICARE-reimbursed facilities respectively, as well as other demographic and military information extracted from DoD-maintained databases (e.g., DEERS)



# This was our first look



## Brief Report: Pediatric Vaccine Completion and Compliance Among Infants Born to Female Active Duty Service Members, 2006–2016

*Celeste J. Romano, MS; Anna T. Bukowinski, MPH; Clinton Hall, PhD; Monica Burrell, MPH; Gia R. Gumbs, MPH; Ava Marie S. Conlin, DO, MPH; Nanda Ramchandrar, MD, MPH*

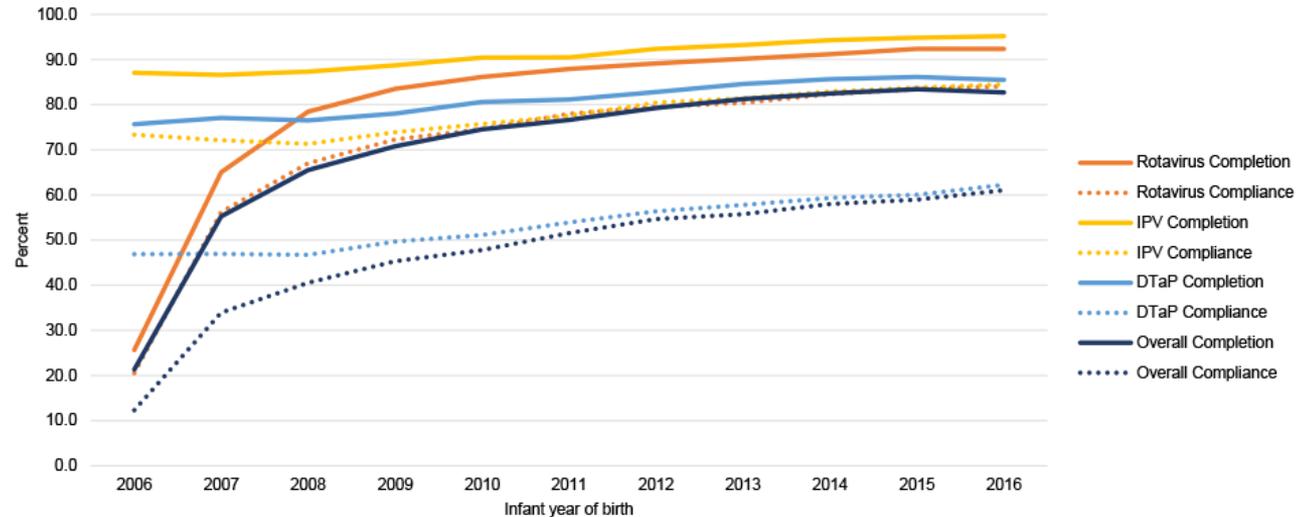
Used the MHS immunization registry and medical encounter data to assess:

1. Rotavirus vaccine coverage relative to IPV and DTaP vaccines
2. Pediatric undervaccination among infants born to female active-duty service members

Romano CJ, Bukowinski AT, Hall C, Burrell M, Gumbs GR, Conlin AMS, Ramchandrar N. Brief Report: Pediatric Vaccine Completion and Compliance Among Infants Born to Female Active Duty Service Members, 2006-2016. MSMR. 2022 Nov 1;29(11):18-22. PMID: 36790926.



**FIGURE.** Percentage of infants born to active duty service members who complete and are compliant with pediatric vaccine recommendations, by vaccine series, and overall, Department of Defense Birth and Infant Health Research program data, 2006-2016 (n=103,522)



Rotavirus vaccination increased following vaccine approval and exceeded national rates and Healthy People 2020 goals by 2009

Incomplete and delayed vaccination was more prevalent for DTaP

Romano CJ, Bukowinski AT, Hall C, Burrell M, Gumbs GR, Conlin AMS, Ramchandrar N. Brief Report: Pediatric Vaccine Completion and Compliance Among Infants Born to Female Active Duty Service Members, 2006-2016. *MSMR*. 2022 Nov 1;29(11):18-22. PMID: 36790926.



Characteristic	Total*		Complete, non-delayed vaccination		Complete, delayed vaccination		Incomplete vaccination	
	No.	%	No.	%	No.	%	No.	%
Total	103,522	100.0	53,653	51.8	27,005	26.1	22,864	22.1
<b>Age of infant birth</b>								
18–24 years	39,897	38.5	18,617	46.7	10,736	26.9	10,544	26.4
25–29 years	32,684	31.6	17,339	53.1	8,522	26.1	6,823	20.9
30–34 years	20,687	20.0	11,742	56.8	5,172	25.0	3,773	18.2
35+ years	10,254	9.9	5,955	58.1	2,575	25.1	1,724	16.8
<b>Race and ethnicity</b>								
American Indian or Alaska Native	2,191	2.1	1,016	46.4	573	26.2	602	27.5
Asian or Pacific Islander	6,988	6.8	3,820	54.7	1,772	25.4	1,396	20.0
Hispanic	15,932	15.4	8,362	52.5	4,313	27.1	3,257	20.4
Non-Hispanic Black	27,685	26.7	13,785	49.8	7,762	28.0	6,138	22.2
Non-Hispanic White	47,032	45.4	24,783	52.7	11,679	24.8	10,570	22.5
Other/Unknown	3,694	3.6	1,887	51.1	906	24.5	901	24.4
<b>Marital status</b>								
Married	79,095	76.4	41,650	52.7	20,411	25.8	17,034	21.5
Unmarried/Unknown	24,427	23.6	12,003	49.1	6,594	27.0	5,830	23.9
<b>Military rank</b>								
Enlisted	86,469	83.5	43,036	49.8	23,264	26.9	20,169	23.3
Officer	17,053	16.5	10,617	62.3	3,741	21.9	2,695	15.8
<b>Service branch</b>								
Air Force	33,655	32.5	16,931	50.3	9,111	27.1	7,613	22.6
Army	35,152	34.0	19,377	55.1	9,301	26.5	6,474	18.4
Coast Guard	2,619	2.5	1,076	41.1	545	20.8	998	38.1
Marine Corps	6,910	6.7	3,600	52.1	1,627	23.5	1,683	24.4
Navy	25,186	24.3	12,669	50.3	6,421	25.5	6,096	24.2
<b>Deployment within 24 months postpartum</b>								
No	86,120	83.2	45,820	53.2	21,906	25.4	18,394	21.4
Yes	17,402	16.8	7,833	45.0	5,099	29.3	4,470	25.7
<b>Infant birth location</b>								
Civilian facility	31,903	30.8	15,900	49.8	8,196	25.7	7,807	24.5
Military treatment facility	71,619	69.2	37,753	52.7	18,809	26.3	15,057	21.0
<b>Primary well-child care location</b>								
Civilian facility	18,156	17.5	8,934	49.2	3,773	20.8	5,449	30.0
Military clinics	85,366	82.5	44,719	52.4	23,232	27.2	17,415	20.4
<b>Change of well-child care location</b>								
No	40,250	38.9	21,082	52.4	9,753	24.2	9,415	23.4
Yes	63,272	61.1	32,571	51.5	17,252	27.3	13,449	21.3
<b>Infant enrollment type</b>								
TRICARE Prime	102,476	99.0	53,285	52.0	26,857	26.2	22,334	21.8
Other	1,046	1.0	368	35.2	148	14.1	530	50.7

Romano CJ, Bukowski AT, Hall C, Burrell M, Gumbs GR, Conlin AMS, Ramchandrar N. Brief Report: Pediatric Vaccine Completion and Compliance Among Infants Born to Female Active Duty Service Members, 2006-2016. MSMR. 2022 Nov 1;29(11):18-22. PMID: 36790926.



# So we took a broader view



We assessed immunization completion and timeliness for eight ACIP-recommended vaccines (each of the combined 7-vaccine series and rotavirus) by age 24 months

Combined 7-vaccine series: DTap (4 doses), polio (3 doses), MMR (1 dose), Hepatitis B (3 doses), Hib (3 doses), varicella (1 dose), PCV13 (4 doses)

- PCV13 was not required for children born in 2010
- We examined rotavirus vaccine (2 doses) separately from the 7-series

Romano CJ, Burrell M, Bukowski AT, et al. Vaccine Completion and Timeliness Among Children in the Military Health System: 2010–2019. *Pediatrics*. 2024;154(4):e2023064965



## We established a large study population

- BIHR program data were used to identify children born at military treatment facilities, 2010-2019
- Additionally, children were required to:
  - Be enrolled in TRICARE in their first year and continuously enrolled through their second
  - Receive at least one immunization at an MTF
  - Have at least one well-child visit annually

**1,149,705**

children born in the Military Health System,  
2010-2019

**448,140**

born at a military treatment facility (MTF)

**338,341**

enrolled in TRICARE through age 2 years

**275,967**

have at least one well-child visit annually at  
an MTF



## And looked for:



- Completion: Received all recommended doses

## AND

- Timeliness: Received recommended doses prior to the age when undervaccination is initiated (per the ACIP schedule)
  - For example, undervaccination for doses recommended at age 2 months begins at age 93 days, and age 4 months at age 154 days

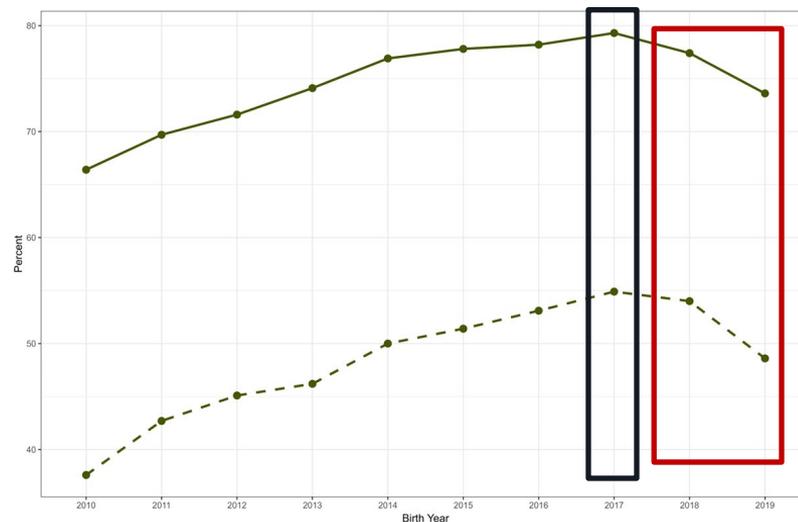


## And this is what we found:



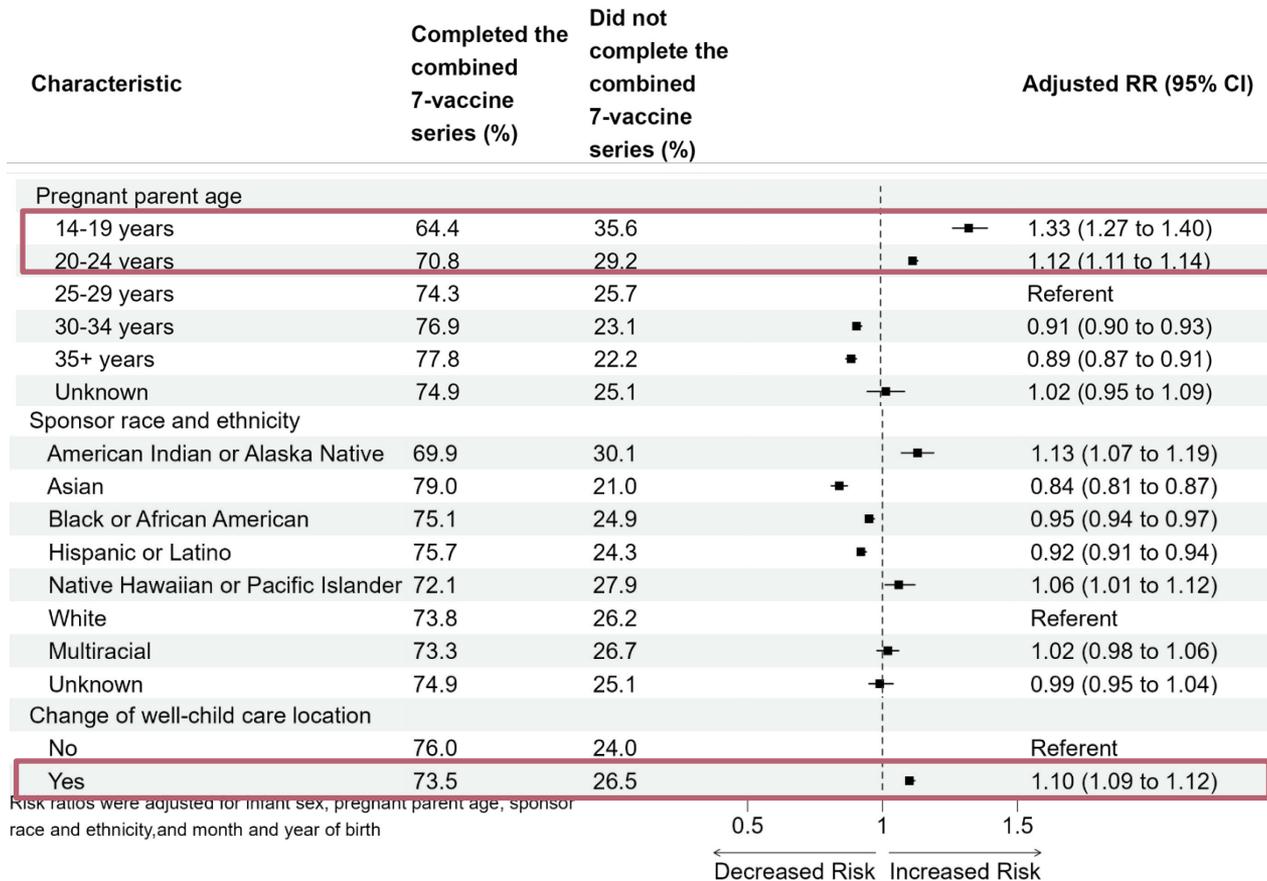
Vaccine series	Completion (%)	Timeliness (%)*
<b>Combined 7-vaccine series</b>	<b>74.4</b>	<b>63.8</b>
<b>Individual vaccine series</b>		
Rotavirus	77.5 (lowest)	93.3
DTaP	83.1	67.3
Hib	86.6	78.9
PCV	88.4	74.5
Hepatitis B	93.3	92.8
Varicella	94.2	93.6
MMR	94.9	94.7
Polio	95.0 (highest)	85.0

\*Calculated among children who completed each relevant series



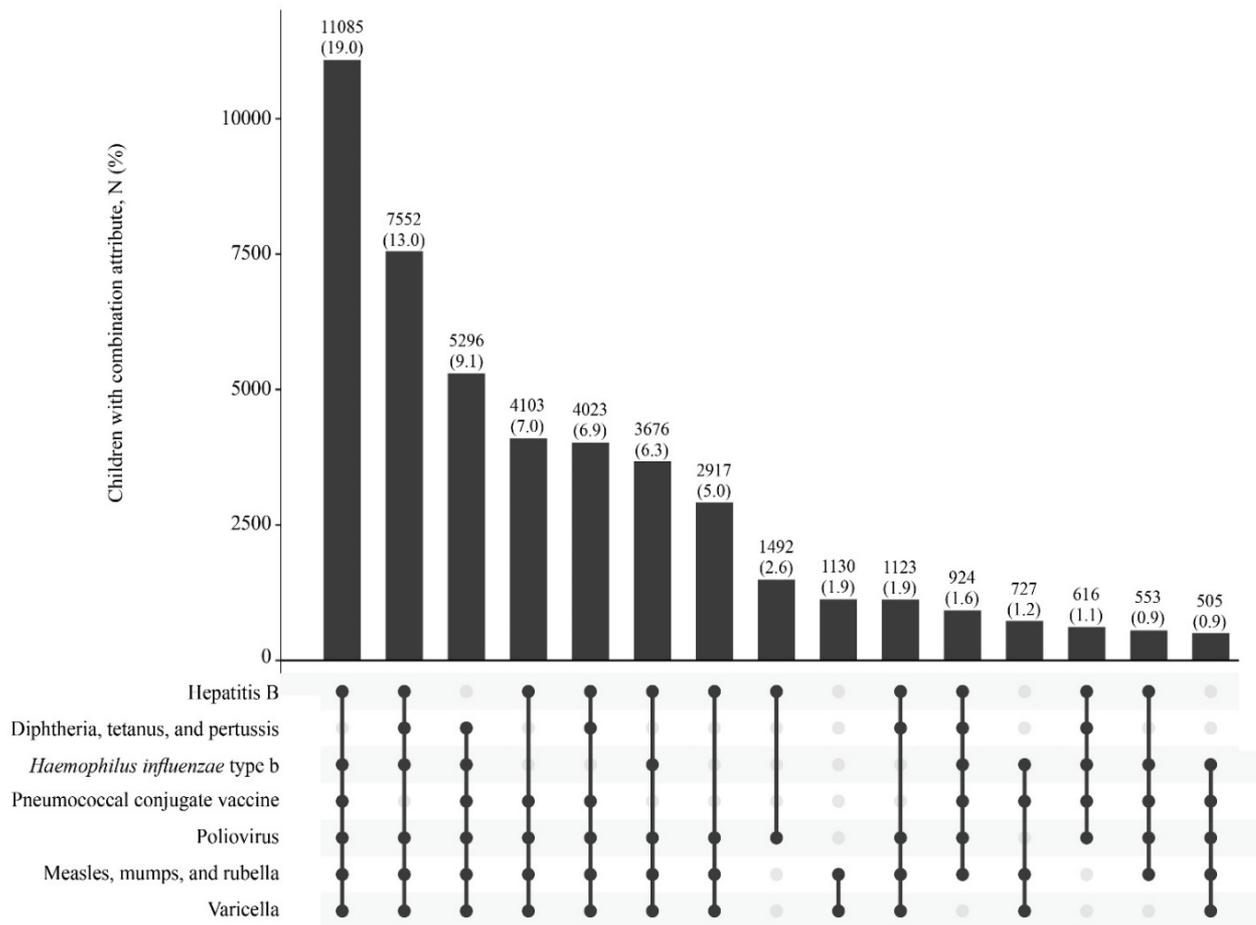
Children affected by the COVID-19 pandemic

Combined 7-vaccine series completion  
 Combined 7-vaccine series timeliness





# Leading contributors to noncompletion of the 7-vaccine series





## These are the key points



- Overall **completion of the combined 7-vaccine series was 74.4%**, with a peak rate of 78.7% for children born 2016–2017
- Among children who completed the vaccine series, **36.2% experienced delays**
- Non-completion and delays for DTaP, Hib, and PCV were among the greatest contributors to overall estimates



## We pivoted from there to look at patterns of non-completion

- Examined 275,967 military-connected children
- Vaccination patterns through age 23 months were categorized by the frequency of limited vaccine visits (i.e., visits with 1-2 vaccines administered)
  - Consistent vaccine limiting: all limited visits
  - Episodic vaccine limiting:  $\geq 1$  limited visit and no more than 3 visits with  $\geq 3$  vaccines



	2 MONTHS	3 MONTHS	4 MONTHS	5 MONTHS	6 MONTHS	9 MONTHS	12 MONTHS	15 MONTHS	18 MONTHS	24 MONTHS	Vaccination Pattern	
Combined 7-vaccine series complete no delays	<b>Child A</b> HepB, DTap, Hib, PCV13, Rotavirus, Polio (2M); DTap, Hib, PCV13, Rotavirus, Polio (3M); DTap, HepB, MMR, Varicella, PCV13, Hib (9M); DTap (12M)											Non-Limiter
	<b>Child B</b> HepB, DTap, Hib, PCV13, Rotavirus, Polio (2M); HepB, DTap, Hib, PCV13, Rotavirus, Polio (3M); HepB, DTap, Hib, PCV13, Rotavirus, Polio (6M); MMR, Varicella (12M); PCV13, Hib (15M); DTap (18M)											Episodic limiter
Combined 7-vaccine series complete with delay	<b>Child C</b> DTap, Rotavirus (2M); PCV13, Hib (3M); DTap, Rotavirus (4M); PCV13, Hib (5M); DTap, PCV13 (6M); Polio, HepB (9M); MMR, Polio (12M); PCV13, Hib (15M); DTap, Varicella (18M); Polio, HepB (24M)											Consistent limiter
	<b>Child D</b> DTap, Hib, PCV13, Rotavirus, Polio (2M); PCV13, Rotavirus (3M); HepB, DTap, Hib, PCV13, Rotavirus, Polio (6M); MMR, Varicella, PCV13 (12M); DTap, Hib (15M)											Episodic limiter
Combined 7-vaccine series incomplete	<b>Child E</b> DTap, Rotavirus (2M); PCV13, Hib (3M); DTap, Rotavirus (4M); PCV13, Hib (5M); DTap, Rotavirus (6M); PCV13, Hib (9M); Polio, Hib (12M); DTap, Polio (18M)											Consistent limiter



# Consistent vaccine limiting was rare



- Consistent vaccine limiting observed in 0.3% and episodic vaccine limiting in 13.4% of the cohort
- Consistent and episodic vaccine limiting were associated with 5.6 (95% CI: 5.5-5.7) and 3.0 (95% CI: 2.9-3.0) times the risk of noncompletion, respectively
- 5.3% of children had fewer than 4 vaccine visits, the minimum number needed to complete all recommended vaccine series

Vaccine series	Overall (n = 275,967)	Vaccination pattern			
		Non-limiter (n = 223,656)	Episodic vaccine limiting (n = 36,879)	Consistent vaccine limiting (n = 758)	Other (< 4 vaccine visits) (n = 14,674)
Hepatitis B (3)	93.3	97.4	93.1	16.6	34.6
Rotavirus (2-3)	77.5	83.7	67.3	30.3	10.8
Diphtheria, tetanus, and pertussis (4)	83.1	90.6	71.6	49.2	0.0
<u>Haemophilus influenzae</u> type b (3-4)	86.6	94.2	72.0	46.4	8.9
Pneumococcal conjugate vaccine (4)	88.4	97.1	72.2	41.3	0.0
Poliovirus (3)	95.0	99.7	94.2	38.4	29.4
Measles, Mumps, and Rubella (1)	94.9	99.5	93.1	47.5	30.4
Varicella (1)	94.2	99.2	90.8	35.4	28.4

Note: DoD, Department of Defense; BIHR, Birth and Infant Health Research



# Application to clinical practice



- Recognize the risk factors
  - Greater risk for non-completion and intermittent limiting among younger parents suggest system barriers such as wait times and limited clinic hours may continue to limit access
    - ✓ Parent-provider communication is especially important, so parents are prepared for pediatric immunizations at each respective visit and delays do not occur due to initial vaccine hesitancy
    - ✓ System prompts to the provider at the point of care may also help prevent missed opportunities
- Don't miss any opportunity
  - PCS and deployments are a vulnerable time
  - Providers should pay special attention to completion of **DTaP, Hib, and PCV** vaccines due to increased risk for delay



## And we still need to grapple with the elephant in the room

- The COVID-19 pandemic has had lasting impact on vaccination rates
  - Likely multifactorial, but an area of active investigation

### WHICH includes...

Hill, Holly A. "Decline in Vaccination Coverage by Age 24 Months and Vaccination Inequities Among Children Born in 2020 and 2021—National Immunization Survey-Child, United States, 2021–2023." *MMWR. Morbidity and Mortality Weekly Report* 73 (2024).

TABLE 1. Estimated vaccination coverage, by age 24 months\* among children born during 2018–2019 and 2020–2021 for selected vaccines and doses — National Immunization Survey-Child, United States, 2019–2023

Vaccine/Dose	% (95% CI)		Difference (2018–2019 to 2020–2021)
	Birth year <sup>†</sup>		
	2018–2019	2020–2021	
<b>DTaP<sup>6</sup></b>			
≥3 doses	94.3 (93.8 to 94.7)	92.5 (91.8 to 93.2)	–1.8 (–2.6 to –1.0) <sup>‡</sup>
≥4 doses	81.8 (81.0 to 82.6)	79.3 (78.2 to 80.4)	–2.5 (–3.8 to –1.1) <sup>‡</sup>
<b>Poliovirus</b>			
(≥3 doses)	93.4 (92.9 to 93.9)	91.9 (91.2 to 92.6)	–1.5 (–2.4 to –0.6) <sup>‡</sup>
<b>MMR</b>			
(≥1 dose)**	92.0 (91.4 to 92.6)	90.3 (89.6 to 91.0)	–1.7 (–2.6 to –0.7) <sup>‡</sup>
<b>Hib<sup>††</sup></b>			
Primary series	93.8 (93.3 to 94.3)	91.6 (90.8 to 92.3)	–2.2 (–3.1 to –1.3) <sup>‡</sup>
Full series	80.0 (79.2 to 80.9)	76.8 (75.7 to 77.9)	–3.2 (–4.6 to –1.8) <sup>‡</sup>
<b>HepB</b>			
Birth dose <sup>55</sup>	80.3 (79.4 to 81.1)	79.5 (78.5 to 80.5)	–0.8 (–2.1 to 0.6)
≥3 doses	92.6 (92.0 to 93.1)	91.1 (90.3 to 91.8)	–1.5 (–2.4 to –0.6) <sup>‡</sup>
<b>VAR</b>			
(≥1 dose)**	91.2 (90.5 to 91.8)	89.9 (89.1 to 90.6)	–1.3 (–2.2 to –0.3) <sup>‡</sup>
<b>PCV</b>			
≥3 doses	93.4 (92.9 to 93.9)	91.6 (90.9 to 92.3)	–1.8 (–2.6 to –0.9) <sup>‡</sup>
≥4 doses	83.4 (82.7 to 84.2)	80.7 (79.6 to 81.8)	–2.7 (–4.1 to –1.4) <sup>‡</sup>
<b>HepA<sup>†††</sup></b>			
≥1 dose	88.1 (87.4 to 88.8)	86.5 (85.6 to 87.4)	–1.6 (–2.7 to –0.4) <sup>‡</sup>
≥2 doses	47.6 (by age 24 mos)	46.0 (44.8 to 47.2)	–1.6 (–3.2 to 0)
≥2 doses	79.8 (by age 35 mos)	77.7 (76.1 to 79.2)	–2.1 (–4.1 to –0.1) <sup>‡</sup>
<b>Rotavirus</b>			
(by age 8 mos) <sup>***</sup>	77.1 (76.2 to 78.0)	75.1 (74.0 to 76.2)	–2.0 (–3.4 to –0.5) <sup>‡</sup>
<b>Influenza</b>			
(≥2 doses) <sup>†††</sup>	63.4 (62.4 to 64.4)	55.6 (54.4 to 56.8)	–7.8 (–9.4 to –6.2) <sup>‡</sup>
<b>Combined seven-vaccine series<sup>555</sup></b>			
	70.1 (69.2 to 71.1)	66.9 (65.7 to 68.2)	–3.2 (–4.8 to –1.6) <sup>‡</sup>
<b>No vaccinations<sup>555</sup></b>			
	0.9 (0.8 to 1.1)	1.2 (1.0 to 1.4)	0.2 (0 to 0.5)



## ...the ever-growing issue of vaccine hesitancy

- In a 2010 survey of 1500 parents:
  - 3% refused all vaccines
  - 19.4% refused at least one
- 87% of pediatricians have encountered vaccine refusal (pre-pandemic)
- But we need more data post-pandemic
  - In a survey from Colorado, parents were more likely to be unsure about trusting vaccine information in the pandemic time-period (aOR = 2.14; 95% CI = 1.55-2.96)

1. Edwards, Kathryn M., et al. "Countering vaccine hesitancy." *Pediatrics* (2016): e20162146.
2. Smith, M. "Vaccine safety: medical contraindications, myths, and risk communication." *Pediatrics in review/American Academy of Pediatrics* 36.6 (2015): 227-238.
3. Higgins DM, Moss A, Blackwell S, O'Leary ST. The COVID-19 Pandemic and Parental Attitudes Toward Routine Childhood Vaccines. *Pediatrics*. 2023 Nov 1;152(5):e2023062927. doi: 10.1542/peds.2023-062927. PMID: 37867454.



## There are different approaches you can take

Address the parents' concern

Adopt a presumed approach

Providing textual information, showing images, and dramatic narratives don't necessarily work and can actually hurt

Hold strong; 47% of parents will come around

Ultimately, the physician recommendation is the strongest factor (according to 80% of parents)

1. Smith, M. "Vaccine safety: medical contraindications, myths, and risk communication." *Pediatrics in review/American Academy of Pediatrics* 36.6 (2015): 227-238.
2. Edwards, Kathryn M., et al. "Countering vaccine hesitancy." *Pediatrics* (2016): e20162146.



# This has been done to great effect by DHA IHD



**TABLE II.** Receipt of Subsequent Vaccinations Among 146 Military Beneficiaries Who Experienced an AEFI and Received Consultative Support From DHA Immunization Health Care Clinicians (Percentage Among Those for Whom Vaccine Was Recommended)

	Any vaccine	AEFI-associated vaccine	Influenza vaccine	COVID-19 vaccine
Total cohort	78.1% (114/146)	57.8% (63/109)	55.2% (80/145)	49.3% (66/134)
Age				
0–17 years	80.4% (41/51)	62.2% (23/37)	60.0% (30/50)	20.0% (9/45)
18 years and older	76.8% (73/95)	55.6% (40/72)	52.6% (50/95)	64.0% (57/89)
Sex				
Male	70.4% (31/44)	69.2% (18/26)	58.1% (25/43)	35.3% (12/34)
Female	81.4% (83/102)	54.2% (45/83)	53.9% (55/102)	54.0% (54/100)
AEFI severity				
Level 1	100% (4/4)	66.7% (2/3)	100% (4/4)	75.0% (3/4)
Level 2	90.7% (49/54)	68.4% (26/38)	71.7% (38/53)	50.0% (27/54)
Level 3	69.6% (55/79)	50.0% (32/64)	41.8% (33/79)	47.8% (32/67)
Level 4	66.7% (6/9)	75.0% (3/4)	55.6% (5/9)	44.4% (4/9)
AEFI type				
Anaphylaxis	50.0% (4/8)	N/A (1/0)	42.9% (3/7)	25.0% (2/8)
Dermatologic reaction	81.5% (44/54)	51.2% (21/41)	57.4% (31/54)	44.4% (24/54)
SIRVA	86.7% (13/15)	46.7% (7/15)	60.0% (9/15)	53.3% (8/15)
Myo/pericarditis	41.7% (5/12)	N/A (2/0)	41.7% (5/12)	N/A (2/0)
Neurologic reaction	90.0% (18/20)	73.7% (14/19)	65.0% (13/20)	60.0% (12/20)
Other	81.1% (30/37)	52.9% (18/34)	51.4% (19/37)	48.6% (18/37)

Loran, David A., Sophia Angelo, and Margaret Ryan. "Specialized Vaccine Care for Adverse Events Following Immunization and Impact on Vaccine Hesitancy in the Military Health System." *Military Medicine* 189.Supplement\_3 (2024): 546-550.



## These are the future directions we need to go

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- We need a better characterization of why and how families engage in vaccine limiting
- We need to figure out how to remove systemic barriers
- We need to learn about the nature of vaccine hesitancy and where it is manifesting in the current geopolitical landscape



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# Questions?



# How to Obtain CE/CME Credit



## Clinical Communities Speaker Series: Cultivating the Wellbeing of Our Military Children, Youth, and Families

Credits are awarded by session. To claim CE/CME credit for the session(s) you attend, complete the evaluation survey and posttest for each session by **Thursday, May 8, at 11:59 PM Eastern Time**.

1. Visit the main event page at <https://www.dhaj7-cepo.com/content/2025-apr-ccss>. From there, register for the event or log in to your account if already registered.
2. Once logged in and registered, on the main event page, select “Get Started” (located in the menu below the event title on desktop and at the bottom of the page on mobile devices). Note: This tab will not appear unless you are registered and logged in to your account.
3. Under the “Get Started” tab, scroll down to a session you attended and select “Claim credit.”
4. Proceed to take the evaluation and posttest to obtain CE/CME credit for the session.

All completed sessions and certificates are available in [your account](#). Refer to your [pending activities](#) for sessions you have yet to complete.

**Questions?** Email the DHA J-7 Continuing Education Program Office at [dha.ncr.j7.mbx.cepo-cms-support@health.mil](mailto:dha.ncr.j7.mbx.cepo-cms-support@health.mil).