1999 Oregon Immunization Survey of Two-Year-Olds

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and
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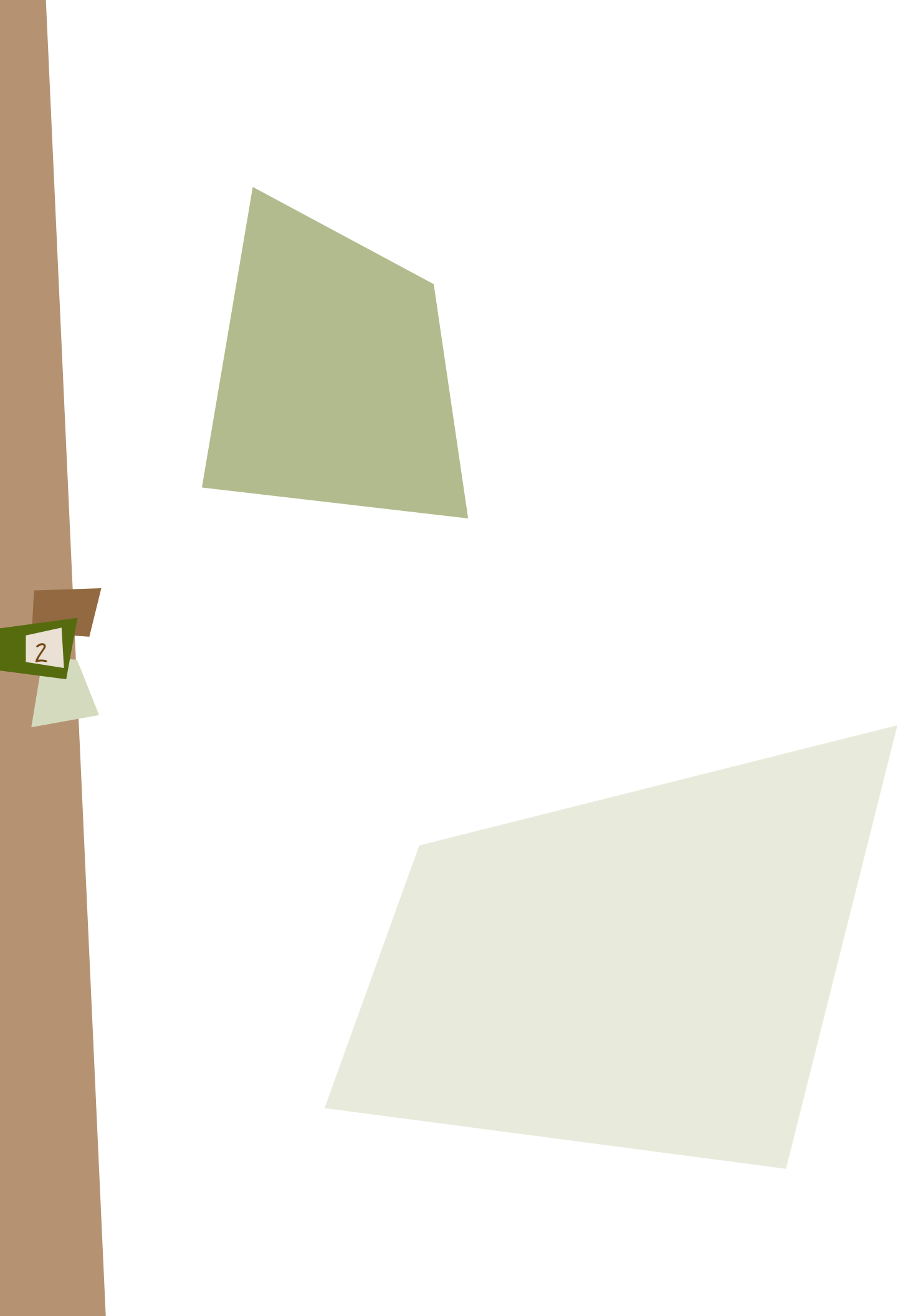

2

Table Of Contents

Executive Summary

Oregon's Benchmark goal and the national Healthy People 2010 goal for immunizations are consistent — achieve a 90% immunization coverage rate for two-year-old children. The classic up-to-date (UTD) rate for the childhood series of four doses of diphtheria, tetanus and pertussis, three doses of polio and one dose of measles, mumps and rubella (4:3:1), remains below the national average, and below our state and national goals.

To help realize our goals, Oregon-specific data is needed to identify pockets of under-immunization, health practices of the under-immunized and barriers that parents and providers face in getting children immunized.

In 1996, Oregon conducted a birth certificate follow-back survey of parents of children 19-35 months of age to collect demographic data, immunization histories, health practices, and reported barriers to receiving immunizations. Completed surveys were received, immunization histories verified, and birth certificate data compiled on 2,452 children (80% response rate).

In this survey the immunization rate among Oregon children 19-35 months old was 81% for the basic 4:3:1 series. The immunization rate did not change significantly when three doses of Haemophilis influenzae type B (Hib) were added to the series. Immunization rates for single antigens were better: 90% percent of children had three doses of OPV, three doses of DTP (four are recommended), one dose of MMR, three doses of Hib and three doses of hepatitis B.

Immunization rates were age-dependent, that is as children got older, the rate of full immunization improved. Only 52% of the children had completed the 4:3:1 series by 18 months of age compared to 78% who completed the series by 24 months of age and 83% who completed the series by 30 months of age.

Immunization rates among African American children (71%) and American Indian children (75%) were significantly lower than rates among Asian children (82%), Hispanic children (82%) and White children (81%).

The children who were under-immunized were a heterogenous group, distinguished by the degree of immunization. Eighty-one percent (81%) of the children were *Fully* immunized with 8 shots; 15.5% were *Almost* immunized with 5-7 immunizations, 2.1% were *Poorly* immunized with 1-4 immunizations and 1.4% were *Unimmunized* with no immunizations. Nearly half of under-immunized children were missing just one immunization (48%) and among parents of the children missing one immunization, 85% believed their child was up-to-date.

Children Poorly immunized, who are more susceptible to vaccine-preventable diseases, were more likely to start their immunizations at a later age, more likely to come from a family of lower socio-economic status, more likely to seek immunizations outside of their primary care, and more likely to have a parent report a barrier to receiving immunizations. The most commonly reported barriers were provider and parent scheduling conflicts, financial cost and child sickness. Multiple strategies are needed to address the challenges faced by the Poorly immunized children.

And finally, as new vaccines become available for other childhood diseases, it is important that Oregon address the barriers faced by families and providers in order to maintain high immunization levels for the basic 4:3:1 series, which will lay the foundation to improve the acceptance of newer vaccines.

Recommendations

- Identify system constraints that make it difficult for infants to start the immunization series on time.
- Immunize children in their medical home.
- Make it easier to schedule immunization visits, with immunization-only visits and weekend and evening hours.
- Screen and immunize children at all appropriate visits, despite minor illnesses.
- Address specific barriers faced by American Indian and African American populations.
- Implement a statewide public/private reminder/recall system for parents and providers.
- Take the 4th Dose DTaP Challenge - administer the 4th DTaP as soon as minimum spacing guidelines are met.
- Target varicella, hepatitis A, and pneumococcal conjugate immunizations in parent and provider education efforts.

Introduction and Background

Until as recently as 1954,[1] infectious diseases that are now vaccine-preventable ranked among the leading causes of childhood death and disability. Polio vaccine, put into widespread use in 1956, effectively broke the epidemic cycle of polio in Oregon by 1960.[2] Diphtheria toxoid has been used since the 1930s, and whole cell pertussis vaccine since the 1940s. Polio vaccine was followed by vaccines for measles (1963), mumps (1966), and rubella (1969). The Advisory Committee on Immunization Practices (ACIP) was established in 1965 to study and make recommendations about immunizations; by 1980 all fifty states required children to have started a series of basic immunizations before entering Kindergarten or First grade, or documented appropriate exemptions (Oregon has both medical and religious exemptions).

With effective vaccines and laws to promote their use, it stands to reason that vaccine-preventable diseases, and their associated morbidity and mortality, should be a thing of the past — but that is not so. Although polio was declared eradicated from the Americas in 1994, outbreaks of measles and pertussis have occurred throughout the United States, including in Oregon where the second highest measles incidence was reported in 1999. Furthermore, as new vaccines become available to fight against hepatitis A and pneumococcal disease, the goal to improve immunization rates remains a public health priority.

Immunization coverage is generally defined as receiving a recommended number of immunizations by a certain age and is considered an important benchmark of child health status. Estimates of immunization coverage vary depending on study design, definitions and the population examined.

Oregon's *1994 Two-Year-Old Immunizations Survey*[3] reported up-to-date rates of 67% for four doses of diphtheria, tetanus and pertussis, three doses of polio and one dose of measles, mumps and rubella (4:3:1 series) at age 24 months. The annual National Immunization Survey (NIS), conducted by the Centers for Disease Control and Prevention (CDC) since 1994, has consistently reported Oregon immunization rates for the 4:3:1 series between 72-76%,

with the most recent 1999 survey reporting a rate of 72.3%[4] for 19-35 month olds. And in this study, Oregon's *1999 Immunization Survey of Two Year Olds*, we report immunization rates for the 4:3:1 series at 81%.

The variability in rates can be explained to some extent by: the population studied, 24-month-olds versus 19-35-month olds; the methods of following up non-responders and verifying immunization records; and the time elapsed between surveys.

While the NIS rates allow Oregon to rank itself nationally and chart progress over time, the NIS data collected do not provide insight into why Oregon's rates are low. Analysis of Oregon-specific data is critical to understanding the factors that influence immunization rates and what strategies are best suited to tackling the problem. In 1996, Oregon launched this study to identify the difficulties faced here and the promising strategies to address them. This report describes the study objectives, methodology, results and recommendations.

Survey Objectives

1. To determine the rates of under-immunization in Oregon's 19-35 month olds.

2. To identify risk factors for the under-immunized children living in Oregon.

3. To determine the immunization rates among different racial and ethnic populations.

4. To identify barriers to immunization as perceived by parents.

Methods

By the time children reach their 19-month birthday they should have received the 4:3:1 series of basic immunizations: four doses for diphtheria, tetanus and pertussis(DTP), three doses for polio (OPV)[5] and one dose for measles, mumps and rubella (MMR) (Appendix 1). Ideally, immunizations should be given at specified ages and after a minimum amount of time has elapsed between doses (for example, children should receive their first DTP at two months of age and their second DTP no sooner than six weeks later). Although children should receive the 4:3:1 series by their 19-month birthday, completing the series may take as long as three years. For the purpose of this study, "two-year-olds" are children 19-35 months of age (that is, children who are not yet three years old). Children studied in the *1999 Oregon Immunization Survey of Two-Year-Olds* received all or part of the series of basic immunizations in 1994, 1995 and 1996.

Sampling

Between November 1, 1993 and April 1, 1995, the Oregon Health Division issued certificates of live birth for 57,776 children whose mothers were living in Oregon. On November 1, 1996, when children in this birth cohort were 19-35 months old, we drew a stratified random sample of birth certificates from six regions (including all Oregon counties) that produced a sample of 2,266 children, or about 375 children per region after four sparsely populated regions were oversampled (see Definitions). Subsequent oversampling of the birth certificates of non-White and Hispanic children increased the sample to 3,149 by adding an average of 221 children to each of four race and ethnicity groups (African American, American Indian, Asian and Hispanic). Race and ethnicity group assignment was based on the child's race and ethnicity recorded on the birth certificate, not the mother's race. At the time the sample was drawn, race and ethnicity were combined as one variable. A child was recorded as African American (non-Hispanic), American Indian (non-Hispanic), Asian (non-Hispanic), Hispanic, White (non-Hispanic) or Other. For this report, all children of Hispanic ethnicity are coded as Hispanic. The method of classifying children by race and ethnicity is given in Appendix 2. We used EpiInfo software to calculate minimum sample sizes for each region and each race and ethnicity group based on expected immunization rates of 67%±5%.[6]

We used post-stratification weights to normalize the sample and weighted sample data to calculate the statistics in this report[7], except as noted.

Data Collection

To verify and correct addresses, we mailed pre-survey postcards to parents or guardians of children listed on the birth certificates. If this address proved incorrect, postcards were re-sent to new addresses obtained from the United States Postal Service, the National Change-of-Address Database (a service which retains change-of-address information for three years), Oregon motor vehicle and drivers license files, Equifax consumer locator files, and Oregon Health Division marriage, divorce and WIC[8] data files. Unlike the National Immunization Surveys and the Oregon *1994 Two-Year-Old Immunizations Survey*, we tried to locate and collect

data about children who had moved out of state and out of the United States. We mailed a fourteen-item questionnaire (Appendix 3) to 3,048 people between December 1, 1996, and January 31, 1997 (101 children in the original sample were eliminated from the sample for reasons described in the results section). We attempted to contact those who did not respond to the mailed survey twice with reminder post-cards, thrice by telephone and at least once in person before they were considered survey non-respondents.

We gathered data about the type and date of each immunization given to children in the survey from: (1) parents who provided immunization records; (2) public and private immunization providers listed by parents on survey forms; and (3) the Oregon Health Division's Women's and Children's Health Data System[9], a patient record system for Oregon county health department clients. We contacted public and private immunization providers when parents: (1) did not provide an immunization record; (2) provided an immunization record that was incomplete; or (3) provided an immunization record that did not correspond to the recommended immunization schedule in Appendix 1.

Data collection was completed in November, 1998, two years after drawing the sample.

Quantitative data analysis

We classified the children by degree of immunization, as *Fully* immunized, *Almost* immunized, *Poorly* immunized and *Unimmunized* depending on the number of DTP, OPV and MMR immunizations they received before November 1, 1996, the day the sample was drawn. Fully immunized children received a series of eight immunizations that included four doses of DTP, three doses of OPV and one dose of MMR (the 4:3:1 series). Almost immunized children received 5-7 immunizations in any combination of DTP, OPV, and MMR. Poorly immunized children received 1-4 immunizations in any combination of DTP, OPV, and MMR. And Unimmunized children received no immunizations for DTP, OPV, or MMR. The analysis of the *1994 Two-Year-Old Immunizations Survey* demonstrated that the under-immunized children were not a homogenous group. Rather those who were severely under-immunized were more likely to have special risk factors that separated them from those

only missing 1-2 immunizations. The following analysis looks at groupings of children by degree of immunization (Fully, Almost and Poorly) to identify the associated risk factors prevalent in each subgroup.

The tables and data analysis only include immunizations received on or before November 1, 1996, the day the sample was drawn. All immunizations were counted regardless of the spacing between doses.

Individual birth certificate data were linked with individual survey response data for both univariate and multivariate logistic regression analysis. We used birth certificate data: (1) to analyze the family demographic characteristics of survey respondents; and (2) to find differences in the family demographic characteristics of Fully, Almost, and Poorly immunized children. Family demographic characteristics include race and ethnicity, parental education, parental age, marital status, prenatal care, place of birth, birth order, and alcohol, tobacco and illicit drug use. We used survey response data: (1) to compute immunization rates; (2) to analyze family income and its relationship to immunization rates; (3) to identify family health practices associated with under-immunization (medical home, choice of immunization provider, health insurance); and (4) to identify barriers associated with under-immunization.

Definitions

Degree of immunization is the classification of children as Fully immunized (8 shots), Almost immunized (5-7 shots), Poorly immunized (1-4 shots) and Unimmunized (no shots). The term Under-immunized is also used to refer to children who have received 1-7 shots (Table 1).

Table 1. Degree of Immunization

Fully Immunized	8 shots
Almost Immunized	5-7 shots
Poorly Immunized	1-4 shots
Unimmunized	0 shots
Under-immunized	1-7 shots

Immunization rates are the number of immunized children divided by the total number of children in the group being considered (eg. Fully, Almost, Poorly or Unimmunized), expressed as a percentage. All immunization rates use weighted data unless otherwise specified. Point estimates and 95% confidence intervals (CI) from standard errors[10] of the immunization rates were calculated with SUDAAN® software to take into account the sample design. Logistic regression models were used to identify risk factors for under-immunization.

Odds Ratio (OR) is the likelihood of a certain risk factor being present in a group. Odds Ratios were calculated for selected variables, quantifying the degree to which certain risk factors were more likely found among the Poorly or Almost immunized children. We chose to estimate Odds Ratios rather than relative risk ratios, because the sampling methodology for the study required complex weighting which could only be accounted for using SUDAAN® software, and SUDAAN® will only calculate ORs for multivariate logistic regression analysis.

Geographic **regions** are six groups of Oregon counties where mothers of children in the sample lived at the time their child was born. Regions 1 and 2 are classified as urban regions in this report; regions 3, 4, 5 and 6 are classified as non-urban regions (**Table 2**).

Table 2. Oregon's Geographic Regions

Region		Urban/ Non-urban	Percent of Births	County of Residence at time of Birth
Region 1	Portland Metro	Urban	22%	Multnomah
Region 2	Portland Metro	Urban	23%	Washington, Clackamas
Region 3	Northwest	Non-urban	22%	Benton,Clatsop, Columbia, Lincoln,Linn, Polk, Marion, Tillamook, Yamhill
Region 4	Southwest	Non-urban	23%	Coos, Curry, Douglas, Jackson, Josephine, Klamath, Lane,
Region 5	Southeast	Non-urban	3%	Baker, Crook, Grant, Harney, Lake, Malheur
Region 6	Northeast	Non-urban	8%	Deschutes, Gilliam, Hood River, Jefferson, Morrow, Sherman, Umatilla, Union, Wallowa, Wasco

Children from **low-income** families are children whose families have annual incomes of $15,000 or less as reported on the survey questionnaire. This is distinct from the federal poverty level, the customary measure of economic under-privilege, which is currently defined as annual income of $15,000 or less for a family of five. We did not collect data about family size from survey participants that would permit us to identify children living at or below the federal poverty level when they were being immunized. Annual income less than $15,000 is our only measure of poverty.

Immunization providers are the places where, or the people from whom, children received immunizations. We classified federal, state, and local health agencies (such as Indian Health Service, migrant health centers and county health departments) as public providers. Private providers included physicians in solo and group practice, and non-federal hospitals.

Children with a **medical home** are children who went to the same clinic or doctor for primary care and immunizations most of the time.[11]

Qualitative data analysis

To gather data about barriers to immunization, parents were asked "Can you think of anything that made it hard to get baby shots for this child?". Parents answering "Yes" to this question were asked to "Please describe the problems." Problems were recorded verbatim in the survey database and assigned to one of eight groups: (1) provider scheduling and clinic practices,[13] (2) child sickness,[14] (3) financial cost,[15] (4) transportation and other access issues,[16] (5) understanding the immunization schedule/no reminder and recall,[17] (6) parental concern,[18] (7) history of reaction,[19] and (8) parental belief that immunizations are not important.[20]

Results

Response Rates

From the original sample of 3,149 birth certificates, 48 children were born outside Oregon, and 53 children were lost to follow-up by adoption, foster care or death, producing a final sample of 3,048. Despite numerous attempts to gather data, 596 (19.6%) did not respond to the survey, producing a response rate of 80.4% (2,452/3,048). Ninety-eight percent of survey respondents were parents of children in the final sample; "parents" will be used throughout the rest of this report to refer to survey respondents.

Of the 2,452 completed surveys, 63.3% of the parents returned the survey by mail, 32.3% participated in a telephone interview with a representative from the Health Division, and 4.4% participated in a face-to-face interview. Parents themselves provided immunization data for 44% of the children in the survey by either photocopying immunization records or recording the type and date of each immunization in a space provided on the survey questionnaire. Public and private health care providers furnished immunization data for 56% of children in the survey by telephone, mail and/or fax.

Response rates varied by region and race and ethnicity. Regional rates ranged from 76.1% in Region 4 (southwest Oregon) to 85.9% in Region 5 (southeast Oregon) (**Table 3**). Race-specific response rates all exceeded 70%, due in part to the effort made to reach survey participants at home (**Table 3**).

We used data from Oregon certificates of live birth to compare the characteristics of survey respondents (n=2,452) and non-respondents (n=596) and found that survey non-respondents were more likely to be non-White, did not finish high school, started prenatal care after the first trimester and have had one previous live birth.

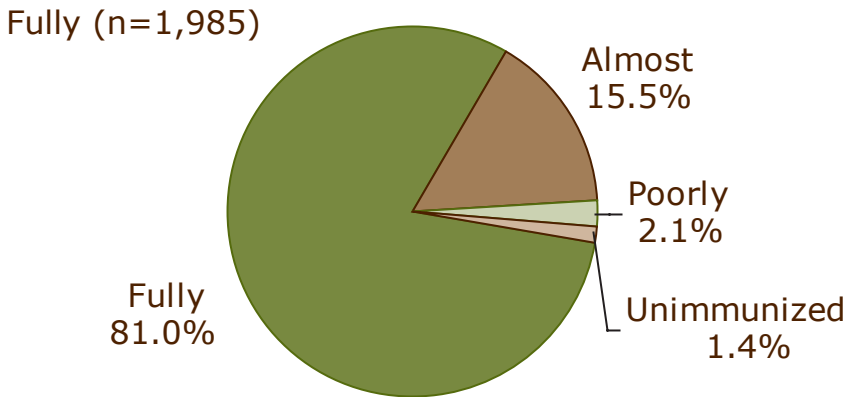
Table 3.	Survey response rates by Region and by Race and Ethnicity		
Region			
Region 1	Metro	80.4%	(600/746)
Region 2	Metro	81.3%	(456/561)
Region 3	Northwest	79.2%	(400/505)
Region 4	Southwest	76.1%	(396/520)
Region 5	Southeast	85.9%	(280/326)
Region 6	Northeast	82.1%	(320/390)
Race and Ethnicity			
African American		75.5%	(259/343)
American Indian		73.4%	(223/304)
Asian		78.9%	(277/351)
Hispanic		71.1%	(263/370)
White		85.1%	(1429/1679)

Note: African American, American Indian, Asian and White are all non-Hispanic.

Immunization Rates (4:3:1)

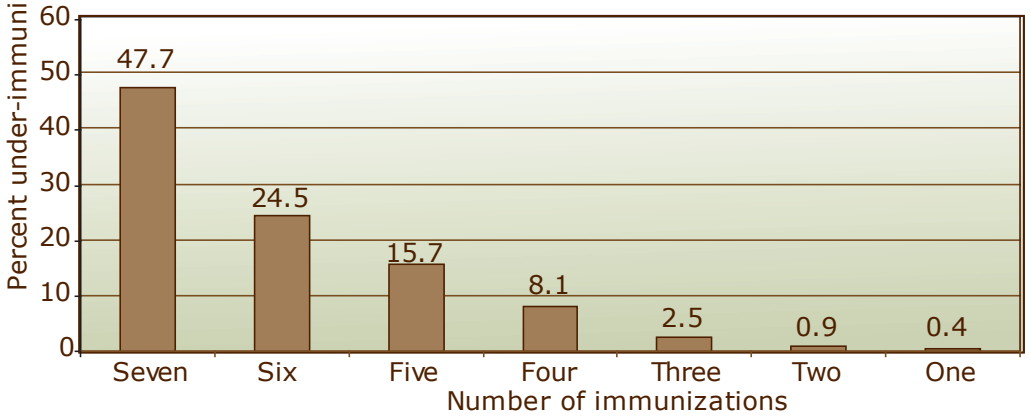
Degree of Immunization. When grouped according to the number of immunizations received or degree of immunization, 81.0% of the children in the survey were Fully immunized (with the 4:3:1 series), 15.5% were Almost immunized (with 5-7 immunizations), 2.1% were Poorly immunized (with 1-4 immunizations) and 1.4% were Unimmunized (**Figure 1**).

Figure 1. The Degree of Immunization



Altogether, 17.6% of the children were under-immunized with one to seven immunizations. **Figure 2** is the percent distribution of the under-immunized children ages 19-35 months by the number of immunizations they actually received. The majority of under-immunized children, 72.2%, were missing just one or two immunizations.

Figure 2. Percent distribution of under-immunized children by number of immunizations received (n=432)



Failure to obtain the fourth DTP dose was a major barrier to full immunization. There was a significant six-percentage-point difference between children who received a 4:3:1 series with four DTPs (81.0%) and a 3:3:1 series with three DTPs (87.0%). Overall immunization rates did not change significantly when three doses of Hib were added to the 4:3:1 series: 80.3% had the 4:3:1 series plus three Hib.

Oregon children had rates of 89.5% for each of the individual following antigens: three OPV, one MMR, three Hib and three hepatitis B virus vaccines. Immunization rates of DTP vary by the number of DTP doses received: 95.3% for three doses and 83.5% for four doses. The rate of varicella immunization, newly implemented in 1996, was 20.4%[21] (**Table 4**).

Table 4. Immunization rates by series & individual antigen
(Rates per 100 children ± 95% confidence intervals)

	Children 19-35 mos (n=2,452)
4DTP:3OPV:1MMR	81.0%(±1.9)
3DTP:3OPV:1MMR	87.0%(±1.6)
4DTP:3OPV:1MMR:3Hib	80.3%(±1.9)
3DTP:3OPV:1MMR:3Hib	86.0%(±1.6)
4 or more DTP	83.5%(±1.7)
3 or more DTP	95.3%(±1.0)
3 or more OPV	91.4%(±1.3)
1 or more MMR	90.8%(±1.4)
3 or more Hib	94.0%(±1.1)
3 or more hepatitis	89.5%(±1.5)
1 or more varicella	20.4%(±2.0)

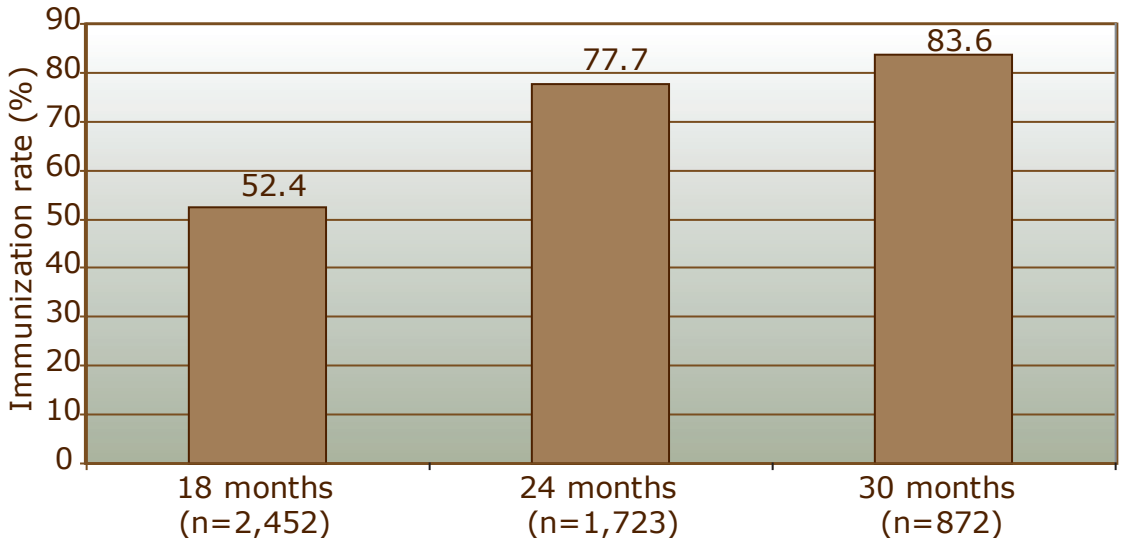
Less than 1.4% of children ages 19-35 months old were unimmunized. Of the 30 unimmunized children in the unweighted sample,[22] the parents of 22 children gave the following reasons for not immunizing their children:

- religious beliefs (n=7);
- immunizations do more harm than good (n= 3);
- just have not thought about it (n=2);
- just have not gotten around to it (n=2)
- none of the above (n=8).

Children born in Region 4 (Lane, Coos, Curry, Douglas, Josephine, Jackson, and Klamath Counties) had the highest rate of being unimmunized (3.0%).

Age.[23] In 1996, when these children were 19-35 months old, the recommended schedule for immunizing infants and children was DTP and OPV at two, four and six months followed by one MMR at 12-15 months and the fourth dose of DTP at 15 months (Appendix 1). All the children in the survey sample were over 18 months old and would have received the 4:3:1 series had the recommended schedule been followed. However, the full immunization rate of children when they were 18 months old was only 52.4% (**Figure 3**, **Table 5**).

Figure 3. Age-specific full immunization rates



At the time the sample was drawn, 1,752 children in the survey were at least 24 months old. The full immunization rate of children when they were 24 months old was 77.7% -- a statistically significant improvement from the full immunization rate of children when they were 18 months old (**Figure 3**, **Table 5**).[24]

Finally, 872 children in the survey were at least 30 months old at the time the sample was drawn. The full immunization rate of children when they were 30 months old was 83.6% -- a statistically significant improvement again from the full immunization rate of children when they were 18 months old (**Figure 3, Table 5**).

The up-to-date rate of immunizations for this sample was clearly age-dependent, that is the older the child at the time the sample was drawn, the better his/her chance of being up-to-date.

Table 5. **Immunization rates by age cohort**
(Rates per 100 children ± 95% confidence intervals)

	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)	Un-immunized (0 shots)
18 mos. old (n=2,452)	52.4%(±2.4)	41.0%(±2.4)	4.9%(±1.0)	1.7%(±0.6)
24 mos. old (n=1,723)	77.7%(±2.3)	18.1%(±2.2)	2.5%(±0.8)	1.7%(±0.7)
30 mos. old (n=872)	83.6%(±2.9)	12.0%(±2.6)	2.4%(±1.1)	2.0%(±1.2)
19-35 mos. old (n=2,452)	81.0%(±1.9)	15.5%(±1.7)	2.1%(±0.7)	1.4%(±0.6)

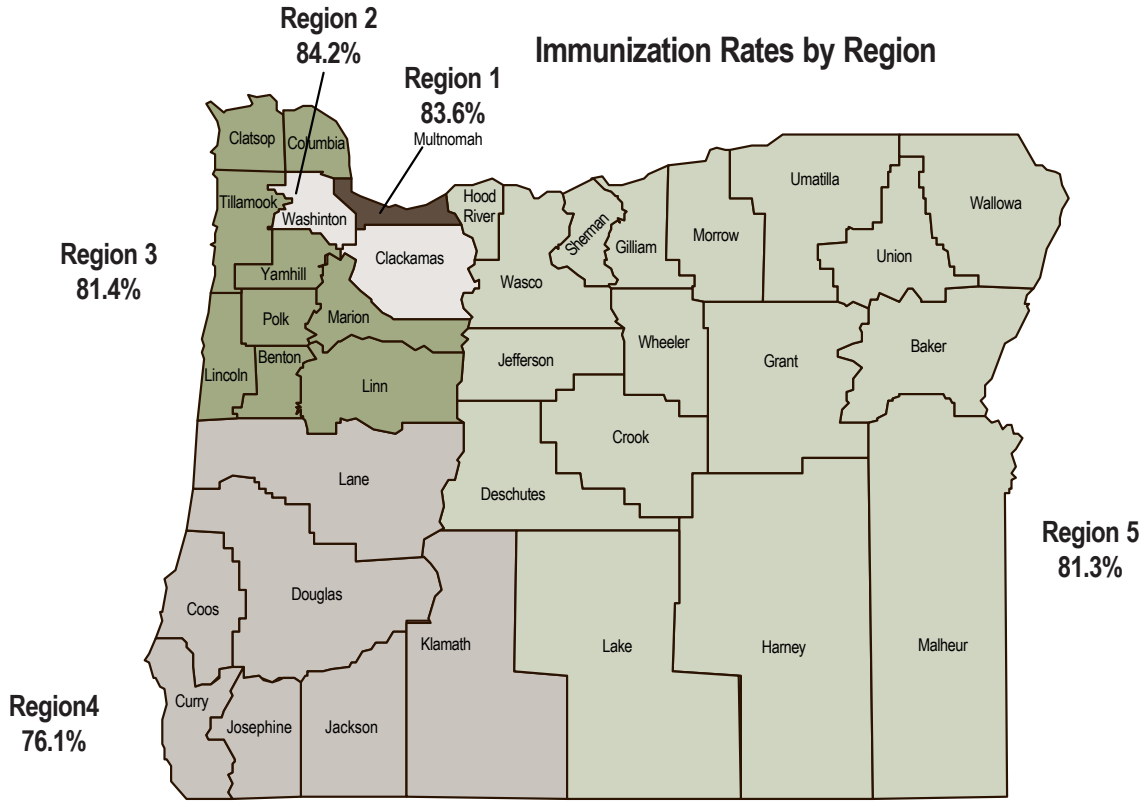
Race and Ethnicity. Asian and Hispanic children were Fully immunized at approximately the same rate as White children, between 80-82% (**Figure 4, Table 6**). African American and American Indian children, on the other hand, had much lower rates of full immunization: 71.4% and 75.3%, respectively[25].

Table 6. Immunization rates by race and ethnicity
(Rates per 100 children ± 95% confidence intervals)

	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)	Un-immunized (0 shots)
African American	71.4% (± 5.5)	23.6% (± 5.2)	3.9% (± 2.4)	1.2% (± 1.3)
American Indian	75.3% (± 5.7)	19.7% (± 5.2)	4.0% (± 2.6)	0.9% (± 1.2)
Asian	82.3% (± 4.5)	14.4% (± 4.1)	2.5% (± 1.8)	0.7% (± 1.0)
Hispanic	82.1% (± 4.6)	14.5% (± 4.3)	3.0% (± 2.1)	0.4% (± 0.7)
White	80.6% (± 2.1)	15.9% (± 1.9)	2.0% (± 0.7)	1.5% (± 0.6)

Note: African American, American Indian, Asian and White are all non-Hispanic.

Geographic Region. Children born in Regions 1 and 2 (metropolitan Portland) had higher rates of full immunization than children born in Regions 3 through 6, with the exception of Region 5 (southeastern Oregon, the most sparsely populated region of the state) (**Figure 5**).



When we looked at the regional distribution of the under-immunized, we found that Regions 6 and 4 have a higher percentage of Poorly immunized and Unimmunized compared to the other regions (**Table 7**).

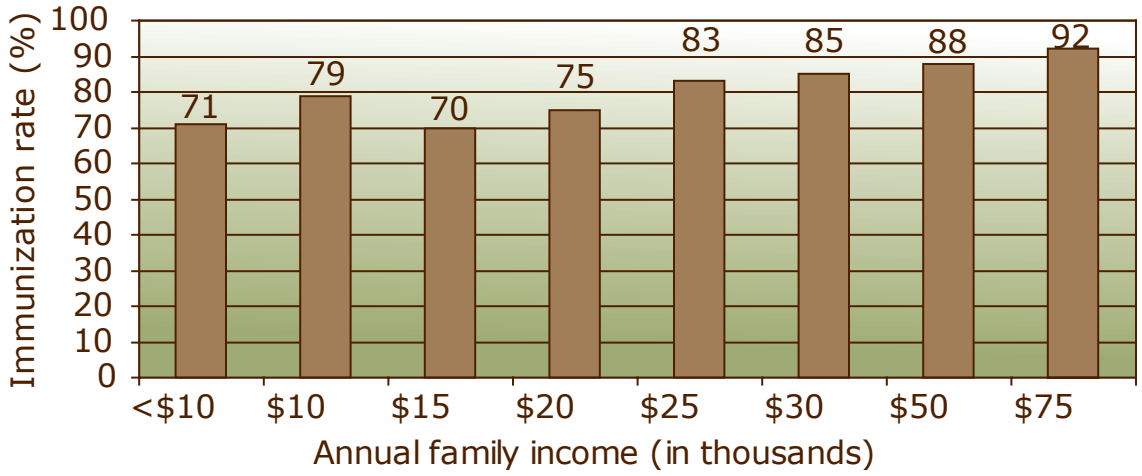
Table 7. **Immunization rates by region**
(Rates per 100 children ± 95% confidence intervals)

	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)	Un-immunized (0 shots)
Region 1	83.6% (± 3.5)	13.6% (± 3.3)	2.3% (± 1.4)	0.5% (± 0.6)
Region 2	84.2% (± 3.8)	13.6% (± 3.7)	1.2% (± 1.1)	1.0% (± 1.1)
Region 3	81.4% (± 4.1)	16.4% (± 4.0)	1.3% (± 1.1)	1.0% (± 1.1)
Region 4	76.1% (± 4.6)	17.3% (± 4.0)	3.3% (± 1.9)	3.4% (± 2.0)
Region 5	81.3% (± 4.6)	16.1% (± 4.3)	2.3% (± 1.8)	0.3% (± 0.7)
Region 6	76.5% (± 4.9)	18.2% (± 4.4)	3.6% (± 2.2)	1.7% (± 1.5)
Statewide	81.0% (± 1.9)	15.5% (± 1.7)	2.1% (± 0.7)	1.4% (± 0.6)

Note: See Table 2 for counties by region.

Annual Family Income. Parents reported annual income in one of eight categories on the survey questionnaire. Immunization rates significantly increased in each income category after the $15,000 to $19,999 income bracket (**Figure 6**).

Figure 6. Full immunization rates by annual family income



To estimate immunization rates by income level we divided the eight annual income categories into two groups: low-income (<$15,000) and higher-income (≥$15,000). As shown in **Table 8**, those families with annual incomes less than $15,000 had significantly lower rates of Fully immunized children. Unfortunately we were unable to calculate the federal poverty level using both income and family size measurements, as data on family size were not collected.

Table 8. **Immunization rates by Income Level**
(Rates per 100 children ± 95% confidence interval)

	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)	Un-immunized (0 shots)
Under $15,000	74.4% (± 4.2)	18.5% (± 3.7)	3.9% (± 1.8)	3.2% (± 1.8)
$15,000 or more	83.0% (± 2.1)	14.5% (± 2.0)	1.6% (± 0.7)	1.0% (± 0.5)

Health Insurance. Parents provided information about their child's health insurance coverage and reported fees paid at the time their children received immunizations.

Approximately 95% of the children in the survey were insured at some time while seeking immunizations, and those reporting insurance coverage were 82.2% Fully immunized (**Table 9**). Among the 2,296 insured children, 55.2% had insurance coverage that required payment of some fee for immunization; and among these, 67.3% paid less than $10 and 32.1% paid $10 or more for immunizations. Interestingly we found that children with insurance requiring a copay were more likely to be Fully immunized compared to children whose insurance did not require any out-of-pocket costs. And among those with a copay, the amount of the copay did not affect the immunization status of the child.

Table 9. Immunization rates by health insurance coverage at time of shots
(Rates per 100 children ± 95% confidence interval)

	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)	Un-immunized (0 shots)
All children in survey sample (n=2,452)				
Insured	82.2% (± 1.9)	15.5% (± 1.8)	1.9% (± 0.6)	0.3% (± 0.3)
Uninsured	75.8% (± 8.1)	17.9% (± 7.3)	6.0% (± 4.4)	0.4% (± 0.8)
Children with insurance (n=2,296)				
Insurance with fees	84.9% (± 2.4)	13.5% (± 2.3)	1.5% (± 0.8)	0.2% (± 0.3)
Insurance without fees	78.9% (± 3.0)	18.1% (± 2.8)	2.5% (± 1.1)	0.6% (± 0.6)
Children with insurance fees (n=1,206)				
Fee under $10	84.7% (± 2.9)	13.6% (± 2.8)	1.6% (± 1.0)	0.02%(± 0.03)
Fee $10 or more	84.9% (± 4.2)	13.5% (± 4.0)	1.2% (± 1.1)	0.4% (± 0.8)

Type of Immunization provider.[26] Children who received immunizations exclusively from private providers were Fully immunized at significantly higher rates than children who received immunizations from both public and private providers or from public providers alone: 83.3%, 78.5%, 72.8%, respectively (**Table 10**).

Keep in mind when considering these findings, that children who received immunizations only from public providers may also be more likely to come from families with lower annual incomes and less likely to be insured.

Table 10. Immunization rates by type of immunization provider
(Rates per 100 children ± 95% confidence interval)

	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)
Private	83.8% (± 2.0)	14.6% (± 1.9)	1.6% (± 0.7)
Private & Public	78.5% (± 4.5)	18.9% (± 4.4)	2.6% (± 1.5)
Public	73.0% (± 7.8)	19.7% (± 7.0)	7.3% (± 4.7)

Risk Factors for Under-immunization

In an effort to understand the population at risk for under-immunization, we first examined some basic socio-demographic characteristics and risk factors collected either on the birth certificate or by the survey. These results, presented below, provide a profile of the population at-risk for under-immunization. Next we narrowed our focus to potentially modifiable risk factors associated individually with under-immunization. And then through multiple regression analysis, were able to pinpoint certain risk factors that will shape the design of strategies for raising coverage rates.

Socio-demographic Characteristics of Respondents

Family socio-demographic characteristics and risk factors presented in **Table 11** were found to be significantly more common as the number of immunizations declined. For example, more children of mothers who completed less than 12 years of education were Poorly (34%) immunized compared to Almost (22%) immunized and Fully (16%) immunized.

Table 11.Selected socio-demographic characteristics and risk factors among the Fully, Almost, and Poorly immunized

Characteristic or Risk Factor		Fully immunized (n=1985)	Almost immunized (n= 379)	Poorly immunized (n=52)
Maternal age <18*	No	96.8 %	95.8%	90.4%
	Yes	3.2%	4.2%	9.6%
Maternal education <12**	No	83.8%	77.9%	66.0%
	Yes	16.2%	22.1%	34.0%
Not first child born**	No	46.0%	36.7%	28.8%
	Yes	54.0%	63.3%	71.2%
Inadequate prenatal care**	No	97.0%	94.4%	84.6%
	Yes	3.0%	5.6%	15.4%
Mother on WIC at time of childbirth**	No	66.2%	55.1%	36.5%
	Yes	33.8%	44.9%	63.5%
Mother unmarried at time of childbirth**	No	78.5%	66.8%	52.9%
	Yes	21.5%	33.2%	47.1%
Family income <$15,000**	No	78.3%	71.9%	56.9%
	Yes	21.7%	28.1%	43.1%
Non-urban region residence*	No	46.9%	39.8%	36.5%
	Yes	53.1%	60.2%	63.5%
No insurance while getting shots**	No	95.1%	93.9%	84.6%
	Yes	4.9%	6.1%	15.4%
No medical home**	No	92.9%	87.9%	75.0 %
	Yes	7.1%	12.1%	25.0%
No personal shot record**	No	80.6%	69.9%	58.8%
	Yes	19.4%	30.1%	41.2%
Received shots from non-private sites**	No	77.4%	70.5%	55.8%
	Yes	22.6%	29.5%	44.2%
Late starter**	No	93.8%	76.8%	50.0%
	Yes	6.2%	23.2%	50.0%
Report barriers to getting shots**	No	85.9%	65.4%	46.2%
	Yes	14.1%	34.6%	53.8%

Note. * p<.05; **p<0.01

Odds Ratios Associated with Under-immunization

Selected modifiable risk factors for under-immunization were identified. The relationship between these risk factors and the odds of being Poorly or Almost immunized compared to Fully immunized are presented in Table 12. For example, uninsured children were 3.4 times more likely to be Poorly immunized compared to Fully immunized, yet only 1.3 times more likely to be Almost immunized compared to Fully immunized.

Table 12. Odds Ratio (OR) of being Almost and Poorly immunized compared to Fully immunized

Risk factor		Almost OR (95% CI)	Poorly OR (95% CI)
Uninsured while getting shots	No	Referent	Referent
	Yes	1.3 (0.7, 2.1)	3.4 (1.4, 8.0)*
Insured with copay	No	Referent	Referent
	Yes	0.7 (0.5, 0.9)*	0.6 (0.3, 1.1)
Insured with co-pay more than $10	No	Referent	Referent
	Yes	1.0 (0.7, 1.5)	0.7 (0.2, 2.2)
Insure with copay and reported that cost prevented shots	No	Referent	Referent
	Yes	2.9 (1.6, 5.2)*	8.8 (3.0, 25.4)*
Annual family income less than $15,000	No	Referent	Referent
	Yes	1.4 (1.1, 1.9)*	2.9 (1.5, 5.3)*
Received shots from public or both public and private providers	No	Referent	Referent
	Yes	1.4 (1.1, 1.9)*	2.7 (1.4, 5.1)*
Reported no medical home	No	Referent	Referent
	Yes	1.8 (1.2, 2.8)*	4.6 (2.2, 9.6)*
No personal shot record	No	Referent	Referent
	Yes	1.8 (1.3, 2.4)*	3.0 (1.5, 5.7)*
Late Starter (received first shot after 90 days)	No	Referent	Referent
	Yes	4.5 (3.2, 6.5)*	15.4 (8.0, 30.0)*
Reported barriers to getting shots	No	Referent	Referent
	Yes	3.2 (2.4, 4.3)*	7.0 (3.7, 13.4)*
Non-urban resident	No	Referent	Referent
	Yes	1.3 (1.0, 1.7)*	1.6 (0.8, 3.0)

OR = odds ratio; CI = confidence interval; * P <.05

Health Insurance. Only 129 children (5.3%) in the survey were uninsured when they were immunized. Yet the uninsured were over 3 times more likely to be Poorly immunized [Odds Ratio = 3.4 (1.4, 8.0), **Table 12**].

Among the insured population, insurance that required a copay and the amount of copay seemed to have no significant impact on immunization rates. Although among parents who had a copay, those who reported that cost prevented them from getting shots for their children were 8 times more likely to have Poorly immunized children (**Table 12**).

Furthermore, families with annual income less than $15,000 were almost 3 times more likely to have Poorly immunized children (**Table 12**).

Medical Home. Having a "medical home," defined as seeing the same clinic or doctor for primary care and immunizations most of the time, was significantly more common among children with higher immunization rates. Children without a medical home were over 4 times more likely to be Poorly immunized and nearly 2 times more likely to be Almost immunized compared to those children who reported a medical home (**Table 12**).

Type of Immunization provider. Eighty-five percent of the children received their immunizations from private providers exclusively. But the 15% who were seen in the public sector or in both the public and private sector, were over twice as likely to be Poorly immunized (**Table 12**). However the type of provider seen may have less impact on immunization rates than the seeking of care outside the medical home, assuming that the majority of medical homes are in the private sector.

Shot Records. The percentage of children whose parents did not have a "shot record"[27] significantly increased as the degree of immunization decreased. Those parents without a shot record were 3 times more likely to have Poorly immunized children and twice as likely to have Almost immunized children compared to those parents who maintained shot records (**Table 12**).

Late Starters. Children who did not receive any immunizations prior to 3 months of age were considered "late starters". In this survey, half of the Poorly immunized children were late starters, making it more difficult for them to get up-to-date due to the necessary shift in the schedule. We found that the late starters were 15 times more likely to be Poorly immunized and over 4 times more likely to be Almost immunized compared to those children who started their shot series on time (**Table 12**).

Reported Barriers to Immunization. Barriers were those circumstances reported by parents that made it hard for their children to get immunizations. Parents were asked "Can you think of anything that made it hard to get baby shots for this child?" and 18.3% (n=446) responded "yes." Parents who reported barriers had children who were 7 times more likely to be Poorly immunized and 3 times more likely to be Almost immunized compared to the children of parents who did not report any barriers (**Table 12**). Reporting barriers was not associated with annual family income, health insurance coverage, or type of immunization provider. Parents who were White and parents who lived in non-urban regions were slightly more likely to report barriers than other parents.

Multivariate Analysis of Risk Factors

Multiple logistic regression models allow us to examine the simultaneous effects of the risk factors as well as any independent effects. Two logistic regression models were constructed: Fully versus Almost Immunized and Fully versus Poorly Immunized. Regression coefficients, or adjusted odds ratios, are presented in **Table 13**.

Eight variables statistically associated with immunization status in the bivariate analysis (**Table 12**) were entered into the multiple logistic regression models. These variables included: late starter; barriers reported; medical home; shot record; family annual income; insurance status while getting shots; geographic location and type of immunization provider seen.

Table 13. Adjusted Odds Ratio of being Almost and Poorly Immunized compared to Fully Immunized

Risk factor		Almost OR (95% CI)	Poorly OR (95% CI)
Late Starter (received first shot after 90 days)	No	Referent	Referent
	Yes	4.3 (2.7, 6.8)*	9.0 (3.7, 17.2)*
Reported barriers to getting shots	No	Referent	Referent
	Yes	3.1 (2.2, 4.5)*	6.7 (2.6, 17.2)*
No medical home	No	Referent	Referent
	Yes	2.4 (1.3, 4.6)*	5.9 (2.2, 5.9)*
Uninsured while getting shots	No	Referent	Referent
	Yes	1.1 (0.6, 2.7)	4.1 (1.2, 14.1)*
Annual family income less than $15,000	No	Referent	Referent
	Yes	1.6 (1.2, 2.3)*	3.1 (1.2, 7.8)*
No personal shot record	No	Referent	Referent
	Yes	1.8 (1.2,2.5)*	2.6 (1.1, 5.9)*
Non-urban resident	No	Referent	Referent
	Yes	1.2 (0.9, 1.7)	1.4 (0.5, 3.4)
Received shots from public or both private and public providers	No	Referent	Referent
	Yes	0.7 (0.4, 1.3)	0.9 (0.3, 2.5)

OR = odds ratio; CI = confidence interval; * P <.05

We found that after controlling for these risk factors, children who started their shot series later than three months after birth, or had parents who reported barriers to immunizations, or reported no medical home, or reported not keeping a shot record, or reported a low annual family income were more likely to be Poorly or Almost immunized.

Additionally, children who were uninsured at the time they received shots were more than 4 times as likely to be Poorly Immunized as those having insurance while getting shots, while no difference was found between the Almost and Fully immunized children.

Barriers to Full Immunization

One of the survey objectives was to identify barriers encountered by parents when trying to get immunizations in Oregon. Some parents reported as many as four barriers when they were asked to describe the barriers in their own words. **Table 14** gives the percent distribution and rank order of barriers reported by 446 parents, grouped by degree of immunization. **Table 15** groups responses by race and ethnicity and geographic region [see footnotes 12-19 for descriptions of the categories in Tables 14 and 15. Note that "history of vaccine reaction" and "don't think vaccines are important" are not included in tables due to very few responses (0.4% - 3.8%)]. Essentially the top 3 barriers are the same for the parents of the Fully and Almost immunized children. Among the parents of the Poorly immunized children, cost is clearly the biggest barrier followed by difficulty understanding the schedule.

Table 14. Percent distributions and rank order (in parentheses) of barriers reported by parents by degree of immunization.

Barriers Reported	Total	Fully immunized (8 shots)	Almost immunized (5-7 shots)	Poorly immunized (1-4 shots)
Provider scheduling & clinic practices	26.3% (1)	24.9% (1)	26.2% (1)	29.7% (3)
Financial cost	22.3% (2)	22.4% (2)	18.8% (3)	36.4% (1)
Child sickness	21.4% (3)	21.6% (3)	24.6% (2)	10.5% (5)
Understanding the immunization schedule	18.6% (4)	20.7% (4)	13.0% (6)	30.4% (2)
Transportation difficulties and access issues	14.6% (5)	11.0% (6)	17.7% (4)	20.1% (4)
Parental concern about vaccines	11.2% (6)	11.1% (5)	14.1% (5)	2.3% (6)

In comparing responses across race and ethnicity (**Table 13**), the non-White parents cited transportation as the second most common barrier. A regional comparison found that urban parents cited cost as the top barrier, followed by difficulty understanding the immunization schedule.

Table 15. Percent distributions and rank order (in parentheses) of barriers reported by parents by race and ethnicity and geographic region.

Barriers Reported	White	Non-White	Urban	Non-Urban
Provider scheduling & clinic practices	26.4% (1)	25.7% (1)	21.1% (3)	29.6% (1)
Financial cost	22.4% (2)	22.0% (3)	30.4% (1)	17.1% (3)
Child sickness	21.5% (3)	21.2% (4)	15.5% (4)	25.2% (2)
Understanding immunization schedule, no reminder and recall	18.0% (4)	21.1% (5)	23.2% (2)	15.6% (5)
Transportation difficulties and other access issues	12.9% (5)	22.1% (2)	12.7% (5)	15.7% (4)
Parental concern about vaccine safety	12.9% (6)	3.3% (7)	8.5% (6)	12.8% (6)

Parental perception: the emerging barrier. Although only 83 parents reported a confusion or unfamiliarity with the schedule, we suspected that more parents were in fact unclear about the immunization schedule and whether or not their child was complete. To assess parental perception of their child's immunization status, the survey asked "In your opinion, has this child gotten all the baby shots recommended for his or her age?"

Among the parents of the Fully immunized, 98.2% correctly reported that their child had completed the 4:3:1 series. However among the parents of the under-immunized, 73.0% thought their child was up-to-date with their immunizations. Most notably, of those children whose parents thought they were up-to-date (n=316), more than half (55.4%) were missing just one immunization, and 72.6% of these (n=175) were missing the fourth DTP.

Discussion

Many consider immunizations to be the gateway to other health services or at minimum a marker of a child's access to other preventive services. Identifying the under-immunized children may improve their immunization rates as well as provide health benefits beyond immunization, such as lead screening, early dental care, etc. The findings of this survey challenge us to look at our under-immunized population as a heterogenous group, possibly requiring different strategies. Given the potential burden of disease that is more likely among the Poorly immunized, it behooves Oregon to identify promising strategies to target this population.

The families of the Poorly immunized are more likely than the Fully immunized to be socio-economically disadvantaged (lower income, less education, younger, without health insurance). They are almost 6 times more likely to seek immunization services outside of the medical home; over 6 times more likely to report a barrier to getting immunized; and 9 times more likely to start their immunizations late. The top barriers mentioned were difficulty with scheduling an appointment with a provider, financial difficulties in covering the costs of immunizations, problems getting shots for sick children, difficulty understanding when their child was due for immunizations, and transportation difficulties or limited access to providers. Furthermore, oversampling among African American and Native American children indicates that they are more likely to be Poorly versus Fully immunized.

Although the Poorly immunized children do pose particular health risks and challenges, the reality of the immunization rates in Oregon are that the majority (81%) are up-to-date on the 4:3:1 series, yet we remain below Oregon's goal and the Healthy People 2010 goal of 90% coverage. The Almost immunized children make up the majority of under-immunization, over 70% of the under-immunized children were missing only 1-2 shots. Of the children missing 1-2 shots, over 80% of their parents thought their child was Fully immunized with the eight-shot series. In effect, these parents face an unperceived barrier of incomplete knowledge of the schedule, and consequently of their child's immunization needs. We assume that these parents are not opposed to the

immunizations and in fact we see that the children are very likely to complete the series as they get older. Rather, the issue appears to be one of awareness of the immunization schedule and access to well-child visits. Parents want their children to be Fully immunized, but they rely on medical providers to ensure this.

Another consideration is the introduction of new vaccines that can dramatically affect the disease burden of children in Oregon. While evaluation of the 4:3:1 series identified rates less than the 90% Healthy People 2010 goal, the disease burden has been low for these primary vaccine-preventable diseases, and each of the individual antigens evaluated (DTP, OPV, MMR, Hib and Hepatitis B) had rates approaching 90%. The least accepted vaccine was varicella with only 20% of the 19-35 month olds immunized. Recent NIS data document Oregon's 1999 varicella rate at 58%, a great improvement but still far from the 2010 goal of 90%. And now Oregon has introduced Hepatitis A vaccine which is struggling to gain a foothold and Pneumococcal Conjugate vaccine which appears to be more welcomed by providers. In all cases, the increase in immunizations with varicella, hepatitis A and pneumococcal conjugate will make a marked difference in the burden of childhood vaccine-preventable diseases in Oregon.

Recommendations

- **Identify system constraints that make it difficult for infants to start the immunization series on time.** Identify system problems that make it hard for parents of newborns to get timely insurance coverage and appointments for their first set of shots, thereby preventing late starts. Also focus on the identified late starters, getting them in for care as soon as they miss the first 2-month visit. Starting them off on the right schedule could really pay off as the series progresses.

- **Immunize children in their medical home.** The model of the medical home for children has been promoted nationally for many years as a means of improving basic preventive care services. It is assumed that if a child sees the same provider for repeated visits, this provider will be able to offer comprehensive care, thereby increasing the opportunities for lead screening, nutrition counseling, and immunization screening and administration. The Vaccines for Children program was developed to support this concept of comprehensive care by providing free immunizations through private providers to eligible clients, thereby preventing the need to refer children for cost reasons.

  Promoting the medical home model in Oregon could reduce multiple appointments with multiple providers, and reduce the scattering of medical records which make screening and forecasting more difficult. Oregon's Immunization Policy Advisory Team has recommended that the Oregon Health Division (OHD) adopt policies that promote the medical home and challenges providers to reduce barriers to children receiving immunizations within the medical home.

- **Make it easier to schedule immunization visits.** The number one barrier reported by parents was the difficulty they had in scheduling appointments with their providers. A variety of obstacles were reported in the survey and have been reported anecdotally. They include: conflicts between provider schedules and parent work schedules; immunizations given only during well-child visits rather than during walk-in or immunization-only

visits; and a limited number of well-child visits for children between 12 and 24 months. Providers need to consider their clienteles' competing obligations and evaluate expanding services (evening and weekend clinics), in order to better immunize their patients.

- **Screen and immunize children at all visits, despite minor illnesses.** Provider education on the application of true contraindications and the importance of screening at every visit, regardless of whether it's a well- or sick-child visit, should increase the number of children identified as being under-immunized. While it is unclear from this survey whether parents or providers chose not to immunized sick children, a recent study in Washington state[28] concluded that providers were less likely to screen and/or immunize at chronic illness visits, acute illness visits or follow up visits even when a child was due immunizations. There are of course true contraindications to immunizations due to moderate illnesses, but in many cases either a system obstacle prevents screening or immunizing (ie. time allotted for sick-child visit does not allow for immunizations) or a provider bias against immunizing mildly ill children prevents these children from getting the immunizations they need.

- **Address specific barriers faced by American Indian and African American populations.** Due to the lower immunization rates among the American Indian and African American children, it is recommended that targeted interventions be designed to address specific barriers. Specifically, parents of African American, American Indian, and Hispanic children were more likely to report transportation barriers, which were not among the top three barriers reported by parents of White and Asian children. Similar to the total population, clinic scheduling, cost and child illness were additional concerns.

- **Implement a statewide public/private reminder/recall system for parents and providers.** A reminder/recall system could help those parents who mistakenly believe their child to be Fully immunized. The Oregon Health Division has dedicated the past few years to developing and collecting data for Immunization ALERT, a statewide immunization registry. ALERT now has

data for approximately 90% of the birth-through-two-year-old population, including immunization histories and demographics. One of the key features of ALERT will be assisting private providers by sending out reminder/recalls to their clients and recall reports to providers. The Oregon Health Division has, for several years, operated a recall system for the public sector, but with nearly 80% of the immunizations given in the private sector, the majority of children aren't being recalled. As the registry matures and both public and private providers exploit the resources it offers, the reminder/recall capability will aid them immensely in their efforts to remind parents of missing immunizations.

- **Take the 4th Dose DTaP Challenge.** Administration of the fourth DTP (now DTaP) could raise the overall full immunization rate by 12 percentage points in this survey. The recommended age for the fourth DTaP is 15-18 months. An informal survey of some providers in Oregon found that most pediatricians recommend a well-baby visit at either 15 or 18 months, which would meet the ACIP recommendation, provided that the minimum 6-month interval between the 3rd and 4th dose is respected. Yet children are either not getting in for that well-child visit or they're already behind on the DTaP schedule and cannot meet the minimum spacing interval. Many parents report difficulty with getting in for routine appointments and if a child starts the series late or delays one shot by a few months, the minimum spacing requirement may not be met at their 15 month visit, and then they are not seen again until 24 months. Of those children missing only their 4th DTP, 35% were late starters.

  For the 65% who were missing their fourth DTP and were not late starters, the flexibility of the immunization schedule can be exploited to administer the fourth DTaP at the 12-month well-baby visit. The fourth dose can be given as early as 6 months following the third DTaP, particularly if a provider has reason to believe the child may not return for the 15- or 18-month visit. Therefore if a child has the third DTaP by 6 months of age, then (s)he is eligible for the fourth dose at 12 months.

- **Target varicella, hepatitis A, and pneumococcal conjugate immunizations in parent and provider education efforts.** While the 4:3:1 series has been critical to minimizing disease incidence in Oregon, it is time to turn more attention to the vaccine-preventable diseases which cause the most childhood morbidity. We need to focus on strategies for simultaneous injections as the number of shots per visit increases, on efforts to resolve or relieve the doubling of cost for these new shots, and on marketing efforts to increase consumer and provider knowledge of these new vaccines.

Limitations

There are several limitations that may influence interpretation of these findings. First, although the survey data were weighted by region and race and ethnicity to represent the 19-35 month age cohort in the state, the data were not weighted to account for non-response. Demographic analysis of non-responders indicate that they were more likely to be non-White, have lower education levels, have not received prenatal care in the first trimester, and have more than one child. These parental attributes have been identified in many studies as risk factors of under-immunization of children. Since children of non-responders were more likely to be at higher risk of under-immunization, not adjusting the data to account for non-response might have caused bias towards overestimating immunization rates in this study.

Another limitation is that we have not controlled confounders in race and ethnicity, region, and some other specific analyses. Immunization coverage among children can be influenced by many factors. Findings of bivariate analyses indicate that race and ethnicity, geographic region, type of immunization provider, family income, and health insurance were associated with immunization status. However, the independent associations between the above factors and immunization status were not the focus of this study and have not been well examined. We have conducted a multivariate analysis of the demographic characteristic of under-immunized children, in which unmarried parents, not first child born, and a mother who smoked during pregnancy were identified as independent risk factors.

Finally, the survey was primarily designed to estimate statewide and regional immunization rates. For most of the counties, the sample size was too small to generate valid county estimates and likewise conduct meaningful county-level analysis.

Endnotes

1.Oregon State Board of Health. 1955 Statistical Report.

2.Oregon State Board of Health. 1960 Statistical Report.

3.Oregon Health Division. 1994 Two-Year-Old Immunizations Survey Final Report. July 27, 1995.

4.National, State, and Urban Area Vaccination Coverage Levels Among Children Aged 19-35 Months – United States, 1999. Morbidity and Mortality Weekly Report, CDC, July 7, 2000, Vol. 49, No. 26.

5.In 1998, the Advisory Committee on Immunization Practices (ACIP) changed the recommendations for polio immunization from three doses of oral polio virus vaccine (OPV) to two doses of inactivated polio virus vaccine (IPV) followed by two doses of OPV. Children in the survey are covered by the earlier ACIP recommendation.

6.Derived from the 1994 Two-Year-Old Immunization Survey results.

7.The sample was normalized using post stratification weights for each combination of region, race and ethnicity. Thus the quotient of total number of births for each combination divided by the number of births in the sample of each combination given the weighting. For example:

$$\text{Post-stratification Asian Children in Region 1} = \frac{\text{974 total births (in Region 1)}}{\text{109 births in sample}} = 8.9$$

8.Women, Infants and Children Special Supplemental Nutrition Program.

9.The Women's and Children's Health Data System was renamed in 2000 to FamilyNet. The immunization module of FamilyNet is the Immunization Record Information System (IRIS).

10.The standard error of an immunization rate is a measure of its reliability or precision. A 95% confidence interval indicates that there is a 95% assurance that the true immunization rate in the childhood population falls between the upper and lower confidence limit. The smaller the confidence interval the more precise the measurement.

11.The American Academy of Pediatrics advocates that "the medical care of infants, children, and adolescents ideally should be accessible, continuous, comprehensive, family-centered, coordinated, and compassionate. It should be delivered or directed by well-trained physicians who are able to manage or facilitate essentially all aspects of pediatric care. The physician should be

known to the child and family and should be able to develop a relationship of mutual responsibility and trust with them. These characteristics define the "medical home." American Academy of Pediatrics. The Medical Home. Pediatrics. 90:5; 774, November, 1992.

12.Includes: difficulty scheduling appointments with doctors; doctors' appointments conflicting with personal or family schedules; clinic practices likely to cause scheduling problems, such as inconvenient clinic hours and limited immunization service hours/days.

13.Includes: parental unwillingness to have their children immunized if they were acutely ill; providers' unwillingness to give immunizations to sick children.

14.Includes: respondents who specifically mentioned that they had no medical insurance, had insurance that did not pay for immunizations, or could not afford the co-payment or deductible; respondents who gave more general answers such as "immunizations are expensive".

15.Includes: not having a car or access to a car; difficulties with long-distance travel; general transportation problems; bad weather; not enough providers in the area.

16.Includes: confusion or unfamiliarity with the immunization schedules, therefore parent did not know when or what immunization were due; no reminder or recall notice was received by parent.

17.Includes: concern about vaccine side effects, adverse events, and vaccine safety; fear of child's pain and crying when receiving immunizations.

18.Includes: history of a child's reactions after immunizations, the type of reaction is not recorded.

19.Includes: respondents who stated this explicitly.

20.The varicella vaccine had just been approved in 1996 when the survey sample was drawn.

21.The parents of eight children report that they had received immunizations and furnished a provider name, but could not furnish nor could we locate immunization records.

22.Methodology note: age-specific immunization rates are the percentage of children 19-35 months (at the time the sample was drawn) who were Fully immunized at a specific age. For the rate at 18 months of age the denominator included all children 19-35 months old; for the rate at 24 months of age the denominator included children 24-35 months old; and for the rate at 30 months of age the denominator included children 30-35 months old.

23.This finding further shows that the full immunization rate at 24 months of age has improved significantly since we conducted our first immunization coverage survey in 1994. In the 1994 Two-Year-Old Immunizations Survey, the full immunization rate of 24- month-old children was 69.9% (67.6% to 72.1%) compared to 77.7% (75.4% to 80.0%) now-- a 7.8 percentage point increase.

24.Unweighted data was used for the race and ethnicity analysis to maximize the benefits of oversampling for specific non-White populations.

25.Children in the survey were analyzed by the type of immunization provider from whom they received shots. Twenty-one children without immunization providers (and no immunizations) are not included in this analysis.

Provider type differed by region of the state, especially in Region 6 where public provider utilization was actually higher than private provider.

26.A handheld record of a child's immunization history kept by parents.

27.deHart, M. Patricia; Gaudino, James A.; Martin, Diane P.; Cheadle, Allen; Moore, Danna L.; Washington State Department of Health. Immunization Practices and Attitudes: Results of a survey of Washington State pediatricians and family practice physicians.

Appendices

Recommended schedule for routine active vaccination of infants and children* at the time of this survey.

Vaccine	At birth (before hospital discharge)	1—2 months	2 months †	4 months	6 months	6—18 months	12—15 months	15 months	4-6 years (before school entry)
Diphtheria- tetanus-pertussis §			DTP	DTP	DTP			DTaP/DTP ¶	DTaP/DTP
Polio, live oral			OPV	OPV	OPV **				OPV
Measles-mumps-rubella							MMR		MMR ††
Haemophilus influenzae type b conjugate									
HbOC/PRP-T §,§§			Hib	Hib	Hib		Hib ¶¶		
PRP-OMP §§			Hib	Hib			Hib ¶¶		
Hepatitis B***									
Option 1	HepB	HepB †††				HepB †††			
Option 2		HepB †††		HepB †††		HepB †††			

* See Table 4 for the recommended immunization schedule for infants and children up to their seventh birthday who do not begin the vaccination series at the recommended times or who are >1 month behind in the immunization schedule.

† Can be administered as early as 6 weeks of age.

§ Two DTP and Hib combination vaccines are available (DTP/HbOC [TETRAMUNE™]; and PRP-T [ActHIB™, OmniHIB™} which can be reconstituted with DTP vaccine produced by Connaught).

¶ This dose of DTP can be administered as early as 12 months of age provided that the interval since the previous dose of DTP is at least 6 months. Diphtheria and tetanus toxoids and acellular pertussis vaccine (DTaP) is currently recommended only for use as the fourth and/or fifth doses of the DTP series among children aged 15 months through 6 years (before the seventh birthday). Some experts prefer to administer these vaccines at 18 months of age.

** The American Academy of Pediatrics (AAP) recommends this dose of vaccine at 6—18 months of age.

†† The AAP recommends that two doses of MMR should be administered by 12 years of age with the second dose being administered preferentially at entry to middle school or junior high school.

§§ HbOC: [HibTITER®] (Lederle Praxis). PRP-T: [ActHIB™, OmniHIB™] (Pasteur Merieux). PRP-OMP: [PedvaxHIB®J (Merck,Sharp, and Dohme). A DTP/Hib combination vaccine can be used in place of HbOC/PRP-T.

¶¶ After the primary infant Hib conjugate vaccine series is completed, any of the licensed Hib conjugate vaccines may be used as a ~4-~booster dose at age 12—15 months.

*** For use among infants born to HBsAg-negative mothers. The first dose should be administered during the newborn period, preferably before hospital discharge, but no later than age 2 months. Premature infants of HBsAg-negative mothers should receive the first dose of the hepatitis B vaccine series at the time of hospital discharge or when the other routine childhood vaccines are initiated. (All infants born to HBsAg-positive mothers should receive immunoprophylaxis for hepatitis B as soon as possible after birth.)

††† Hepatitis B vaccine can be administered simultaneously at the same visit with DTP (or DTaP), OPV, Hib, and/or MMR.

Appendix 2

HISPANIC ETHNICITY and RACE OF CHILD

HISPANIC

Mother	Father	=	Child
Yes	Yes	=	Yes
Yes	No	=	Yes
Yes	Unk	=	Yes
No	Yes	=	Yes
No	No	=	No
No	Unk	=	No
Unk	Yes	=	Yes
Unk	No	=	No
Unk	Unk	=	Unk

Child Hispanic is based on combination of Mother's Hispanic and Father's Hispanic. If either Mother's or Father's Hispanic code = 1-5, then general Hispanic = yes.

RACE

		White	Black	Am Ind	Chin	Japan	Hawaii	Other	Filip	Unk	Asian
	Race of FATHER =	1	2	3	4	5	6	7	8	9	0
RACE OF MOTHER	1=White	1	2	3	4	5	6	7	8	1	0
	2=Black	2	2	3	4	5	6	7	8	2	0
	3=American Indian	3	2	3	4	5	6	7	8	3	0
	4=Chinese	4	2	3	4	5	6	7	8	4	0
	5=Japanese	5	2	3	4	5	6	7	8	5	0
	6=Hawaiian	6	6	6	6	6	6	6	6	6	6
	7=Other	7	2	3	4	5	6	7	8	7	0
	8=Filipino	8	2	3	4	5	6	7	8	8	0
	9=Unknown	1	2	3	4	5	6	7	8	9	0
	0=Other Asian or Pacific Islander	0	2	3	4	5	6	7	8	0	0

Code for RACE OF CHILD is found at intersection of Race of FATHER and Race of MOTHER in above table. Source: Oregon Health Division, Center for Health Statistics (Vital Statistics)

Appendix 3

BABY SHOT SURVEY

WHAT TO DO

Please fill out this survey for this child, even if he or she has never had any baby shots. Return the survey in the postage-paid envelope as soon as possible. If you would rather give us answers by telephone, call (503) 731-4486 to set up a convenient time. Collect calls are welcome.

This information is **very important** for us to keep Oregon's children healthy. We know this is a detailed survey. Because your help is so important to us, we will send you $10 for answering all of our questions. Thank you.

INSTRUCTIONS *Questions 1 and 2 are about this child's CURRENT health insurance. Please think about the insurance this child has TODAY for these questions.*

Question 1: Does this child have health insurance right now?

- ○ No ➡ *GO TO QUESTION 3 NOW*
- ○ Yes ➡ Does this child have "Oregon Health Plan" or "Medicaid" for health insurance?
  - ☐ No ➡ This child's insurance is called _____
  - ☐ Yes ➡ *GO TO QUESTION 3 NOW*

Question 2: Can you take this child to <u>any</u> doctor or medical provider in Oregon using this health insurance?

- ○ No
- ○ Yes
- ○ I don't know.

INSTRUCTIONS *Questions 3 through 7 are about the baby shots this child has had. If your child has <u>not</u> had any baby shots, complete question 3, then skip to question 8.*

Question 3: Has this child ever had any baby shots?

- ○ No ➡ Please complete the following sentence with **one** of the phrases below: ***This child has not had baby shots because...****
  - ☐ we do not feel those diseases will affect this child.
  - ☐ of religious beliefs.
  - ☐ baby shots do more harm than good.
  - ☐ getting childhood diseases is natural.
  - ☐ we just have not thought about it.
  - ☐ we just have not gotten around to it.
  - ☐ Other _____

***NOTE** *After you have completed this sentence, go to Question 8.*

- ○ Yes ➡ *GO TO QUESTION 4 NOW*

Question 4: We may need to find out more details about this child's baby shots. In the chart below, write down **anything** you recall about where this child got baby shots.

NOTE
If this child got free baby shots at an immunization drive, record the COUNTY where it was held and anything else you recall.

A	B
DOCTOR AND/OR CLINIC Street Address City, State, County & Zip Code Phone Number	DOCTOR AND/OR CLINIC Street Address City, State, County & Zip Code Phone Number
C	**D**
DOCTOR AND/OR CLINIC Street Address City, State, County & Zip Code Phone Number	DOCTOR AND/OR CLINIC Street Address City, State, County & Zip Code Phone Number

Question 5: Do you have any record(s) of this child's baby shots?

- ○ No ➡ *GO TO QUESTION 6 NOW*
- ○ Yes ➡ **Please get the record(s). Make a PHOTOCOPY and mail it back with the rest of this survey. DO NOT send originals. Or, you can RECORD the information into the chart below. DO NOT fill it in from memory alone.**

Disease the Baby Shot is for:	Names for this Baby Shot	Dose	Date Given (mo/day/yr)	Doctor, Office, or Clinic Where the Baby Shot was Given
Diphtheria/Tetanus/ Pertussis	DTP, DTaP, DT, DTP/ACT-Hib*, DTP/Hib*, Tetra*, Tetramune*	1st		
		2nd		
		3rd		
		4th		
Polio	eIPV, IPV, OPV, TOPV, Sabin, Salk	1st		
		2nd		
		3rd		
Hepatitis B *Hep B is not the same shot as Hib.*	Engerix, Recombivax, Hep B, HB, HBV	1st		
		2nd		
		3rd		
Measles/Mumps/Rubella	MMR	1st		
Varicella	Chickenpox, Var, Varivax, VZV	1st		
Haemophilus influenzae type B *Hib is not the same shot as Hep B.*	ACT-Hib, Hib, HibTITER, HbCV, HbOC, PedvaxHIB, PrpHBIT, PRP-D, PRP-OMP, PRP-T, DTP/ACT-Hib*, DTP/Hib*, Tetra*, Tetramune*	1st		
		2nd		
		3rd		
		4th		

NOTE ** DTP/ACT-Hib, DTP/Hib and Tetra[mune] are combination shots for DTP and Hib. Record them under both Diphtheria/Tetanus/Pertussis and Haemophilus influenzae type B.*
Please attach another sheet if you have more doses or other baby shots to record.

INSTRUCTIONS *Questions 6 and 7 are about this child's health care when he or she was getting baby shots. Please think back to that time now.*

Question 6: Did this child ever have any health insurance during the time he or she was getting baby shots?

N ○ No ➡ *GO TO QUESTION 7 NOW*

Y ○ Yes ➡ Did you have to pay anything for a baby shot when this child had health insurance?

N ☐ No ➡ *GO TO QUESTION 7 NOW*

Y ☐ Yes ➡ In general, did you pay:

D DON'T KNOW

A. ___ $10 or less

B. ___ More than $10

C. DON'T KNOW

X. NO ANS.

➡ Did this cost ever prevent or delay you from getting a baby shot for this child?

___ No

___ Yes

Question 7: Did this child go to the same clinic or doctor for basic visits and baby shots most of the time?

○ No

○ Yes

INSTRUCTIONS *Questions 8 through 11 are about baby shots more generally. Please take a few moments to answer them.*

Question 8: Have you ever been reminded (by mail or telephone) about the next baby shot(s) that this child needs?

○ No

○ Yes

Question 9: Can you think of anything that made it hard to get baby shots for this child?

○ No

○ Yes. *Please describe the problem(s) here:*

Question 10: In your opinion, has this child gotten all the baby shots recommended for his or her age?

○ No

○ Yes

Question 11: Which of these statements best matches your feelings (pick **only** one):

○ Baby shots protect the health of children.

○ Baby shots hurt the health of children.

○ Baby shots have no effect on the health of children.

INSTRUCTIONS *These last questions ask you for some general information. All of these details will be kept secret. We will only report a summary of the data without using any names.*

Question 12: Does this child go outside the home for childcare on a regular basis?

- ○ No ➡ *GO TO QUESTION 13 NOW*
- ○ Yes ➡ Does this childcare occur in someone's home?
  - ☐ No
  - ☐ Yes

Question 13: What is your relation to this child?

- ○ Mother
- ○ Father
- ○ Close relative (for example: grandparent, stepparent, aunt, uncle, sibling)
- ○ Other _____

Question 14: My family's yearly income is:

- ○ Less than $10,000
- ○ Between $10,000 and $14,999
- ○ Between $15,000 and $19,999
- ○ Between $20,000 and $24,999
- ○ Between $25,000 and $34,999
- ○ Between $35,000 and $49,999
- ○ Between $50,000 and $74,999
- ○ $75,000 or more

INSTRUCTIONS *We may need to call you if we have questions, so please fill out this last section completely. We also need this data in order to generate and send your check. Please print clearly. If you do not wish to be paid, mark the box at the end of the survey.*

AGAIN, THANK YOU FOR YOUR TIME!

_____
Today's Date

_____
Name

_____ _____
Address Home Phone Number

_____
City County State Zip

☐ Check here if you do not wish to be paid $10.

Survey Responses (Unweighted)

Question 1: Does this child have health insurance right now?

Yes	88.9%
No	11.1%

If the Child has health insurance, does this child have "Oregon Health Plan" or "Medicaid" for health insurance?

Yes	25.2%
No	74.8%

Question 2: Can you take this child to any doctor or medical provider in Oregon using this health insurance?

Yes	27.5%
No	35.3%
Don't know	4.0%
No answer	33.6%

Question 3: Has this child ever had any baby shots?

Yes	98.9%
No	1.1%

Question 4: Please write down anything you recall about where this child got baby shots.

Question 5: Do you have any record(s) of this child's baby shots?

Yes	77.1%
No	21.4%
No answer	1.5%

Question 6: Did this child ever have any health insurance during the time he or she was getting baby shots?

Yes	93.6%
No	5.3%
No answer	1.1%

If the answer is "Yes", did you have to pay anything for a baby shot when this child had health insurance?

Yes	55.2%
No	44.6%
Don't know	0.2%

If you paid, in general, did you pay:

A. $10 dollar or less	67.3%
B. More than $10	32.1%
Don't know	0.6%

Question 7: Did this child go to the same clinic or doctor for basic visits and baby shots most of the time?

Yes	90.5%
No	8.3%
Don't know	1.2%

Question 8: Have you ever been reminded (by mail or telephone) about the next baby shot(s) that this child needs?

Yes	36.3%
No	63.6%
No answer	0.1%

Question 9: Can you think of anything that made it hard to get baby shots for this child?

Yes	18.3%
No	81.7%

Question 10: In your opinion, has this child gotten all the baby shots recommended for his or her age?

Yes	92.3%
No	7.4%
Don't know	0.2%

Question 11: Which of these statements best matches your feelings (pick only one):

Baby shots protect the health of children. 97.8%

Baby shots hurt the health of children. 1.2%

Baby shots have no effect on the health of children 0.7%

Don't know 0.4%

Question 12: Does this child go outside the home for child care on a regular basis?

Yes	41.4%
No	58.6%

Question 13: What is your relation to this child?

Mother	90.8%
Father	7.5%
Close relative	1.1%
Other	0.6%

Question 14: My family's yearly income is:

Less than $10,000	11.9%
Between $10,000 and 14,999	11.1%
Between $15,000 and 19,999	8.2%
Between $20,000 and 24,999	9.7%
Between $25,000 and $34,999	15.4%
Between $35,000 and $49,000	18.2%
Between $50,000 and $74,999	15.3%
$75,000 or more	7.8%
No answer	2.3%

For more information please contact the Department of Human Services, Oregon Health Division, Immunization Program at: (503) 731-4020, or visit our website at: www.healthoregon.org

To request this material in an alternate format (e.g., braille) please call 503-731-4020.