

PRAMSGRAM

OKLAHOMA PREGNANCY RISK ASSESSMENT MONITORING SYSTEM VOL. 15 NO 1 SPRING 2011

Characteristics of Toddlers and Infants With Up-to-Date Immunization Status

Background:

One of the most notable public health accomplishments of the past century is the development and use of vaccines.¹ Childhood immunization programs have played a vital role in reducing infant and child mortality and morbidity, both in the United States and the world. Although vaccine preventable diseases are at or near all time lows, they still exist in the world and are only a plane ride away.² History has shown that a return of these diseases can occur when vaccine coverage is low.³ For this reason, it remains essential that high vaccination coverage rates are achieved.

The most intensive period of vaccination occurs during the first two years of life when as many as 25 immunizations are recommended to provide protection against 13 diseases.⁴ In measuring vaccine coverage levels, the Centers for Disease Control and Prevention (CDC) conducts the National Immunization Survey (NIS) to provide annual estimates on vaccine coverage levels of 19-35 month old children. Oklahoma has consistently ranked low nationally in the percent of children completing the primary immunization series, although improvements have been noted since 2006. The NIS has also consistently ranked Oklahoma 50th in the percent of children starting out on schedule.⁵ Strategies for continued improvement must address potential barriers for children starting the vaccination series on time and staying on schedule.

A base standard used by CDC to measure vaccine coverage is the 4:3:1:3:3 series. This series identifies the percent of young children who have received a primary series of immunizations against nine diseases, generally due by 15-24 months of age. The series includes 4 doses of DTaP (Diphtheria, Tetanus, and Pertussis), 3 doses of Polio, 1 dose of MMR (Measles, Mumps, and Rubella), 3 doses of Hib (Haemophilis influenza type B), and 3 doses of Hepatitis B.^{4,5}

The Oklahoma State Immunization Information System (OSIIS) is a confidential registry utilized by a majority of Oklahoma providers to review and record vaccination events over the internet. An estimated 65-70% of

In Oklahoma:

- In 2007, 78.4% of infants born in Oklahoma had a complete 4:3:1:3:3 immunization series by 24 months of age.
- Pregnancy intention and parity were found to be significantly associated with immunization status at 24 months.
- Race, ethnicity, maternal education, and marital status were not significant factors with immunization coverage at 24 months.
- Infants were more likely to be up-to-date for their first series of immunizations by 3 months of age (DTaP, Polio, Hib, HepB).
- Infants of mothers who breastfed them for 8 weeks or more, intended their pregnancy, and/or reported the infant had a medical home were more likely to be up-to-date with their immunizations.
- Non-Hispanic mothers and mothers older than 20 years of age were also more likely to have infants with up-to-date status for the earliest immunizations (at 3 months of age).

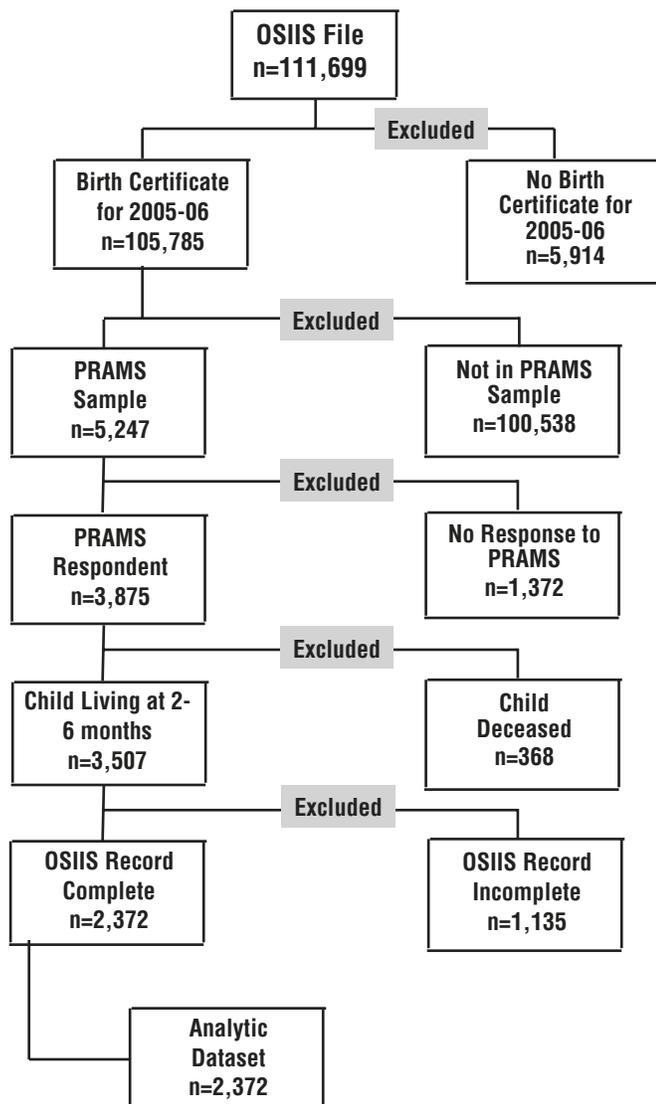
Oklahoma two-year-old children have complete immunization records in OSIIS. While OSIIS offers enormous potential in identifying state and regional vaccine coverage rates, it captures little information beyond basic demographics that identify risk factors related to poor coverage. The Oklahoma Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing, population-based survey of new mothers that identifies maternal and early infancy risk factors. By linking OSIIS data with PRAMS, a more complete picture of maternal and family factors that impact immunization coverage may be formed.

This PRAMSGRAM reviews the linked OSIIS and PRAMS data set and current findings to determine which population of mothers are most at risk for having an under-vaccinated toddler and offers recommendations to increase vaccination coverage among those most at risk.

Methods:

This study utilized a 2005-2006 birth cohort dataset consisting of 111,699 records from OSIIS and 3,875 PRAMS records. A total of 3,250 PRAMS records (84% matching rate) were successfully linked to an OSIIS record by birth certificate number using SAS v9.2. For this analysis, factors influencing the completion of the sampled infant's 4:3:1:3:3 series by 24 months of age and the infant's 1:1:1:1 series (DTaP, Polio, Hib, Hep B) by 3 months of age were examined. Records were excluded from the study if immunization information was incomplete (indicating the child had most likely moved or changed to a provider no longer participating in OSIIS) or the infant died during the 24 month interval following birth, resulting in a final analysis dataset containing 2,372 linked PRAMS/OSIIS records (See Figure 1).

Figure 1. Process for Determining Inclusion in Linked PRAMS and OSIIS Dataset



Due to the PRAMS stratified weighted sample, SUDAAN 10.0.1 was used to perform the statistical analysis. In the descriptive analysis, the percentage of linked infants with complete immunization status by 24 months was measured by demographic and health indicator variables. Chi-square tests were performed to test associations between immunization status and the selected variables. Logistic regression modeling was performed to produce adjusted odds ratios (AOR) as measures of association between selected independent variables and immunization status. A second analysis was performed to measure the association between selected variables and immunization status at 3 months of age. Variables were considered statistically significant at $p < 0.05$.

Results:

Overall, 78.4% of the 2,372 linked PRAMS records from the 2005-2006 birth cohort (excluding incomplete records and deceased infants) were considered to have a complete 4:3:1:3:3 series immunization record at 24 months of age. No statistically significant differences in immunization status by socioeconomic or demographic groups were discovered among this age group (Table 1).

The Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing, population-based study designed to collect information about maternal behaviors and experiences before, during, and after pregnancy. On a monthly basis, PRAMS samples between 200 and 250 recent mothers from the Oklahoma live birth registry. Mothers are sent as many as three mail questionnaires seeking their participation, with follow-up phone interviews for non-respondents. A systematic stratified sampling design is used to yield sample sizes sufficient to generate population estimates for groups considered at risk for adverse pregnancy outcomes. Information included in the birth registry is used to develop analysis weights that adjust for probability of selection and non-response.

Table 1. Percentage of mothers by maternal demographics who had up-to-date 4:3:1:3:3 immunization status for their infant by 24 months of age, linked PRAMS/OSIIS 2005-2006 birth cohort.

Maternal Demographics	<i>n</i>	%	95% Confidence Interval (CI)	<i>Chi Square (χ²) p-value</i>
Overall	2,372	78.4	75.7, 80.9	
Race				
White	1,733	79.6	76.5, 82.4	.2978
African Am.	272	76.0	65.8, 83.9	
Am. Indian	313	73.7	65.6, 80.5	
Hispanic Ethnicity				
Hispanic	321	82.2	74.9, 87.8	.2061
Non-Hispanic	2,051	77.7	74.7, 80.4	
Education				
<High school*	470	76.6	69.6, 82.4	.7647
High school	975	78.7	74.4, 82.4	
>High school	504	76.4	70.4, 81.6	
Age at Delivery				
<20 years	370	83.1	75.5, 88.7	.0864
20-29 years	1,441	76.2	72.7, 79.5	
30+ years	561	81.4	76.0, 85.8	
Marital Status				
Married	1,291	79.1	75.5, 82.3	.5786
Unmarried	1,081	77.6	73.3, 81.4	
Medicaid				
Yes	1,558	77.6	74.1, 80.8	.6512
No	756	79.4	74.9, 83.4	
Household Income				
<100% FPL	454	74.3	67.2, 80.3	.0785
≥100% FPL	891	81.2	77.0, 84.9	
County of Residence				
Rural	489	79.4	73.2, 84.5	.6974
Urban	1,883	78.1	75.0, 80.9	

* Excluding mothers less than 18 years of age.

Pregnancy intention and parity were found to be significantly associated with immunization status (Table 2). PRAMS respondents who reported having an intended pregnancy were more likely to have completed their infant's 4:3:1:3:3 vaccines than women who reported their

pregnancy was unintended (81.0% vs. 75.7%). Nulliparous women were more likely to have their infant's immunization status up-to-date by 24 months compared with multiparous women (85.6% vs. 73.7%).

Table 2. Characteristics and behaviors of mothers who had up-to-date 4:3:1:3:3 immunization status for their infant by 24 months of age, linked PRAMS/OSIIS 2005-2006 birth cohort.

Maternal Characteristic	<i>n</i>	%	95% CI	<i>χ²</i>
Overall	2,372	78.4	75.7, 80.9	
Smoking During Pregnancy				
Smoker	538	75.4	68.8, 81.0	.2844
Non-Smoker	1,815	79.1	76.1, 81.8	
Infant in Child Care at 2-6 Months				
Yes	498	79.3	73.9, 83.8	.6709
No	1,789	78.0	74.8, 81.0	
Breastfeeding at 8 Weeks				
Yes	998	77.6	73.2, 81.4	.6479
No	1,347	78.8	75.2, 82.1	
Pregnancy Intention				
Intended	1,138	81.0	77.2, 84.3	.0483
Unintended	1,206	75.7	71.7, 79.3	
Parity				
Nulliparous	976	85.6	81.6, 88.9	<.0001
Multiparous	1,373	73.7	70.0, 77.1	
Birth Weight				
< 2,500 grams	1,181	76.0	73.3, 78.5	.1969
≥ 2,500 grams	1,191	78.6	75.6, 81.2	

When controlling for multiple maternal demographic, socio-economic, and health characteristics in a multivariate logistic regression model, women reporting intended pregnancies showed a higher odds (AOR= 1.39, 95% CI= 1.11-1.73) of completing their infant's 4:3:1:3:3 immunization status by 24 months of age (Table 3).

Table 3. Multivariate logistic regression odds ratios of mothers having up-to-date 4:3:1:3:3 immunization status for their infant by 24 months of age, with 95% confidence intervals, linked PRAMS/OSIIS 2005-2006 birth cohort.

Maternal Characteristic	Adjusted Odds Ratio (AOR)	95% CI
Pregnancy Intention		
Unintended	1.00	1.00, 1.00
Intended	1.39	1.11, 1.73

In an effort to examine the data more closely, a second analysis was performed to determine if factors present at 24 months were different than those that impacted immunization status for the first series of vaccinations (1:1:1:1) when the infant reached 3 months of age.

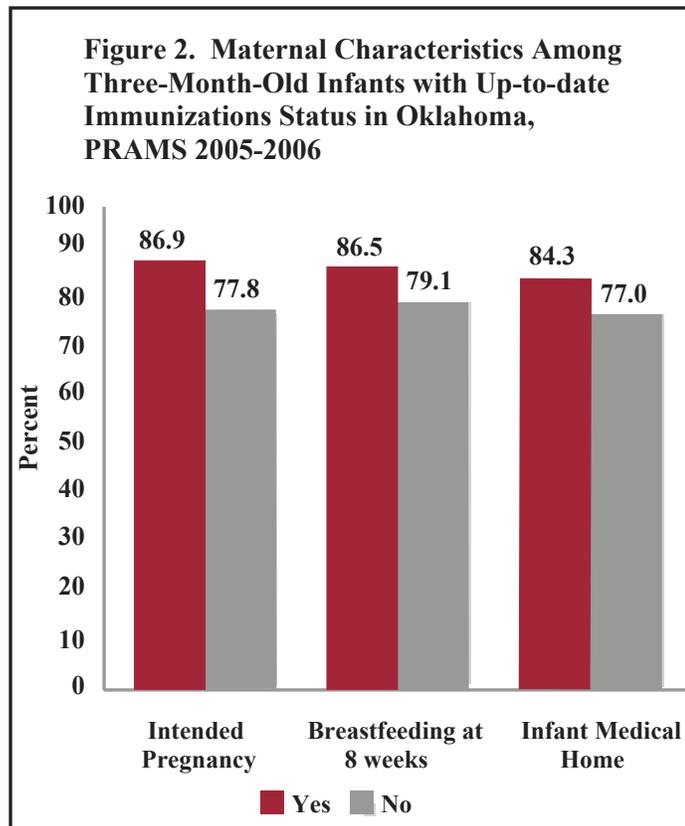


Figure 2 highlights the differences between groups of infants with up-to-date immunization status at 3 months of age. Pregnancy intention remained a significant factor. Breastfeeding and the presence of a medical home (having a health care provider that mothers could contact

at any time who regularly takes care of their infant for well child and sick care) became significant contributors to timely immunizations. To determine the strength of these associations, a logistic regression was performed.

Table 4. Logistic Regression of Characteristics Associated With *NOT* Having Up-To-Date Immunization Status At Three Months of Age, Oklahoma PRAMS-OSIIS Linked Data 2005-2006.

Characteristic	Adjusted Odds Ratio (AOR)	Lower 95% CI	Upper 95% CI
Maternal Age			
<20 (reference)	1.00	1.00	1.00
20-29	0.30	0.15	0.61
30 or more	0.17	0.08	0.35
Maternal Ethnicity			
Non-Hispanic	0.42	0.25	0.73
Hispanic (reference)	1.00	1.00	1.00
Pregnancy Intention			
Unintended (reference)	1.00	1.00	1.00
Intended	0.52	0.39	0.69
Breastfed 8 or More Weeks			
No (reference)	1.00	1.00	1.00
Yes	0.62	0.47	0.81
Infant Has a Medical Home			
No (reference)	1.00	1.00	1.00
Yes	0.42	0.28	0.62

The results of the logistic regression examining infants' immunization status at 3 months of age are markedly different from the analysis of children at 24 months (Table 4). While ethnicity was not significant when the infant was older, at 3 months, ethnicity is a contributing factor, non-Hispanic women were significantly less likely to have an under-vaccinated 3 month old compared to Hispanic women. Maternal age also became significant at this early age, mothers under 20 were more likely to have infants not up-to-date at 3 months of age compared to mothers aged 20-29 and aged 30 and older (AOR=0.30 and 0.17, respectively).

Pregnancy intention maintained significance, with a stronger association during the 3 month time period than at 24 months. Women who had intended pregnancies were half as likely as women with unintended pregnancies to have under-vaccinated infants (AOR=0.52, 95% CI: 0.39-0.69). Breastfeeding and medical home became significant. Infants who breastfed for eight weeks or more were less likely than infants not breastfed for this time period to be under-vaccinated. In addition, the absence of a medical home significantly contributed to the likelihood of being under-vaccinated at 3 months compared to infants with medical homes (AOR=0.42, 95% CI: 0.28-0.62). Factors that were not found to be significant include maternal race, insurance status, having a postpartum checkup, father's presence in the home, marital status, residence, and maternal education levels.

Discussion:

Most 24-month-old children in Oklahoma were up-to-date with their immunizations; however, almost one in four were not. Although there were only a few key variables shown to be related to immunization status, targeted interventions can be developed to work with women at risk for unintended pregnancies and those women with more than one child. One such intervention currently implemented by the Oklahoma State Department of Health (OSDH) Immunization Service is Operation Buzzer Beater (OBB). The intent of OBB is to target the parents of 21-month-old Oklahoma children that are missing at least *one dose* of the 4:3:1:3:3 vaccination series to ensure the series is completed by 24 months of age. Evaluation of this intervention is on-going.

Further investigation into maternal characteristics with infant and toddler immunization status at various ages may prove useful in identifying additional maternal and family characteristics associated with unvaccinated or inadequately vaccinated infants and toddlers. What influences the decision to immunize or delay immunizations during one period of the child's life may change due to age of the child, personal circumstances, health history, and family structure. A review of the PRAMS-OSIIS data to examine possible correlates of under-vaccination at two months of age found that breastfeeding status, maternal age, maternal ethnicity, medical home, and pregnancy intention were strongly associated with being up-to-date on vaccinations at 3 months of age.

The issue of unintended pregnancy appears to have far-reaching implications on infant and toddler health for Oklahoma's children. While all the socioeconomic and personal factors that contribute to an unintended pregnancy cannot be fully explored in studies like PRAMS, it is clear that prevention of unintended pregnancy should continue to be a priority for Oklahoma.

Additionally, by linking PRAMS and OSIIS data to The Oklahoma Toddler Survey (TOTS), the PRAMS follow-back survey when the PRAMS infant turns two-years-old, some of the later influences may be explored more in-depth.

This study is subject to some limitations. All data were self-reported from PRAMS. The OSIIS data were dependent upon provider participation and maintenance of records within the system. Private providers were more likely to only include children with Medicaid in the OSIIS system and therefore, their patients with private insurance were underrepresented in the linked dataset. Infants and toddlers who died prior to 24 months were also excluded from the analysis dataset.

Recommendations:

1. Continue to analyze linked data from PRAMS and OSIIS to determine at-risk infants for under-vaccination at 6 months.
2. Work with private providers in the state to expand the use of OSIIS in order to better understand risk factors associated with under-vaccination for all Oklahoma toddlers.
3. Work with parent organizations (such as the Parent Teacher Association (PTA)) to provide evidence-based information about vaccine safety and the importance of being up-to-date with immunizations.
4. Continue training on the importance of data entry and verification among those utilizing OSIIS.
5. Continue support of interventions like OBB to increase the number of children completing their 4:3:1:3:3 immunization primary series on time.
6. Expand the use of Public Service Announcements (PSAs) to reassure the general public about the safety and necessity of vaccinations.
7. Support and encourage breastfeeding beyond eight weeks for the many protective health factors it provides.
8. Facilitate the linking of infants and toddlers to a medical home for their routine health care (e.g., via the online SoonerCare/Medicaid application).

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