RETROSPECTIVE IMMUNIZATION COVERAGE SURVEY

2007-2008 Results (School Year 2011-12)

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ACRONYMS

CI	Confidence interval
HP2010	Healthy People 2010
KCI	Kansas Certificate of Immunizations
KDHE	Kansas Department of Health and Environment
KSDE	Kansas State Department of Education
UTD	Up-to-date

VACCINE ACRONYMS

DTaP4	4 doses of diphtheria and tetanus toxoids and acellular pertussis vaccines including diphtheria and tetanus toxoids (DTaP/DT) vaccine
HepB3	3 doses of hepatitis B vaccine
Hib3	3 doses of *Haemophilus influenzae* type b vaccine
MMR1	1 doses of measles, mumps, and rubella vaccine
PCV4	4 doses of pneumococcal conjugate vaccine
Polio3	3 doses of polio vaccine
Var1	1 dose of varicella vaccine
4-3-1-3-3	DTaP4-Polio3-MMR1-Hib3-HepB3
4-3-1-3-3-1-4	DTaP4-Polio3-MMR1-Hib3-HepB3-Var1-PCV4

EXECUTIVE SUMMARY

Overview

The Kansas Certificates of Immunizations (KCIs) and other immunization records for children enrolled in a kindergarten class in Kansas public and private schools during the 2011-2012 school year were collected and evaluated for immunization coverage levels. Children born between September 2, 2004, and September 1, 2005, were included in this study, and their immunization coverage levels at 24 months of age, which corresponds to September 2, 2007, and September 1, 2008, were analyzed. In total, there were 793 schools (689 public and 104 private) included in the analysis, which consisted of a representative sample of 14,336 children from both public and private schools.

Coverage at 24 Months of Age

The statewide coverage level for the 4-3-1-3-3 series (DTaP4, Polio3, MMR1, Hib3, HepB3) for children by 24 months of age was 71.7%, which was below the Healthy People 2010 (HP2010) goal of at least 80%. Three vaccinations reached the HP2010 goal of 90% immunization coverage or better: Polio3, MMR1, and HepB3. Of the vaccination series that are required for school entry (DTaP, Polio, MMR, HepB, and Var) and thus recorded more reliably on the immunization record, DTaP4 was the farthest from reaching the HP2010 goal, with 80.2% coverage.

The 105 Kansas counties were grouped into 3 categories based on population density, and coverage levels were compared among these groups (Appendix 1). Counties that were "sparsely populated" (<20 persons per square mile) had higher coverage levels for the 4-3-1-3-3 series (78.6%) than "moderately populated" (20 – 149.9 persons per square mile, 71.8%) and "urban" (≥150 persons per square mile, 68.2%) counties. Polio3, MMR1, HepB3, PCV4, and Var1 showed no significant variation in coverage levels between population density groups. Two counties had greater than 90% coverage for all vaccinations; both were sparsely populated (Appendix 2).

RETROSPECTIVE IMMUNIZATION COVERAGE SURVEY 2007-2008 (SCHOOL YEAR 2011-2012)

INTRODUCTION

Objective
This study was conducted to estimate the immunization coverage levels of children at 24 months of age.

Study Population
The study population included a representative sample of all kindergarten students enrolled in both public and private schools in the 2011-2012 school year.

Study Design
A stratified, cross-sectional design was utilized for this study, with each county representing a stratum. The characteristics of interest, or outcome variables, were the percentages of children who were immunized against diphtheria, tetanus, pertussis, polio, measles, mumps, rubella, *Haemophilus influenzae* type b, hepatitis B virus, varicella, and pneumococcal disease. Vaccination coverage was retrospectively assessed for these children at 24 months of age.

Immunization coverage levels were measured for single vaccination series and combinations of vaccinations according to the recommended immunization schedule for children by 24 months of age (Appendix 4).[1] ***The results of the survey refer to children who were born between September 2, 2005, and September 1, 2006. The coverage levels refer to the point in time at which these children turned 24 months old, between September 2, 2007, and September 1, 2008.***

METHODS

Sampling Techniques
A probability sample of all children enrolled in Kansas public school kindergartens was drawn. To ensure an adequate sample size in each county and to maximize the efficiency of the sampling process, a different sampling ratio was established for each county, and a probability sample was selected using a systematic sampling technique. Due to the small size of the private school population in Kansas, all records from private schools were solicited.

Data Collection
All Kansas public and private schools with a kindergarten class received a letter, co-signed by officials representing the Kansas Department of Health and Environment (KDHE) and the Kansas State Department of Education (KSDE), requesting their participation in the survey. The letters sent to public schools specified the number of records required to generate estimates of county-specific immunization coverage levels and outlined the process of systematically selecting a probability sample of records. The study coordinator at each school (typically the school nurse) was instructed to select all kindergarten exemptions for submission to KDHE, then, depending on the calculated sampling ratio for their county,

[1] The Recommended Immunization Schedule used, as reference for ages and immunization in this paper was the schedule approved by the Advisory Committee on Immunization Practices (ACIP), the American Academy of Pediatrics (AAP) and the American Academy of Family Physicians (AAFP) for the year 2006.

proceed to select all, every other, every third, every sixth, every eighteenth, or every twentieth immunization record regardless of the size of the kindergarten class at that school. The private schools were instructed to select all immunization records (including exemptions). Children who were exempt from immunizations were excluded from the sampling. The schools were informed they could submit KCIs or any other form of immunization record, including printouts from computerized record keeping programs. The study coordinators were also advised to remove all personal identifiers, except date of birth, to ensure confidentiality. Copies of the immunization records, exemption records, the current total number of kindergarten enrollees, the total number of exemptions and the number of records sent for both medical and religious exemption in each school were forwarded to KDHE.

Data Analysis

In the 2011-12 survey, the analysis method changed from previous years. In the current study, the immunization coverage levels account for both exempt and non-exempt children's immunization status.[2] Consistent with studies from the 2007-08 Retrospective Survey onward, children who had a date of birth recorded on the Kansas Certificate of Immunizations (KCI) or other data source and were the appropriate age for the analysis were included in the denominator. Point estimates of coverage levels and 95% confidence intervals (95% CI) for DTaP4, Polio3, MMR1, Hib3, HepB3, Var1, PCV4 vaccinations, 4-3-1-3-3 series, and 4-3-1-3-3-1-4 series were calculated. A child was considered up-to-date (UTD) for single vaccination series if, at 24 months of age, he or she had received at least four doses of DTaP (DTaP4), three doses of polio (Polio3), one dose of measles, mumps, and rubella (MMR1), three doses of *H. influenzae* type b (Hib3), three doses of hepatitis B (HepB3), one dose of varicella (Var1) vaccine, or four doses of pneumococcal conjugate (PCV4). A child was considered up-to-date for the 4-3-1-3-3 series if he or she was up-to-date for DTaP4, Polio3, MMR1, Hib3, and HepB3 vaccinations, and up-to-date for the 4-3-1-3-3-1-4 series if he or she was up-to-date for DTaP4, Polio3, MMR1, Hib3, HepB3, Var1, and PCV4 vaccinations. Approximately 0.8% of children in the study had a history of varicella infection recorded on their immunization record and these children were included in the denominator, but only those who reported history of vaccination were included in the numerator. This methodology was performed because the date of disease was frequently not recorded; thus it could not be determined at what age the child had varicella.

Analyses were performed using weighted data and accounted for the complex sample design effect due to the stratification process and differences in sampling ratios between counties.[3] Sample weights were calculated using the number of kindergartners enrolled in a county and the number of records analyzed for that county.

All population and birth cohort data were calculated from the 2006 Annual Summary of Vital Statistics.[4] The 105 counties were categorized based on population densities, and for the purpose of this analysis, counties were grouped into "urban," "moderately populated," and "sparsely populated" (Appendix 1). Immunization coverage level estimates were compared among these groups.

$$2 \quad \frac{\left(\text{Weighted percentage of non-exempt children UTD} \times \text{Number of non-exempt children}\right) + \text{Number of exempt children UTD}}{\text{Total number of children enrolled}}$$

[3] Complex survey design effect was accounted for by using the SAS Procedure PROC SURVEYFREQ.

[4] 2006 Annual Summary of Kansas Vital Statistics (http://www.kdheks.gov/ches).

The results from this survey were compared with the results from the 2008 National Immunization Survey (NIS).[5,6] Data for the population-based NIS are collected by the Centers for Disease Control and Prevention (CDC) through a telephone survey of randomly selected households. For accuracy, healthcare providers of children included in the survey are contacted by mail.

RESULTS

Data Collection

Letters of invitation to participate in the survey were sent to 846 Kansas schools; of these, 727 were public schools and 119 were private. Twenty-six schools reported not having a kindergarten class for the 2011-2012 school year and 26 did not respond. Immunization data were received from 794 schools (690 public schools and 104 private schools) with kindergarten classes, corresponding to a school participation of 96.8%. In total, 793 schools were included in the analysis (689 public schools and 104 private schools). Records from one school were not included in the analysis because the dates of birth had been removed.

The number of children enrolled in kindergarten at the public and private schools that submitted immunization data were 38,402, which was 94% of the 40,896 children in that birth cohort. The children in the birth cohort that did not participate in the study include children who were home schooled or attended other special schools as well as those enrolled in schools that did not participate in the study. The number of immunization records received was 16,405, which is equivalent to one child selected for every 2.4 children enrolled. The range of the sample size by county was 9 to 1,174 records while the range of student enrollment was 9 to 7,526.[7] Submitting schools reported 494 exemptions in the 2011-12 kindergarten class, which accounted for 1.3% of all kindergartners enrolled in participating schools. Of those, 354 exemption records were submitted to KDHE for this study.

Of the 16,405 immunization records submitted and examined, 16,221 (99%) had readable birth dates and immunization dates. Sixty-nine percent of schools submitted KCIs, while 27% submitted printouts from a computerized record keeping program, and 4% of the schools submitted a combination of the two types of records. For the 24 month old analysis, 14,336 (88%) children were included in the analysis because they were 24 months of age between September 2, 2007 and September 1, 2008.

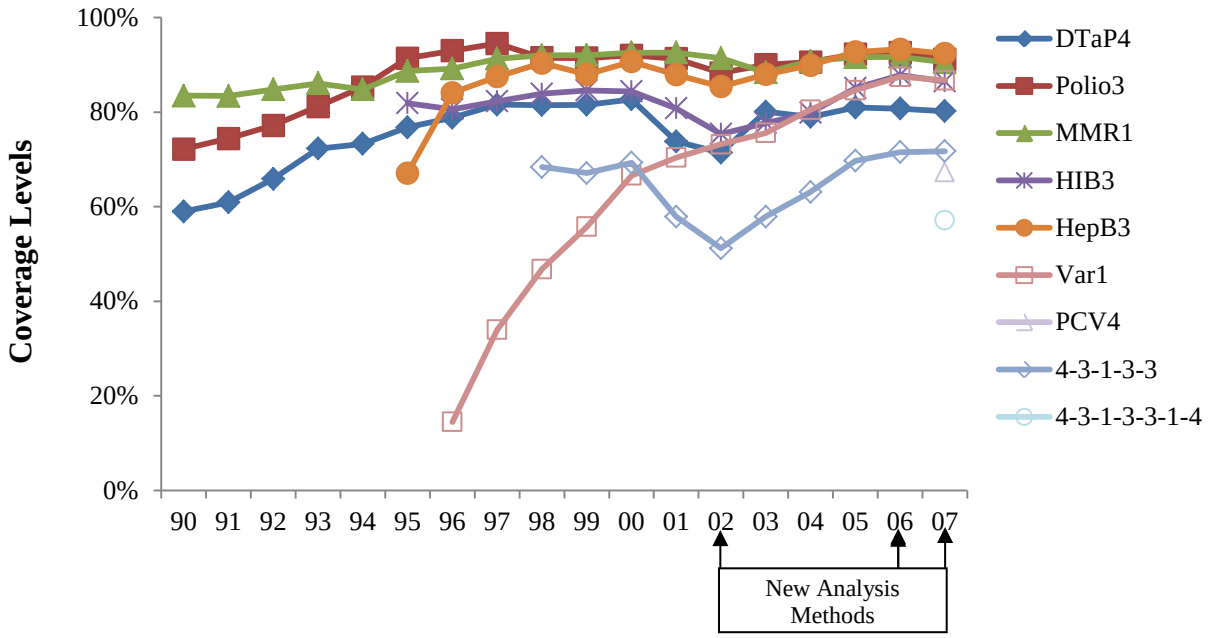
The number of records included in the analysis by population density were: 3,554 (24.8% of all records used, representing 10.9% of the population after weighting) in sparsely populated, 7,457 (52.0% of all records used, representing 38.7% of the population after weighting) in moderately populated, and 3,325 (23.2% of all records used, representing 50.1% of the population after weighting) in urban counties.[8] The 2006 birth cohort distribution across the state of Kansas was 10.6% in sparsely populated, 34.6% in moderately populated and 54.8% in urban counties.

[5] http://www.cdc.gov/vaccines/stats-surv/nis/default.htm#nis
[6] Children in the 2008 NIS were born between January 2005 and June 2007
[7] Estimates from counties with small sample size (<50) may be unstable and changes over time should be interpreted with caution
[8] Percentages are rounded

Statewide Immunization Coverage by Age 24 Months

The immunization coverage levels for DTaP4, Polio3, MMR1, HIB3, HepB3, and Var1 were all greater than 80%, but only HepB3, MMR1, and Polio3 met the HP2010 goal of 90%. PCV4 had the lowest immunization coverage level at 67.3% (Figure 1). The immunization coverage level for 4-3-1-3-3 and 4-3-1-3-3-1-4 was 71.7% and 57.2%, respectively (Table 1).

FIGURE 1: Immunization coverage levels at 24 months of age by vaccine, Kansas 1990 - 2007.*†



* Based on retrospective surveys from school years starting in 1994 through 2011

† Due to new analysis methods, comparisons of immunization coverage levels over time should be interpreted with some caution. See Discussion section for additional information.

TABLE 1: Immunization coverage levels at 24 months of age by vaccine, Kansas 2007-2008.*

	Percent (%) †	95% CI†
DTaP4	80.2	79.0 - 81.4
Polio3	91.2	90.3 - 92.1
MMR1	90.5	89.7 - 91.3
Hib3	86.5	85.3 - 87.7
HepB3	92.4	91.6 - 93.2
Var1	86.7	85.8 - 87.7
PCV4	67.3	65.7 - 68.9
4-3-1-3-3 Series	71.7	70.3 - 73.2
4-3-1-3-3-1-4 Series	57.2	55.5 - 58.8

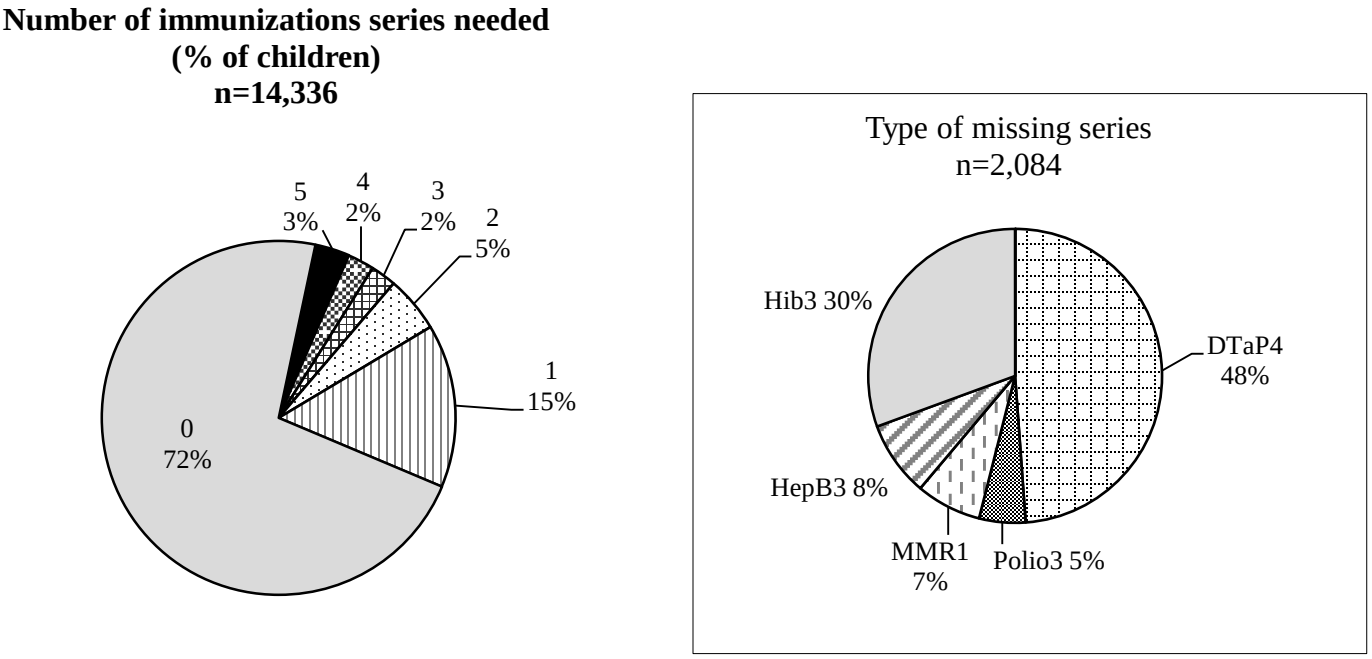
* Based on the retrospective survey for the school year starting 2011

† Percentage up-to-date and 95% confidence interval

Of the children missing at least one series of the 4-3-1-3-3-1-4 at 24 months of age, 47% (20% of total population studied) needed to complete only one immunization series (DTaP4, Polio3, MMR1, Hib3,

HepB3, Var1, *or* PCV4) (Figure 2). If these children had received the missing immunization series, the coverage levels for 4-3-1-3-3-1-4 would have increased from 72% to 86%. Among children who needed one immunization series, the majority (48%) needed DTaP4. Of children not up-to-date at 24 months of age, 11% (3% of total population studied) were not up-to-date on any of the vaccination series (DTaP4, Polio3, MMR1, Hib3, and HepB3).

FIGURE 2: Number and type of immunization series children at 24 months of age needed to be up-to-date for the 4-3-1-3-3, Kansas 2007 - 2008.*†



*Based on the retrospective survey for the school year starting 2011
†Percentages are rounded
§Percentages based on weighted frequencies.

County-level Immunization Coverage of Children at 24 Months of Age

Immunization coverage was also analyzed at the county level. The number of counties meeting the Healthy People 2010 goal for individual vaccinations varied greatly with only 10 counties (representing less than one percent of the birth cohort) having 90% coverage or better for DTaP4 while 83 counties (representing 86% of the birth cohort) had 90% coverage or better for HepB3 (Table 2).[9] No counties achieved 100% coverage for all vaccinations. Of the 37 counties who obtained 80% coverage or better for the 4-3-1-3-3 series, 35 (95%) were sparsely populated. All vaccination coverage levels are displayed by county in Appendix 2.

Thirty-seven counties (representing less than nine percent of the birth cohort) reached the HP2010 goal of at least 80% coverage for the 4-3-1-3-3 series, while 76 counties (representing 63% of the birth cohort) had 90% coverage or greater for Polio3. For MMR1, 64 counties (representing 53% of the birth cohort) had vaccination coverage meeting the HP2010 goal, and for Hib3, 55 counties (representing

[9] Healthy People 2010 set goals of 90% coverage for DTaP4, Polio3, MMR1, Hib3, HepB3, Var1, and PCV4, and 80% coverage for 4-3-1-3-3 series among children aged 19 to 35 months.

21% of the birth cohort) had coverage of at least 90%. Thirty-seven counties (representing 14% of the birth cohort) had 90% or greater coverage for Var1.

TABLE 2: Number of Kansas counties meeting the Healthy People 2010 goals for 2007-2008.*

	Number of counties (n = 105)
DTaP4	10
Polio3	76
MMR1	64
Hib3	55
HepB3	83
Var1	37
PCV4	4
4-3-1-3-3 Series	37

* Based on the retrospective survey for the school year starting 2011

Counties were classified based on their population densities, and coverage levels were compared among the three categories (Table 3). Counties that were sparsely populated had significantly higher coverage levels for DTaP4, Hib3, the 4-3-1-3-3 and 4-3-1-3-3-1-4 series than counties with greater population densities (moderately populated and urban). There was no statistical difference for any vaccinations between urban and moderately populated counties.

TABLE 3: Kansas immunization coverage levels by peer group for 2007-2008.*

Counties by Population Density – Condensed Groups n=14,336			
	Sparsely Populated n=3,554 % (95% CI)	Moderately Populated n=7,457 % (95% CI)	Urban n=3,325 % (95% CI)
DTaP4	83.3 (81.6 - 84.9)	79.9 (78.4 - 81.4)	78.9 (76.5 - 81.3)
Polio3	92.3 (91.1 - 93.5)	92.2 (91.1 - 93.2)	89.7 (87.8 - 91.7)
MMR1	91.5 (90.3 - 92.7)	89.9 (88.8 - 90.9)	90.7 (89.1 - 92.2)
Hib3	91.0 (89.7 - 92.3)	87.4 (85.8 – 89.0)	83.4 (81.0 - 85.9)
HepB3	93.7 (92.6 - 94.8)	93.2 (92.3 - 94.1)	91.0 (89.3 - 92.7)
Var1	87.2 (85.6 - 88.8)	86.4 (85.1 - 87.7)	86.8 (85.0 - 88.6)
PCV4	71.9 (69.2 - 74.6)	65.2 (62.8 - 67.7)	66.9 (64.0 - 69.8)
4-3-1-3-3 Series	78.6 (76.7 - 80.6)	71.8 (69.9 - 73.7)	68.2 (65.4 - 71.1)
4-3-1-3-3-1-4 Series	64.0 (61.2 - 66.8)	55.3 (52.9 - 57.6)	55.5 (52.6 - 58.4)

* Based on the retrospective survey for the school year starting 2011

National Immunization Survey (NIS) Coverage at 19-35 Months of Age

Comparison of Kansas NIS results for immunization coverage at 19-35 months of age with results from the current retrospective study showed significant coverage differences in Polio3, Hib3, PCV4, and the 4-3-1-3-3-1-4 series (Table 4).[10] The other immunization estimates (DTaP4, MMR1, HepB3, Var1, and the 4-3-1-3-3 series) did not vary significantly between the two surveys. The US National immunization coverage measured by NIS was significantly higher than the vaccination coverage levels measured by the retrospective study for all vaccinations other than DTaP4 and HepB3. The estimates from the

[10] http://www2a.cdc.gov/nip/coverage/nis/nis_iap2.asp?fmt=v&rpt=tab02_antigen_iap&qtr=Q1/2008-Q4/2008

Kansas NIS were not statistically different from the US National NIS estimates for any of the vaccination series.

TABLE 4: Kansas and US National immunization coverage levels.

	Retrospective Study* % (95% CI)	Kansas NIS§ % (95% CI)	US National NIS§ % (95% CI)
DTaP4	80.2 (79.0 - 81.4)	85.7 (80.5 - 90.9)	84.6 (83.6 - 85.6)
Polio3	91.2 (90.3 - 92.1)	95.4 (92.6 - 98.2)	93.6 (93.0 - 94.2)
MMR1	90.5 (89.7 - 91.3)	91.9 (88.3 - 95.5)	92.1 (91.4 - 92.8)
Hib3	86.5 (85.3 - 87.7)	93.7 (90.7 - 96.7)	90.9 (90.2 - 91.6)
HepB3	92.4 (91.6 - 93.2)	94.4 (91.3 - 97.5)	93.5 (92.8 - 94.2)
Var1	86.7 (85.8 - 87.7)	90.1 (85.4 - 94.8)	90.7 (90.0 - 91.4)
PCV4	67.3 (65.7 - 68.9)	80.7 (75.5 - 85.9)	80.1 (79.0 - 81.2)
4-3-1-3-3 series	71.7 (70.3 - 73.2)	78.2 (72.3 - 84.1)	78.2 (77.1 - 79.3)
4-3-1-3-3-1-4 series	57.2 (55.5 - 58.8)	69.5 (63.0 – 76.0)	68.4 (67.2 - 69.6)

* Based on the retrospective survey for the school year starting 2011

§Based on 2008 NIS, children aged 19-35 months of age

DISCUSSION

In the 2011-12 Retrospective Study, data analysis methods changed from previous years. The new method allows for a more accurate estimation of immunization coverage levels by taking into account immunizations received by both exempt and non-exempt children. Due to the new method, coverage levels over time should be interpreted with some caution.

Polio3, MMR1, and HepB3 were the only vaccinations that met the Healthy People 2010 goal of at least 90% coverage. The immunization estimate for PCV4 was the farthest from meeting the HP2010 goal with coverage of 67.3%. However, since PCV4 is not required for school entry, this may reflect a lack of recording the immunization series on the immunization record; further evidence of this can be seen in the Kansas NIS which reported coverage for PCV4 at 80.7%. The 4-3-1-3-3 series remains approximately 8 percentage points from meeting the HP2010 goal of 80% coverage, which similar to PCV4, may be a consequence of Hib3 not being required for school entry and thus not being recorded on the immunization record. Of the children who were not up to date for the 4-3-1-3-3 series, missing DTaP4 series accounted for the majority. If children missing only one vaccination series, either DTaP4, Polio3, MMR1, Hib3, or HepB3 were up-to-date, Kansas would have a 86% coverage level for the 4-3-1-3-3 series, which would exceed the HP2010 goal.

The coverage level estimates were compared to determine if variations existed among counties of different population densities. For the 4-3-1-3-3 series, the coverage level of sparsely populated counties, which only accounted for 10.9% of the population surveyed, was statistically higher compared to moderately populated and urban counties. Due to a lack of demographic data collected on children included in the survey, analyses could not be performed to determine contributing factors for this result. However, previous studies have similarly found immunization coverage to be lower in urban and inner-city settings than rural settings; this has been associated with lower socio-economic status of those living

in urban settings.[11] Due to the large percentage of the population living in the 5 urban counties (50.1%), targeting this population to improve vaccination coverage would increase statewide immunization coverage levels.

The western half of the state had the largest concentration of counties with high immunization levels (90% or greater) for the majority of vaccinations, including: DTaP4, Hib3, Var1, and PCV4 (Appendix 3). Additionally, this region also had a large number of counties with 80% coverage or greater for the 4-3-1-3-3 and the 4-3-1-3-3 series. The western part of the state is comprised of predominantly sparsely populated counties, which is consistent with the significantly higher coverage level for DTaP4, Hib3, 4-3-1-3-3 series, and 4-3-1-3-3-1-4 series between sparsely populated counties and those with greater population densities. This higher immunization coverage among sparsely populated counties also accounts for the number of counties reaching HP2010 goals representing a smaller proportion of the birth cohort (e.g., 10 counties reaching the DTaP4 goal of 90% representing less than 1% of the birth cohort).

The coverage level for the 4-3-1-3-3-1-4 series was lower in the 2011-12 Retrospective Survey (57.2% [95% CI 55.5 – 78.8]) when compared to the NIS for 19-35 month olds (69.5% [95% CI 63.0-76.0]) for Kansas; however, the 4-3-1-3-3 was not significantly different. Hib3 and PCV4 were significantly lower in the retrospective study compared to the KS NIS coverage. One potential reason for the differences in coverage levels could be due to Hib3 and PCV4 not being required for school entry and thus may not be routinely recorded on school immunization records; this could contribute to the 4-3-1-3-3-1-4 being lower as well. Additionally, there may be differences in coverage levels between the two studies due to the Kansas retrospective study assessing coverage at 24 months of age and the NIS assessing immunization coverage at 19-35 months of age.

Vaccine coverage is of great public health importance. By having greater vaccination coverage, there is an increase in herd immunity, which leads to lower disease incidence and an ability to limit the size of disease outbreaks. In 2006, a widespread outbreak of mumps occurred in Kansas and across the United States. Prior to the outbreak, the incidence of mumps was at a historical low, and even with the outbreak, mumps disease rates were lower than in the pre-vaccination era. Due to high vaccination coverage, tens or hundreds of thousands of cases were possibly prevented.

However, due to unvaccinated and undervaccinated individuals, the United States has seen a rise in diseases that were previously present at low levels. In 2008, the United States had 140 measles cases, more than any year since 1996, and in 2011 the United States has documented 222 cases of measles, of which 86% were unvaccinated or had unknown vaccination history.[12] Additionally, there has been a rise in the number of pertussis cases throughout the United States, and as of October 22, 2012, Kansas has had 501 cases[13], whereas in 2011 Kansas only documented 145 cases.

[11] Williams I, Milton J, Farrell J, Graham N. 1995. Interaction of Socioeconomic Status and Provider Practices as Predictors of Immunization Coverage in Virginia Children. Pediatrics. 96(3): 439-446; Feldman S, Andrew M, Gilber J, Bracken B, Thompson E. 1994. Measles Immunization of 2-Year-Olds in a Rural Southern State. JAMA. 271: 1417-1420.
[12] Centers for Disease Control and Prevention. Measles – United States, 2011. MMWR 2012; 61: 253-7.
[13] Data are provisional and subject to change.

Limitations

One limitation of this study is Hib3 and PCV4 are not required for school entry and may not consistently be reported on the immunization record, thus appearing to show decreased coverage levels for the individual vaccines as well as the 4-3-1-3-3 and 4-3-1-3-3-1-4 series. This is evident in Appendix 2 for several counties that have low levels for Hib3, PCV4 and 4-3-1-3-3 and 4-3-1-3-3-1-4. Additionally, no descriptive data are collected about sex, race, or ethnicity.

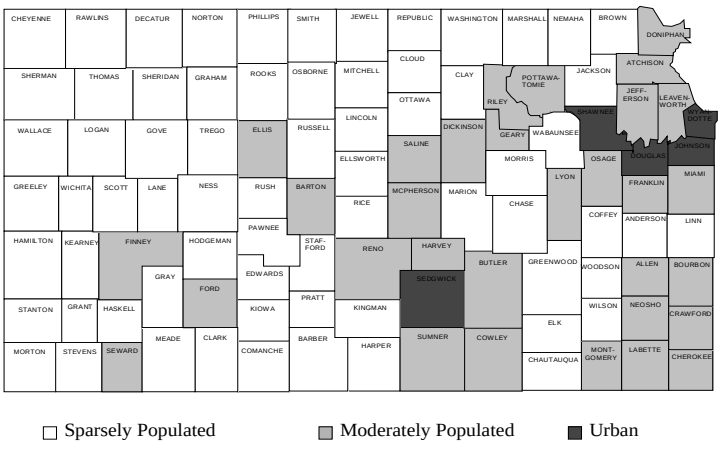
Strengths

Despite the limitations, the retrospective immunization survey provides a good estimation of early childhood immunization coverage levels for Kansas. It allows state and local officials to identify counties and regions with low vaccine coverage levels. Focus on these areas with implementation of enhanced vaccination delivery methods and educational campaigns can aid in Kansas achieving a 90% coverage goal. To aid in this goal, a similar survey is planned for next year.

Appendix 1: Kansas counties categorized based on population density, 2000.

Sparsely Populated		Moderately Populated	Urban
Anderson	Marion	Allen	Douglas
Barber	Marshall	Atchison	Johnson
Brown	Morris	Barton	Sedgwick
Chase	Morton	Bourbon	Shawnee
Chautauqua	Nemaha	Butler	Wyandotte
Cheyenne	Ness	Cherokee	
Clark	Norton	Cowley	
Clay	Osborne	Crawford	
Cloud	Ottawa	Dickinson	
Coffey	Pawnee	Doniphan	
Comanche	Phillips	Ellis	
Decatur	Pratt	Finney	
Edwards	Rawlins	Ford	
Elk	Republic	Franklin	
Ellsworth	Rice	Geary	
Gove	Rooks	Harvey	
Graham	Rush	Jefferson	
Grant	Russell	Labette	
Gray	Scott	Leavenworth	
Greeley	Sheridan	Lyon	
Greenwood	Sherman	McPherson	
Hamilton	Sherman	Miami	
Harper	Smith	Montgomery	
Haskell	Stafford	Neosho	
Hodgeman	Stanton	Osage	
Jackson	Stevens	Pottawatomie	
Jewell	Thomas	Reno	
Kearny	Trego	Riley	
Kingman	Wabaunsee	Saline	
Kiowa	Wallace	Seward	
Lane	Washington	Sumner	
Lincoln	Wichita		
Linn	Wilson		
Logan	Woodson		

Persons per Square Mile in Peer Groups
Sparsely Populated = ≤19.9
Moderately Populated = 20 – 149.9
Urban = ≥ 150.0



APPENDIX 2: Immunization Coverage Levels of Children 24 Months of Age for Kansas Counties 2007-2008.*[§]

COUNTY	DTaP4	Polio3	MMR1	Hib3	HepB3	Var1	PCV4	4-3-1-3-3	4-3-1-3-3-1-4
STATEWIDE	*80%*	*91%*	*91%*	*87%*	*92%*	*87%*	*67%*	*72%*	*57%*
ALLEN	82%	95%	90%	93%	96%	85%	78%	77%	67%
ANDERSON	88%	91%	91%	88%	94%	87%	81%	74%	62%
ATCHISON	79%	94%	90%	90%	89%	87%	75%	70%	61%
BARBER	85%	85%	90%	85%	90%	81%	57%	85%	57%
BARTON	84%	95%	91%	85%	97%	90%	74%	78%	69%
BOURBON	80%	89%	93%	95%	87%	83%	71%	75%	55%
BROWN	87%	98%	96%	96%	98%	88%	83%	86%	69%
BUTLER	75%	89%	84%	87%	89%	84%	62%	66%	52%
CHASE	71%	92%	79%	88%	92%	63%	42%	71%	25%
CHAUTAUQUA	83%	96%	92%	94%	96%	88%	52%	83%	50%
CHEROKEE	74%	91%	88%	85%	90%	84%	64%	71%	55%
CHEYENNE	75%	100%	91%	81%	100%	78%	78%	72%	69%
CLARK	93%	93%	86%	93%	93%	86%	86%	86%	79%
CLAY	72%	94%	89%	92%	92%	86%	66%	69%	54%
CLOUD	74%	93%	95%	80%	95%	81%	67%	74%	61%
COFFEY	82%	90%	91%	89%	89%	83%	65%	77%	51%
COMANCHE	82%	82%	88%	88%	88%	88%	61%	82%	61%
COWLEY	84%	96%	94%	89%	97%	91%	53%	77%	47%
CRAWFORD	78%	90%	87%	87%	88%	75%	48%	69%	38%
DECATUR	80%	100%	100%	100%	80%	100%	80%	70%	70%
DICKINSON	86%	91%	93%	88%	92%	90%	72%	76%	64%
DONIPHAN	84%	98%	95%	87%	99%	89%	78%	80%	69%
DOUGLAS	79%	92%	89%	69%	90%	86%	53%	58%	43%
EDWARDS	81%	87%	98%	94%	100%	89%	60%	81%	58%
ELK	79%	98%	96%	93%	98%	88%	68%	72%	58%
ELLIS	86%	92%	96%	83%	95%	93%	70%	71%	63%
ELLSWORTH	88%	99%	97%	96%	99%	93%	70%	88%	63%
FINNEY	78%	92%	88%	90%	94%	88%	76%	74%	67%
FORD	87%	97%	93%	92%	97%	91%	69%	82%	63%
FRANKLIN	74%	89%	87%	81%	92%	83%	72%	67%	58%
GEARY	74%	91%	82%	86%	92%	82%	64%	67%	53%
GOVE	83%	86%	81%	86%	89%	81%	83%	78%	78%
GRAHAM	69%	94%	88%	94%	88%	88%	75%	63%	63%
GRANT	82%	95%	94%	91%	98%	93%	69%	80%	65%
GRAY	87%	95%	95%	96%	96%	91%	68%	83%	57%
GREELEY	88%	88%	88%	88%	88%	88%	88%	88%	88%
GREENWOOD	88%	95%	95%	96%	95%	93%	77%	86%	73%
HAMILTON	94%	97%	97%	94%	97%	97%	54%	91%	51%
HARPER	73%	87%	88%	87%	90%	84%	51%	67%	44%
HARVEY	83%	88%	90%	92%	96%	88%	63%	69%	50%
HASKELL	82%	95%	89%	91%	97%	91%	72%	79%	63%
HODGEMAN	86%	91%	91%	96%	96%	81%	67%	86%	58%
JACKSON	87%	96%	93%	86%	96%	87%	81%	78%	69%
JEFFERSON	83%	95%	93%	90%	95%	90%	81%	76%	65%

COUNTY	DTaP4	Polio3	MMR1	Hib3	HepB3	Var1	PCV4	4-3-1-3-3	4-3-1-3-3-1-4
STATEWIDE	*80%*	*91%*	*91%*	*87%*	*92%*	*87%*	*67%*	*72%*	*57%*
JEWELL	92%	100%	100%	100%	100%	100%	92%	92%	85%
JOHNSON	83%	91%	93%	85%	92%	89%	70%	73%	61%
KEARNY	88%	92%	94%	95%	100%	94%	83%	88%	80%
KINGMAN	79%	82%	85%	81%	82%	72%	33%	69%	31%
KIOWA	83%	100%	88%	88%	100%	100%	58%	71%	54%
LABETTE	78%	94%	91%	90%	95%	88%	68%	75%	63%
LANE	96%	100%	96%	100%	100%	100%	96%	93%	89%
LEAVENWORTH	82%	95%	93%	92%	95%	88%	76%	75%	63%
LINCOLN‡	.	.	.	.	.	.	.	.	.
LINN	80%	89%	88%	92%	93%	82%	74%	72%	60%
LOGAN	85%	81%	87%	81%	92%	77%	79%	79%	69%
LYON	78%	89%	88%	94%	95%	82%	44%	75%	34%
MARION	81%	89%	90%	82%	84%	81%	67%	69%	47%
MARSHALL	83%	92%	94%	90%	94%	86%	69%	83%	63%
MCPHERSON	86%	95%	93%	66%	94%	92%	45%	58%	38%
MEADE	75%	83%	86%	88%	88%	74%	35%	70%	31%
MIAMI	75%	90%	89%	74%	94%	88%	57%	56%	41%
MITCHELL	68%	93%	84%	88%	93%	76%	52%	61%	47%
MONTGOMERY	80%	89%	92%	87%	90%	90%	67%	74%	59%
MORRIS	84%	97%	92%	92%	97%	81%	64%	82%	56%
MORTON	86%	88%	83%	86%	88%	81%	54%	65%	43%
NEMAHA	89%	96%	94%	96%	97%	91%	83%	89%	78%
NEOSHO	53%	89%	88%	87%	86%	87%	53%	48%	45%
NESS	75%	84%	91%	94%	95%	86%	68%	70%	60%
NORTON	89%	96%	95%	95%	96%	93%	60%	89%	54%
OSAGE	80%	91%	93%	85%	92%	92%	77%	73%	66%
OSBORNE	73%	81%	89%	89%	89%	89%	65%	73%	65%
OTTAWA	82%	96%	88%	93%	97%	90%	77%	79%	68%
PAWNEE	92%	97%	97%	97%	97%	88%	77%	89%	65%
PHILLIPS	87%	93%	87%	93%	96%	91%	83%	80%	72%
POTTAWATOMIE	89%	92%	91%	88%	90%	87%	78%	79%	68%
PRATT	88%	93%	93%	92%	89%	89%	70%	81%	64%
RAWLINS	67%	75%	80%	67%	80%	71%	63%	59%	50%
RENO	79%	93%	88%	86%	94%	81%	73%	71%	59%
REPUBLIC	88%	100%	94%	92%	100%	92%	84%	84%	78%
RICE	71%	88%	86%	86%	90%	85%	68%	71%	61%
RILEY	81%	94%	91%	86%	90%	85%	66%	71%	54%
ROOKS	94%	98%	99%	98%	98%	96%	94%	92%	91%
RUSH	93%	96%	96%	98%	96%	93%	91%	93%	91%
RUSSELL	88%	90%	92%	92%	88%	90%	79%	83%	73%
SALINE	83%	93%	91%	91%	95%	90%	78%	80%	71%
SCOTT	88%	96%	98%	95%	96%	88%	79%	84%	68%
SEDGWICK	75%	88%	89%	85%	90%	85%	65%	66%	52%
SEWARD	79%	92%	95%	92%	95%	86%	71%	76%	61%
SHAWNEE	85%	93%	93%	83%	95%	88%	74%	72%	60%
SHERIDAN	63%	79%	84%	89%	89%	84%	74%	63%	58%

COUNTY	DTaP4	Polio3	MMR1	Hib3	HepB3	Var1	PCV4	4-3-1-3-3	4-3-1-3-3-1-4
STATEWIDE	*80%*	*91%*	*91%*	*87%*	*92%*	*87%*	*67%*	*72%*	*57%*
SHERMAN	83%	90%	88%	87%	90%	88%	76%	78%	71%
SMITH	95%	97%	95%	97%	97%	95%	81%	93%	79%
STAFFORD	86%	89%	96%	94%	93%	96%	74%	80%	65%
STANTON	86%	100%	95%	86%	95%	86%	76%	76%	71%
STEVENS	79%	87%	87%	86%	94%	87%	70%	75%	66%
SUMNER	75%	90%	87%	89%	94%	81%	35%	68%	27%
THOMAS	83%	92%	88%	91%	95%	81%	78%	76%	70%
TREGO	89%	94%	95%	95%	100%	95%	84%	89%	78%
WABAUNSEE	87%	94%	96%	92%	94%	96%	82%	79%	74%
WALLACE	91%	96%	100%	98%	98%	100%	87%	91%	87%
WASHINGTON	84%	94%	94%	91%	92%	93%	77%	73%	66%
WICHITA	100%	100%	100%	97%	100%	94%	88%	97%	85%
WILSON	84%	91%	89%	92%	94%	88%	79%	79%	72%
WOODSON	81%	100%	90%	100%	97%	94%	77%	81%	74%
WYANDOTTE	70%	86%	87%	81%	87%	84%	61%	60%	50%

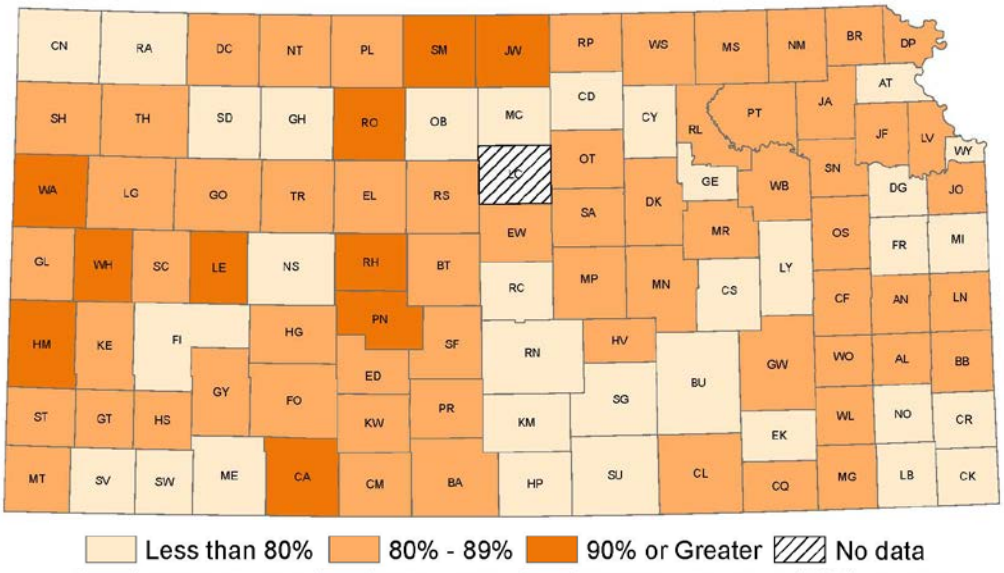
* Based on the retrospective survey for the school year starting 2011.

§ Due to Hib3 and PCV4 not being required for school entry, these vaccines may not consistently be reported on the immunization record, thus decreasing coverage levels for the individual vaccines, as well as the 4-3-1-3-3 and 4-3-1-3-3-1-4 series. This is evident for several counties that have low coverage levels for the 4-3-1-3-3 and 4-3-1-3-3-1-4 series as well as low Hib3 and PCV4 coverage levels.

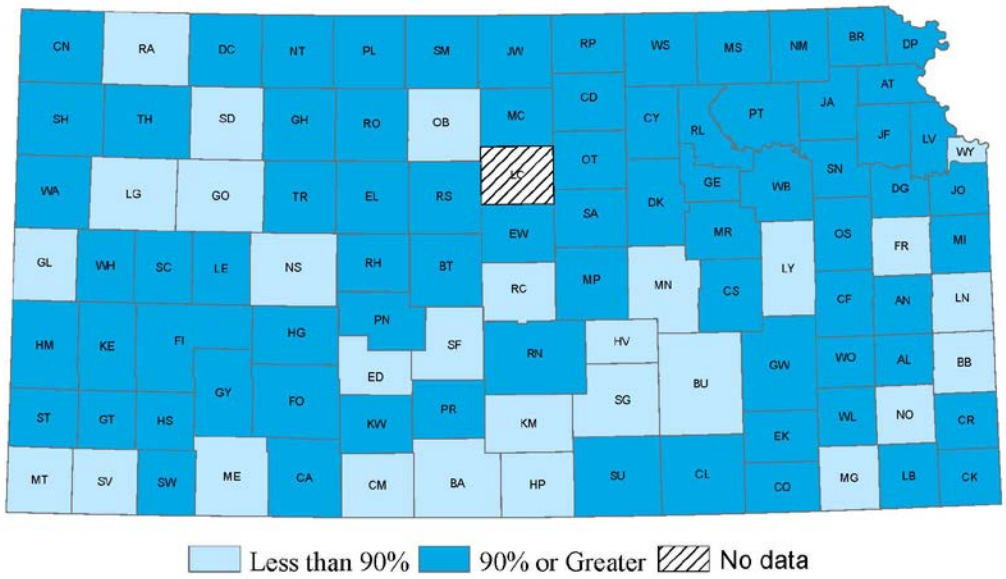
‡ No data available due to dates of birth not being included on the KCIs submitted from Lincoln County.

Appendix 3: Maps of immunization coverage levels by county, 2011-12 Retrospective Survey.

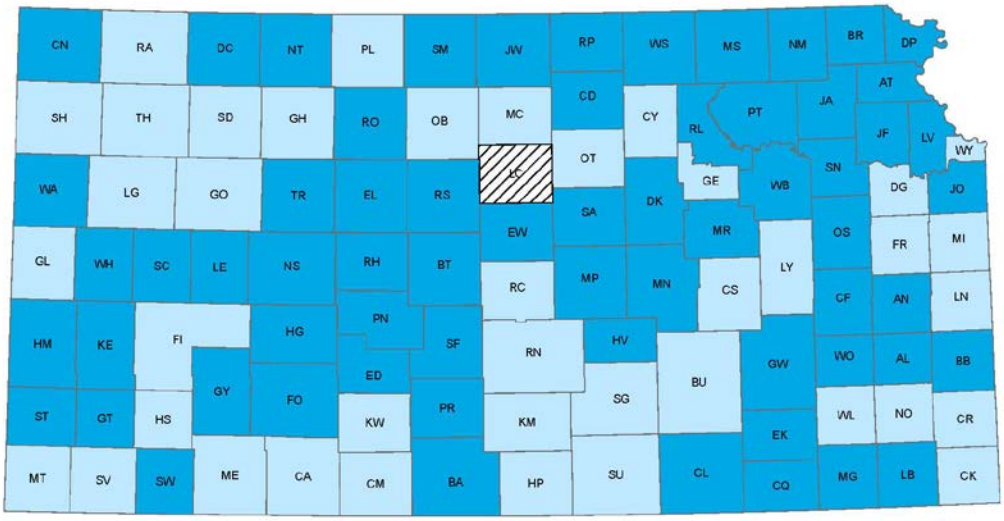
DTaP4 Coverage Levels for Retrospective Survey, 2011-12



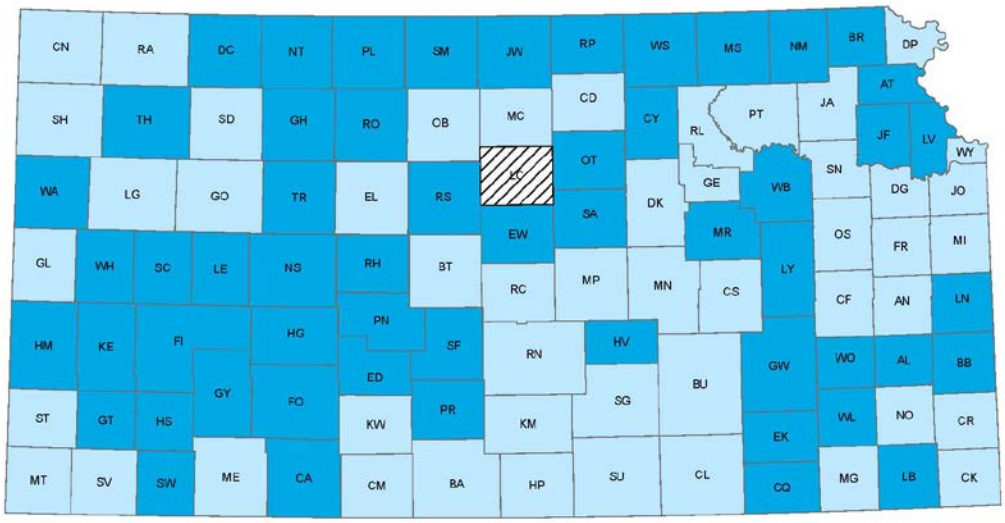
Polio3 Coverage Levels for Retrospective Survey, 2011-12



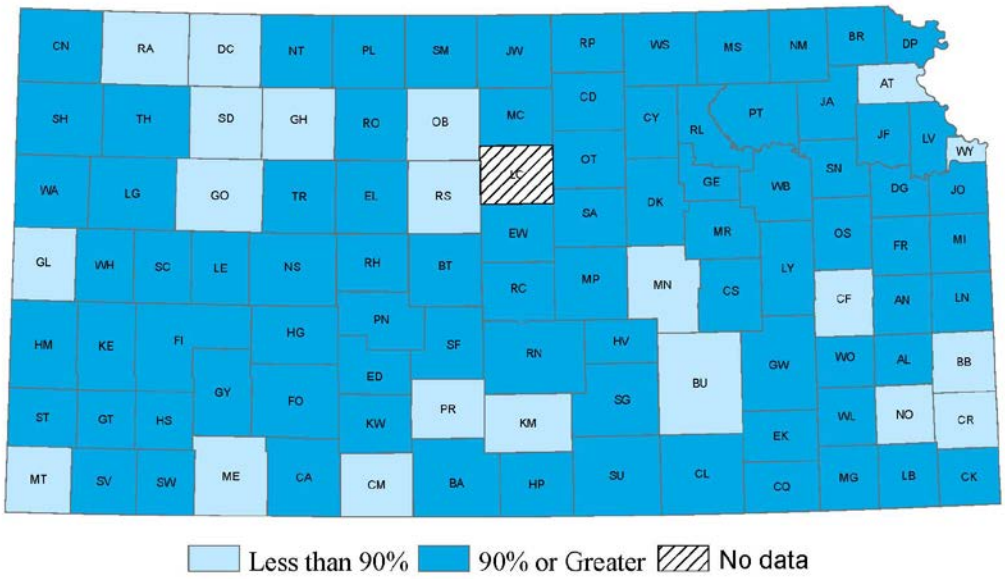
MMR1 Coverage Levels for Retrospective Survey, 2011-12



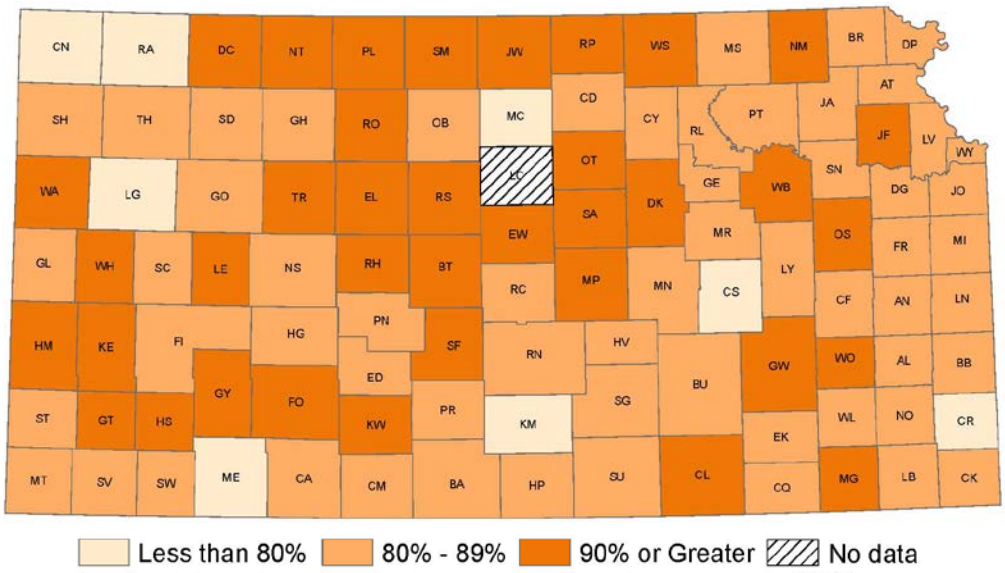
Hib3 Coverage Levels for Retrospective Survey, 2011-12



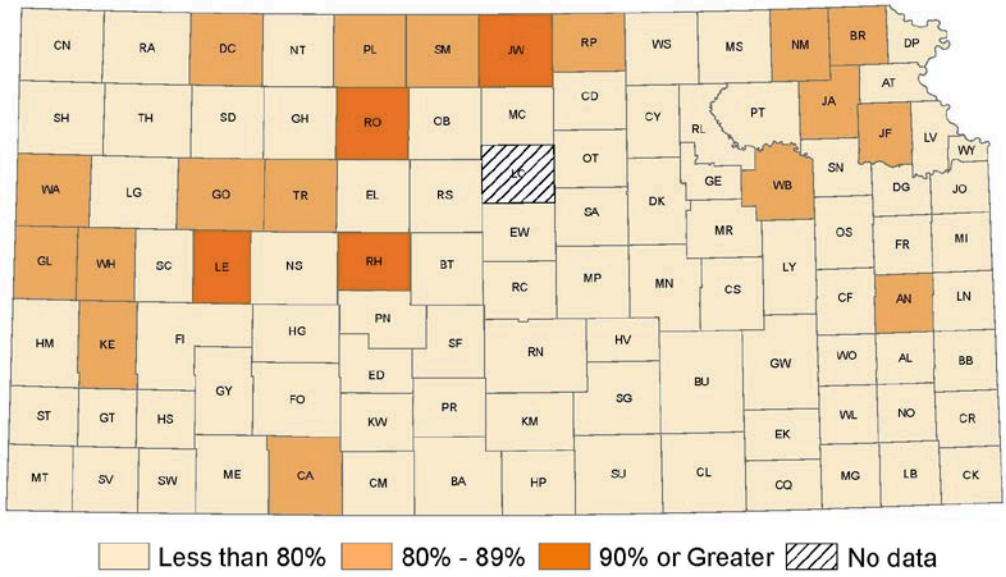
HepB3 Coverage Levels for Retrospective Survey, 2011-12



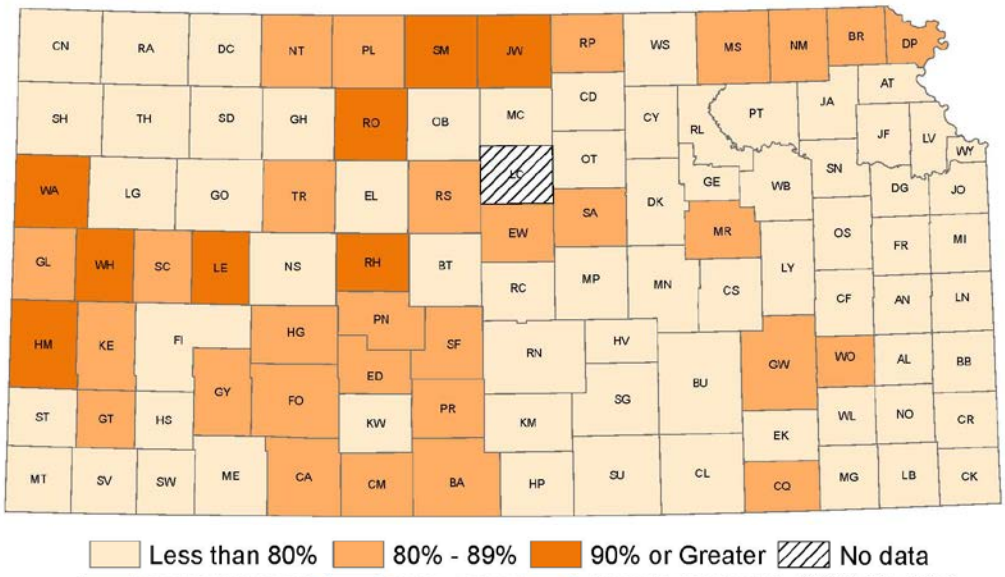
Var1 Coverage Levels for Retrospective Survey, 2011-12



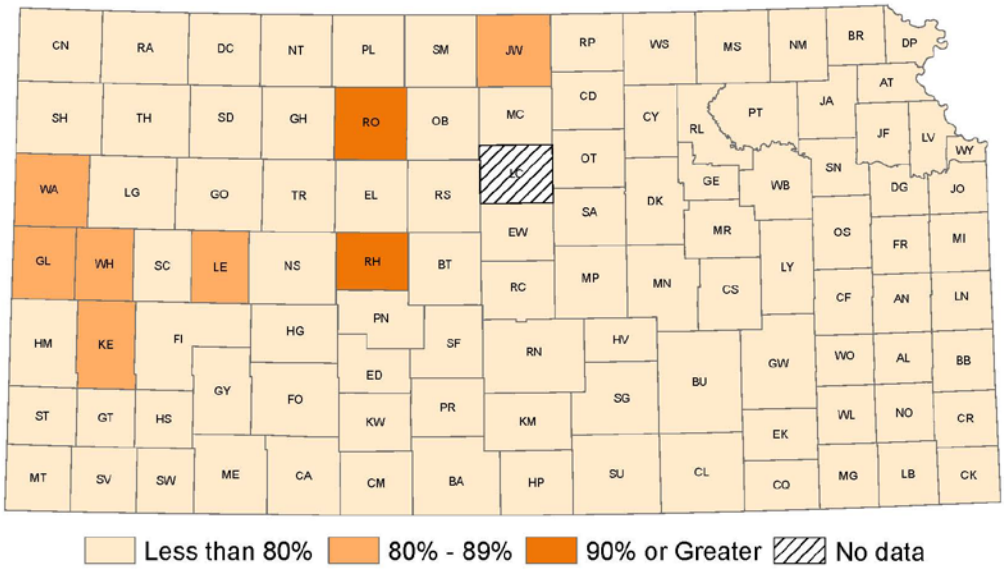
PCV4 Coverage Levels for Retrospective Survey, 2011-12



4-3-1-3-3 Coverage Levels for Retrospective Survey, 2011-12

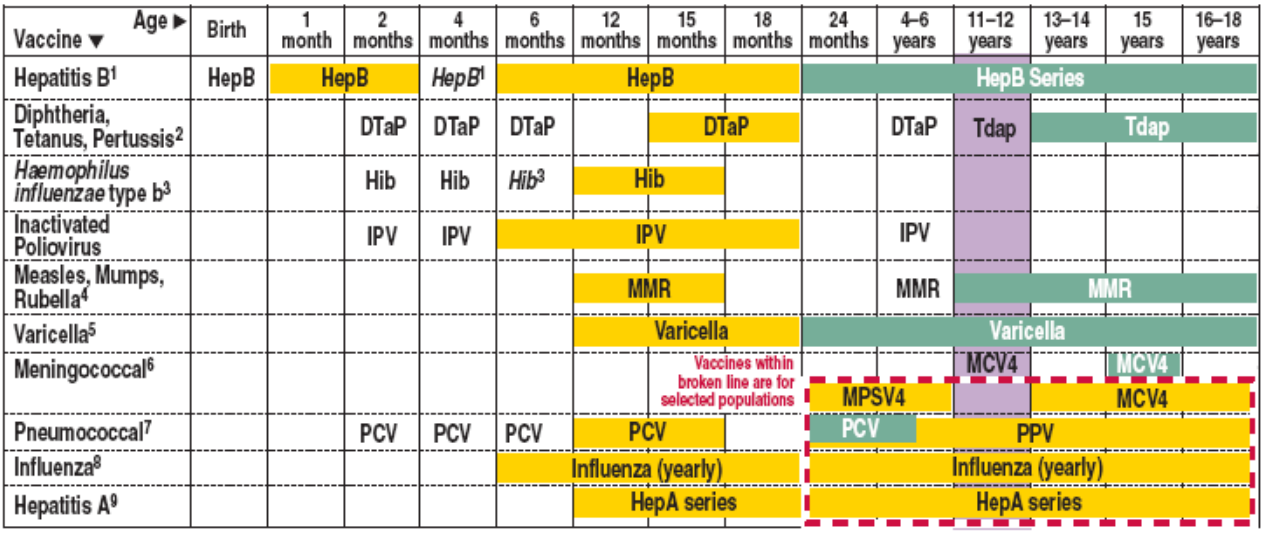


4-3-1-3-3-1-4 Coverage Levels for Retrospective Survey, 2011-12



Appendix 4: CDC's 2006 Advisory Committee on Immunization Practices (ACIP) Recommendations http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5451-Immunizationa1.htm?s_cid=mm5451-Immunizationa1_e

FIGURE. Recommended childhood and adolescent immunization schedule, by vaccine and age — United States, 2006



This schedule indicates the recommended ages for routine administration of currently licensed childhood vaccines, as of December 1, 2005, for children through age 18 years. Any dose not administered at the recommended age should be administered at any subsequent visit, when indicated and feasible. Indicates age groups that warrant special effort to administer those vaccines not previously administered. Additional vaccines might be licensed and recommended during the year. Licensed combination vaccines may be used whenever any components of the combination are indicated and other components of the vaccine are not contraindicated and if approved by the Food and Drug Administration for that dose of the series. Providers should consult respective Advisory Committee on Immunization Practices (ACIP) statements for detailed recommendations. Clinically significant adverse events that follow vaccination should be reported through the Vaccine Adverse Event Reporting System (VAERS). Guidance about how to obtain and complete a VAERS form is available at http://www.vaers.hhs.gov or by telephone, 800-822-7967.

Range of recommended ages | Catch-up immunization | Assessment at age 11–12 years

1. **Hepatitis B vaccine (HepB).** ***AT BIRTH:*** **All newborns** should receive monovalent HepB soon after birth and before hospital discharge. **Infants born to mothers who are hepatitis B surface antigen (HBsAg)-positive** should receive HepB and 0.5 mL of hepatitis B immune globulin (HBIG) within 12 hours of birth. **Infants born to mothers whose HBsAg status is unknown** should receive HepB within 12 hours of birth. The mother should have blood drawn as soon as possible to determine her HBsAg status; if HBsAg-positive, the infant should receive HBIG as soon as possible (no later than age 1 week). **For infants born to HBsAg-negative mothers,** the birth dose can be delayed in rare circumstances but only if a physician's order to withhold the vaccine and a copy of the mother's original HBsAg-negative laboratory report are documented in the infant's medical record. ***FOLLOWING THE BIRTH DOSE:*** The HepB series should be completed with either monovalent HepB or a combination vaccine containing HepB. The second dose should be administered at age 1–2 months. The final dose should be administered at age ≥24 weeks. Administering four doses of HepB is permissible (e.g., when combination vaccines are administered after the birth dose); however, if monovalent HepB is used, a dose at age 4 months is not needed. **Infants born to HBsAg-positive mothers** should be tested for HBsAg and antibody to HBsAg after completion of the HepB series at age 9–18 months (generally at the next well-child visit after completion of the vaccine series).
2. **Diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP).** The fourth dose of DTaP may be administered as early as age 12 months, provided 6 months have elapsed since the third dose and the child is unlikely to return at age 15–18 months. The final dose in the series should be administered at age ≥4 years. **Tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (Tdap adolescent preparation)** is recommended at age 11–12 years for those who have completed the recommended childhood DTP/DTaP vaccination series and have not received a tetanus and diphtheria toxoids (Td) booster dose. Adolescents aged 13–18 years who missed the age 11–12-year Td/Tdap booster dose should also receive a single dose of Tdap if they have completed the recommended childhood DTP/DTaP vaccination series. **Subsequent Td** boosters are recommended every 10 years.
3. ***Haemophilus influenzae*** **type b conjugate vaccine (Hib).** Three Hib conjugate vaccines are licensed for infant use. If PRP-OMP (PedvaxHIB® or ComVax® [Merck]) is administered at ages 2 and 4 months, a dose at age 6 months is not required. DTaP/Hib combination products should not be used for primary immunization in infants at ages 2, 4, or 6 months but may be used as boosters after any Hib vaccine. The final dose in the series should be administered at age ≥12 months.
4. **Measles, mumps, and rubella vaccine (MMR).** The second dose of MMR is recommended routinely at age 4–6 years but may be administered during any visit, provided at least 4 weeks have elapsed since the first dose and both doses are administered at or after age 12 months. Children who have not previously received the second dose should complete the schedule by age 11–12 years.
5. **Varicella vaccine.** Varicella vaccine is recommended at any visit at or after age 12 months for susceptible children (i.e., those who lack a reliable history of varicella). Susceptible persons aged ≥13 years should receive 2 doses administered at least 4 weeks apart.
6. **Meningococcal vaccine (MCV4).** Meningococcal conjugate vaccine (MCV4) should be administered to all children at age 11–12 years as well as to unvaccinated adolescents at high school entry (age 15 years). Other adolescents who wish to decrease their risk for meningococcal disease may also be vaccinated. All college freshmen living in dormitories should also be vaccinated, preferably with MCV4, although **meningococcal polysaccharide vaccine (MPSV4)** is an acceptable alternative. Vaccination against invasive meningococcal disease is recommended for children and adolescents aged ≥2 years with terminal complement deficiencies or anatomic or functional asplenia and for certain other high risk groups (see *MMWR* 2005;54[No. RR-7]); use MPSV4 for children aged 2–10 years and MCV4 for older children, although MPSV4 is an acceptable alternative.
7. **Pneumococcal vaccine.** The heptavalent **pneumococcal conjugate vaccine (PCV)** is recommended for all children aged 2–23 months and for certain children aged 24–59 months. The final dose in the series should be administered at age ≥12 months. **Pneumococcal polysaccharide vaccine (PPV)** is recommended in addition to PCV for certain high-risk groups. See *MMWR* 2000;49(No. RR-9).
8. **Influenza vaccine.** Influenza vaccine is recommended annually for children aged ≥6 months with certain risk factors (including, but not limited to, asthma, cardiac disease, sickle cell disease, human immunodeficiency virus infection, diabetes, and conditions that can compromise respiratory function or handling of respiratory secretions or that can increase the risk for aspiration), health-care workers, and other persons (including household members) in close contact with persons in groups at high risk (see *MMWR* 2005;54[No. RR-8]). In addition, healthy children aged 6–23 months and close contacts of healthy children aged 0–5 months are recommended to receive influenza vaccine because children in this age group are at substantially increased risk for influenza-related hospitalizations. For healthy, nonpregnant persons aged 5–49 years, the intranasally administered, live, attenuated influenza vaccine (LAIV) is an acceptable alternative to the intramuscular trivalent inactivated influenza vaccine (TIV). See *MMWR* 2005;54(No. RR-8). Children receiving TIV should be administered an age-appropriate dosage (0.25 mL for children aged 6–35 months or 0.5 mL for children aged ≥3 years). Children aged ≤8 years who are receiving influenza vaccine for the first time should receive 2 doses (separated by at least 4 weeks for TIV and at least 6 weeks for LAIV).
9. **Hepatitis A vaccine (HepA).** HepA is recommended for all children at age 1 year (i.e., 12–23 months). The 2 doses in the series should be administered at least 6 months apart. States, counties, and communities with existing HepA vaccination programs for children aged 2–18 years are encouraged to maintain these programs. In these areas, new efforts focused on routine vaccination of children aged 1 year should enhance, not replace, ongoing programs directed at a broader population of children. HepA is also recommended for certain high risk groups (see *MMWR* 1999;48[No. RR-12]).

The Childhood and Adolescent Immunization Schedule is approved by the Advisory Committee on Immunization Practices (http://www.cdc.gov/nip/acip), the American Academy of Pediatrics (http://www.aap.org), and the American Academy of Family Physicians (http://www.aafp.org).