

Identifying Infants at Risk of Adverse Outcomes Using Administrative Data

Findings from Washington State

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Report to the Washington State Department of Children, Youth, and Families

THE VISION OF THE DEPARTMENT of Children, Youth, and Families (DCYF) is to ensure that "Washington state's children and youth grow up safe and healthy." One strategy to reach this vision is to develop methods by which children at risk for adverse outcomes may be identified and their families offered supportive evidence-based interventions early in the child's life. This report summarizes a set of predictive models which used administrative data available at birth to predict adverse outcomes for children on Medicaid born between State Fiscal Year (SFY) 2010 and SFY 2015. The three outcomes of interest were: 1) infant mortality, 2) Child Protective Services involvement before age four, and 3) developmental disorder diagnosis before age four. The findings demonstrate the utility of combining birth certificate information and other state administrative data about maternal and child factors to identify infants that are most at risk of adverse outcomes.

Key Findings

- 1. Infant mortality was predicted with high accuracy and was primarily associated with newborn health factors such as low birth weight, low Apgar score,¹ and diagnosis of a pervasive developmental disorder (chromosomal abnormalities).** Prevention efforts should therefore target the prenatal period in order to improve newborn health and reduce infant mortality.
- 2. Child Protective Services (CPS) involvement was predicted with high accuracy: 64 percent of infants in the top decile (highest risk scores) came under CPS case management before their fourth birthday.** Previous maternal child welfare involvement was a strong predictor of the child's CPS involvement, as were newborn drug or alcohol exposure diagnosis, and two or more previous births to the mother. Older maternal age was a protective factor. The high predictive accuracy of the model suggests it could be refined for use in targeting preventative interventions for families.
- 3. The risk model for developmental disorder diagnosis identified associations with predictors, but the model predicted the outcome with only moderate accuracy.** Infants diagnosed with pervasive developmental disorders (e.g. Down syndrome) were very likely to be later diagnosed with a developmental delay, while other newborn health and maternal factors had associations with delay of much smaller magnitude. Even with a comprehensive set of predictors, the risk model was only moderately accurate in identifying developmental delay, suggesting the need for universal assessment of development for children.

¹ An index used to evaluate the condition of a newborn infant based on a rating of 0, 1, or 2 for each of the five characteristics of color, heart rate, response to stimulation of the sole of the foot, muscle tone, and respiration with 10 being a perfect score.

Factors Associated with Risk of Adverse Outcomes

Risk and Protective Factors

Table 1 displays a summary of significant predictors of each of the outcomes:

1. Infant mortality (infant death prior to age one)
2. Child Protective Services (CPS) involvement before age four.
3. Developmental delay diagnosis before age four.

Factors highlighted in shades of yellow/brown increase risk of the outcome, and factors highlighted in blue decrease risk of the outcome. Factors without any highlighting were not significantly related to the outcome. The darker the shade, the larger the magnitude of the association.

Indicators of poor newborn health, including low birth weight, low Apgar score, pervasive developmental disorder diagnosis, and hospital transfer after birth were associated with infant mortality. Additional risk factors with associations of a smaller magnitude included pre-term birth, having a mother who had four or more previous births, maternal mental health condition, unmarried mother, and missing information on initiation of prenatal care. Male infants and infants in urban counties were also more likely to die within the first year of life.

Infants whose mothers were involved in the child welfare system in the twelve months before birth were much more likely to be involved in a CPS case by the age of four, controlling for other factors. Infants with drug or alcohol-related diagnoses, and those born into families with more children were also at heightened risk. All maternal exposures except lack of wages were associated with increased risk of CPS involvement as were inadequate prenatal care, low birth weight, pre-term birth, and unmarried status. Older maternal age, higher maternal education, and limited English proficiency were all protective against CPS involvement. Infants in counties with higher child abuse and neglect victimization rates and in urban counties were also more likely to experience CPS involvement.

Infants who were diagnosed with a pervasive developmental disorder had a much higher likelihood of being diagnosed with a developmental delay, as would be expected. Newborn health factors, older maternal age, multiple births, and most of the maternal exposure variables were associated with increased odds of an infant being diagnosed with a developmental disorder. Infants who had mothers with more education and more previous births were less likely to be diagnosed with a developmental disorder.

Study Design

The cohort for this study consisted of 259,649 infants born to mothers on Medicaid between SFY 2010 and SFY 2015. Infant mortality among the cohort, defined as the death of an infant before his or her first birthday, was identified from the First Steps Database (FSDB). CPS involvement was defined as any CPS case management before the child turned four and was identified using the Famlink data system. This included CPS investigations and Family Assessment Response (FAR) cases. Developmental delay diagnosis was defined as diagnoses of specific developmental disorders, intellectual disability, or tic disorders before the child turned four and was identified using Medicaid claims in ProviderOne. Since identifying developmental delay was dependent on Medicaid claims, the cohort for that analysis was limited to children who had at least 12 months of Medicaid between birth and their fourth birthday (N = 251,601). The infant mortality analysis and CPS involvement analysis used the full cohort. The same set of predictors was used to predict each of the three outcomes. The sources for predictors included FSDB birth certificate information and Integrated Client Database (ICDB) administrative data. Only 70 percent of the cohort, selected at random, was used for model fitting and the remaining 30 percent of the sample was set aside to assess the accuracy of the models (see next section).

TABLE 1.

Factors Associated with Risk of Adverse Outcomes

ODDS RATIOS

Greater than 1 means higher risk.
Less than 1 indicates lower risk.

	1 = equal odds	Statistically significant odds ratios (at p<.05) shown only		
← LOWER RISK		HIGHER RISK →		
		Infant Mortality	CPS Case	Dev. Delay
Newborn health				
Low birth weight		3.31	1.12	1.81
Pre-term birth		1.72	1.15	1.51
Low Apgar score (<8)		6.59		1.52
Hospital transfer		2.51		1.75
Pervasive developmental disorder diagnosis		14.40		11.38
Drug or alcohol-affected infant diagnosis			2.55	1.30
Prenatal care				
Late initiation of prenatal care (no prenatal care)			1.86	
Late initiation of prenatal care (after first trimester)			1.14	0.91
Late initiation of prenatal care (unknown month)		1.38	1.25	
Child demographics				
Male		1.23		1.91
Multiple birth			1.19	1.35
Maternal demographics				
Unmarried as of birth		1.24	1.56	1.06
18 to 20 years (relative to under 18)			0.75	1.24
21 to 25 years (relative to under 18)			0.59	1.45
26 to 30 years (relative to under 18)			0.48	1.57
31 to 35 years (relative to under 18)			0.44	1.71
35+ years (relative to under 18)			0.38	1.86
Hispanic (relative to white)			0.70	1.46
Black (relative to white)			0.87	0.92
Native American (relative to white)			1.24	1.14
Asian (relative to white)			0.65	1.14
Pacific Islander (relative to white)			0.79	0.78
Other (relative to white)			0.23	
More than one race (relative to white)			1.08	
High school or GED (relative to less than high school)			0.83	0.95
Some college, no degree (relative to less than high school)			0.75	0.90
Associate's degree or above (relative to less than high school)			0.58	0.81
Unknown education level (relative to less than high school)			0.81	
1 prior birth (relative to none)			1.47	0.94
2 or 3 prior births (relative to none)			2.13	0.82
4 or more prior births (relative to none)		1.66	2.92	0.66
Limited English proficiency			0.71	1.20
Maternal exposures				
Smoked during pregnancy			1.71	1.06
Mental health condition within prior 12 months		1.39	1.58	1.33
Substance use disorder within prior 12 months			1.72	1.08
Criminal justice involvement within prior 12 months			1.67	
Domestic violence within prior 12 months			1.61	1.17
Child welfare involvement within prior 12 months			4.83	1.53
Basic Food receipt within prior 12 months			1.85	1.07
Homelessness within prior 12 months			1.61	1.19
Disability within prior 12 months			1.91	1.81
Earned no wages within prior 5 years				1.11
County-level				
County with moderate child victimization rate (relative to low)			1.09	
County with high child victimization rate (relative to low)			1.21	
Urban high density county (relative to non-urban high density)		1.24	1.13	1.18

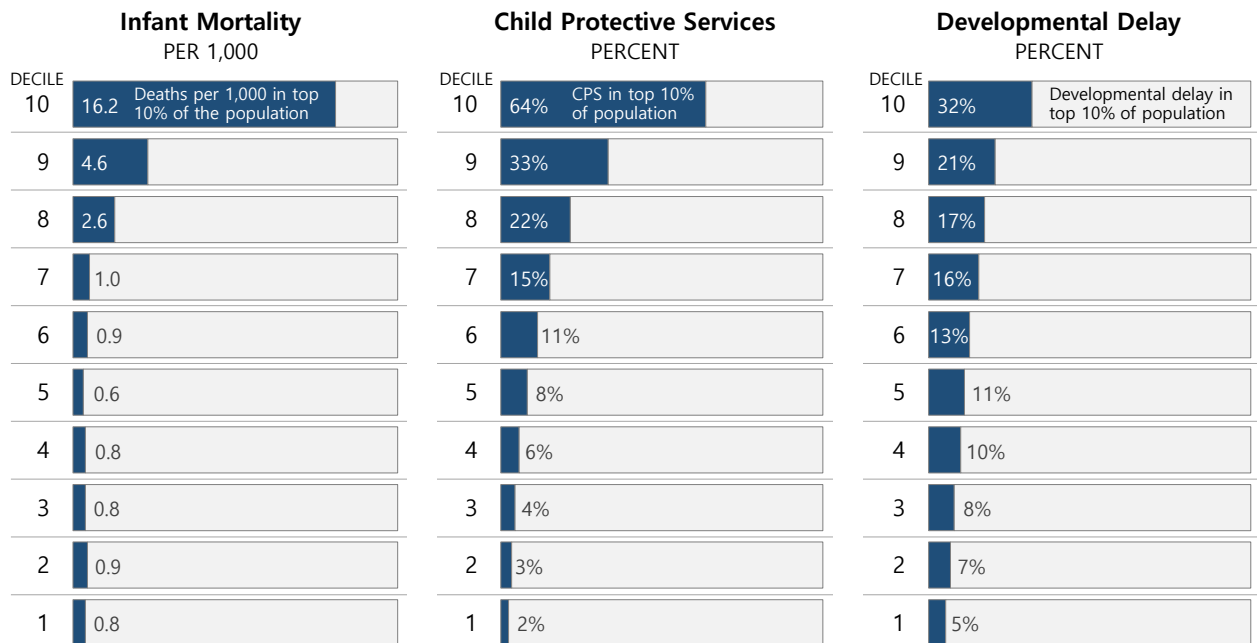
Assessing the Predictive Models

The models in the previous section were able to identify factors significantly associated with each of the adverse outcomes. However, the models performed differently in their ability to accurately identify infants at risk of each outcome. In order to identify infants at high risk, the results from the models were used to assign individual infants a risk score based on his or her exposure to each of the predictor variables. For this process the 30 percent of infants who were not part of the initial model testing dataset (N = 77,894) were scored and their risk scores compared to the actual occurrence of each of the three outcomes.

One way to assess the predictive accuracy of a model is to divide the population into deciles (ten equal groups) based on risk scores and compare the occurrence of the adverse event in each decile. If the model is performing well, infants in the highest deciles should experience the events of interest at much higher rates than infants in the lowest deciles. Figure 1 displays this performance graphically.

FIGURE 1.

Adverse Outcome by Decile TOTAL CHILDREN/INFANTS = 77,894



The infant mortality model performed well when identifying infants most at risk of dying. In the lowest decile, fewer than 1 in 1,000 infants died as compared to the highest decile, where 16 out of 1,000 infants died. Infants in the top decile were 21 times more likely to die than the bottom decile (16.18/0.77).

The CPS model also performed well when identifying children most at risk of becoming CPS-involved. In the lowest decile, about 2 percent of children came into a CPS case as compared to 64 percent of children in the highest decile. Children in the top decile were nearly 27 times more likely to become CPS involved than children in the bottom decile (63.7 percent/2.4 percent).

The model predicting developmental delay did not perform as well as the other two models. While the top decile had the highest prevalence of developmental delay diagnosis (32 percent), the top decile was only 6 times more likely to be diagnosed with developmental delay when compared to the bottom decile (32.1 percent/5.3 percent).

Identifying Infants at Risk of Adverse Outcomes

In this section, the predictive models were used to identify infants in the SFY 2016 Medicaid birth cohort at risk of adverse outcomes. Using a more recent birth cohort allows for identifying areas of need across the state for resource planning and deployment of preventive and early interventions. While infants at risk could be identified using each of the predictive models, only the infant mortality and CPS involvement outcomes will be discussed here.

In SFY 2016, a total of 43,917 infants were born through Medicaid-paid deliveries. Figures 2 and 3 display the 4,391 infants in the SFY 2016 birth cohort identified as highest risk for infant mortality based on their observed characteristics measured at birth, by county and school district, respectively. The highest risk infants were selected by identifying infants with the top 10 percent of risk scores for infant mortality. Note that while these infants were at highest risk of mortality, in any given year in Washington state only about 400 infants out of approximately 87,000 live births experience mortality, including both Medicaid and private pay births. Therefore, counts in the tables should not be confused with counts of infant deaths, but instead they highlight areas of the state where more infants have exposure to risk factors associated with infant mortality.

Figures 4 and 5 display the 4,391 infants from the SFY 2016 birth cohort (top 10%) identified as highest risk for CPS involvement by county and school district. In contrast to infant mortality, CPS involvement is much less rare: the out-of-sample test of the CPS predictive model found about 64 percent of the infants in the top 10 percent of risk scores became involved in CPS before the age of four. In all figures, geographic units with 10 or fewer infants at risk were suppressed, and areas with no identified births were labeled as no data. Maps show percent share, while the accompanying bar chart displays the geographical units with highest counts of infants at risk.

The greatest numbers of infants at risk of mortality were found in King, Pierce, Snohomish, and Spokane counties. Yakima and Clark counties also contained large numbers of infants at high risk of mortality. The school district map offers a more detailed picture. Spokane school district, located in Spokane County, contained the greatest number of infants at risk followed by Seattle school district (King County), Tacoma school district (Pierce County), and Kent school district (King County). The next highest numbers were found in Highline, Auburn, and Federal Way school districts (King County), Everett, Mukilteo, and Edmonds school districts (Snohomish County), Bethel school district (Pierce County), and Yakima school district (Yakima County).

The greatest numbers of infants at risk of CPS involvement were found in Pierce County and King County, followed by Spokane, Snohomish, and Yakima counties. As was the case with mortality, Spokane school district (Spokane County) had the greatest numbers of infants at risk of CPS involvement, followed by Tacoma school district (Pierce County). Additional school district with large numbers of infants at high risk of CPS involvement include Seattle, Kent, Federal Way, and Auburn school districts (King County), Yakima school district (Yakima County), Vancouver school district (Clark County), Bethel and Clover Park school districts (Pierce County), and Everett school district (Snohomish County).

It is unsurprising that the more urban, high-density areas of the state have higher counts of infants at risk, since they contain a greater number of infants in general. However, it is interesting to note many school districts identified as high risk on both outcomes were suburban areas near larger cities, for example Kent, Auburn, Federal Way, and Highline are suburban areas outside of Seattle located in south King County; Bethel and Clover Park are located in Pierce County outside of Tacoma; and Vancouver, Washington in Clark County is just across the Columbia River from Portland, Oregon.

Infants at High Risk of Mortality

FIGURE 2.

Infants at High Risk of Mortality Prior to Age One

Percent Share by County, HIGH-RISK INFANTS IN SFY 2016 BIRTH COHORT = 4,391

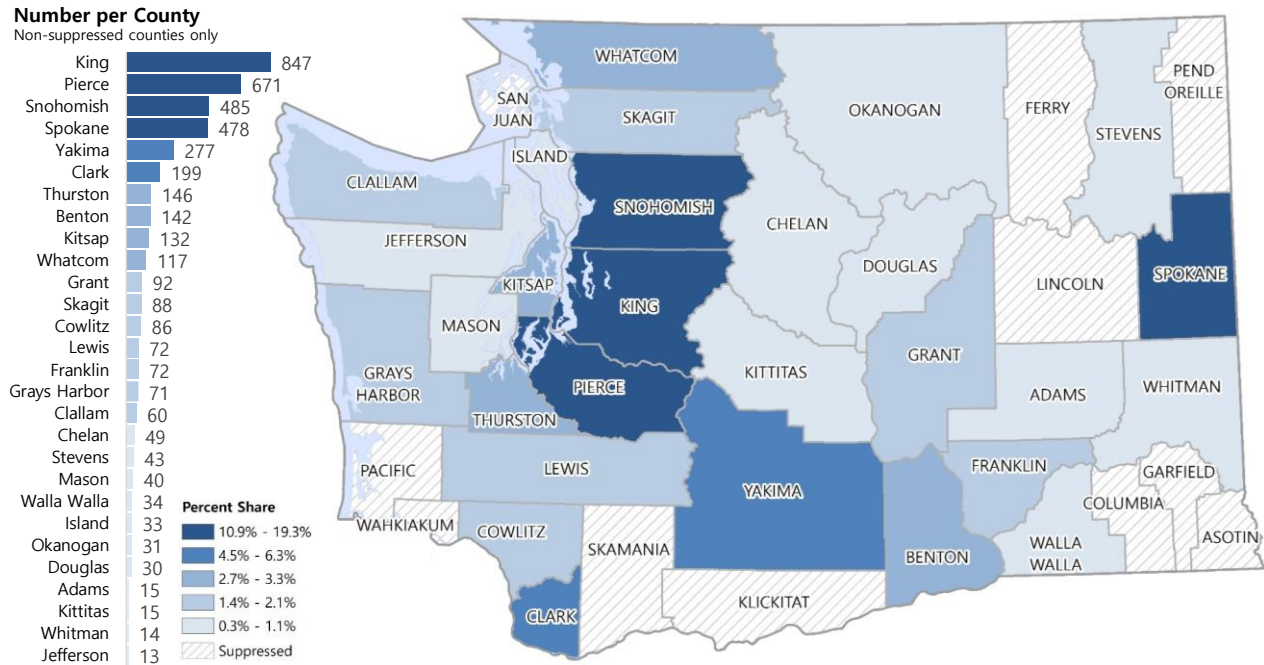
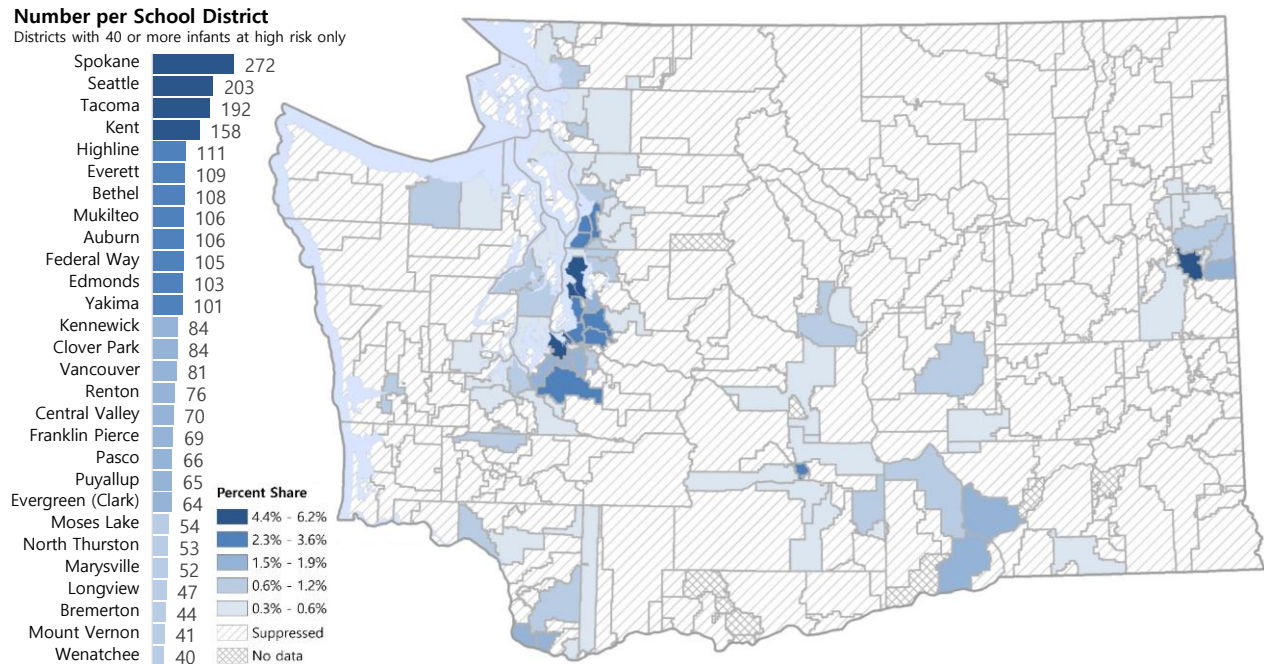


FIGURE 3.

Infants at High Risk of Mortality Prior to Age One

Percent Share by School District, HIGH-RISK INFANTS IN SFY 2016 BIRTH COHORT = 4,391



Infants at High Risk of CPS Involvement

FIGURE 4.

Infants at High Risk of CPS Involvement Prior to Age Four

Percent Share by County, HIGH-RISK INFANTS IN SFY 2016 BIRTH COHORT = 4,391

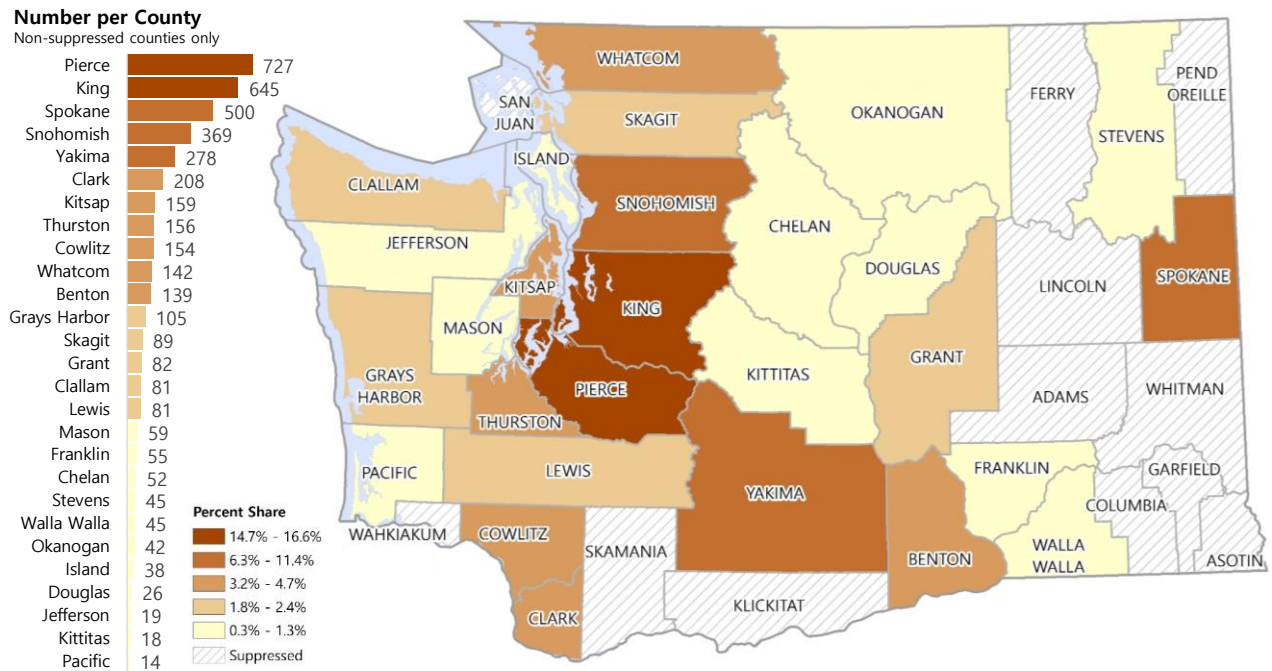
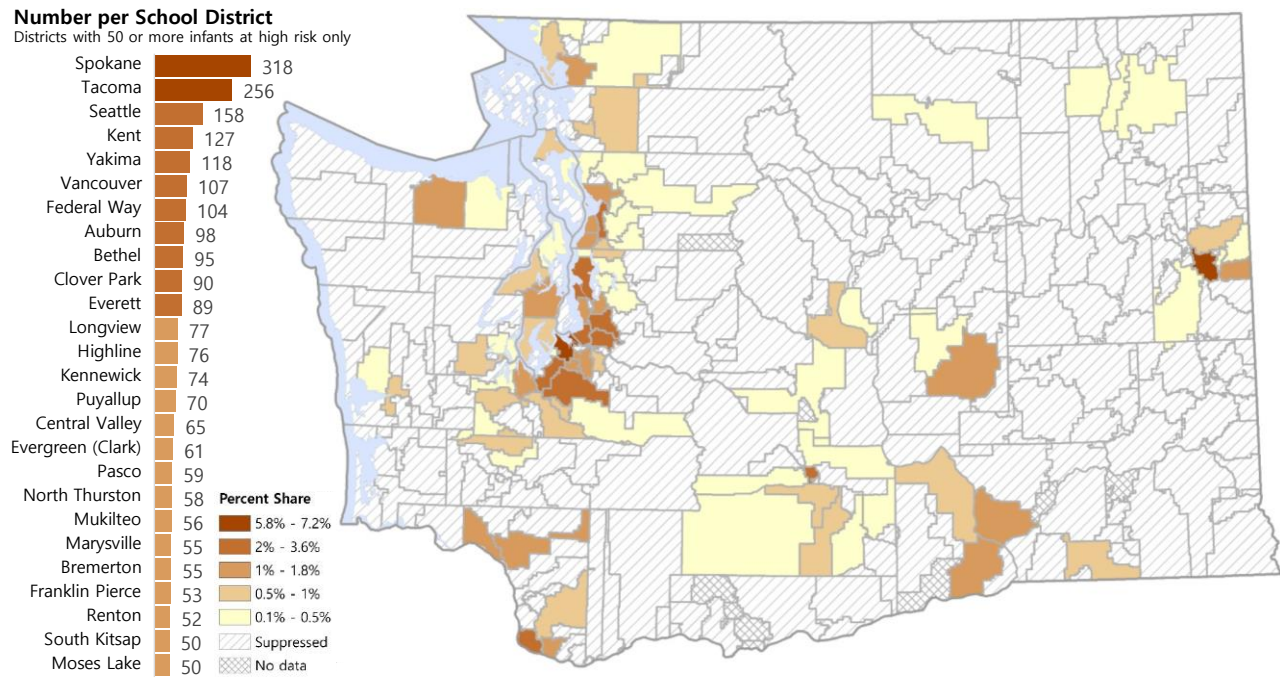


FIGURE 5.

Infants at High Risk of CPS Involvement Prior to Age Four

Percent Share by School District, HIGH-RISK INFANTS IN SFY 2016 BIRTH COHORT = 4,391



Infants at Highest Risk of CPS Involvement

Table 2 highlights the prevalence of selected risk factors for all infants born on Medicaid in SFY 2016 and for the infants in the top 10 percent on risk scores for CPS involvement. Mothers of high risk infants appear to have multiple complex needs: a majority had previous child welfare involvement, a diagnosed mental health condition, and/or substance use issues, and over half smoked cigarettes during pregnancy. Over 80 percent of the infants at highest risk had mothers who were unmarried.

Nearly all (94 percent) of the highest risk infants were born to mothers who received Basic Food in the year before birth, indicating DSHS Economic Services Administration's (ESA) community services offices (CSOs) could be a point of referral to preventative services. While it is true that most of the highest risk mothers used Basic Food before giving birth, over 80 percent of the women that used Basic Food before giving birth were not part of the highest risk group. Therefore, while pregnant women using Basic Food could be a useful base population, the presence of other important risk factors from the predictive model (e.g. child welfare involvement, criminal justice involvement, homelessness) would need to be used to identify the most at risk within the pregnant Basic Food population.

TABLE 2.

Comparison of Risk Factors in the Top Decile and Total Population

	All SFY 2016 births N = 43,917	High Risk SFY 2016 births N = 4,391
Maternal exposures		
Basic Food, prior 12 months	50.8%	94.3%
Child welfare, prior 12 months	8.7%	71.4%
Mental health condition, prior 12 months	23.4%	61.9%
Substance use, prior 12 months	11.2%	60.2%
Smoked during pregnancy	11.9%	51.1%
Unemployed, prior 5 years	27.3%	33.8%
Criminal justice involvement, prior 12 months	5.0%	27.7%
Homeless, prior 12 months	2.8%	15.8%
Disability, prior 12 months	2.0%	10.4%
Domestic violence, prior 12 months	1.1%	6.2%
Maternal demographics		
Mother was unmarried	53.5%	83.6%
Less than high school education	21.4%	37.4%
2 or 3 prior children	28.9%	36.7%
4 or more prior children	7.6%	15.1%
Prenatal care		
Prenatal care began after 1st trimester	31.2%	42.2%
Newborn health		
Newborn alcohol/drug diagnosis	2.2%	19.2%
Pre-term birth	9.1%	17.3%
Low birth weight	7.2%	14.0%
County-level		
High county CA/N rate	28.1%	36.3%

Over 70 percent of infants at the highest risk of CPS involvement were born to mothers who had interacted with the child welfare system in the year prior to their birth. This means their mothers were either associated with a screened in intake, received case management, or received services from the state's child welfare agency. A majority of the highest risk infants had mothers known to the child welfare system, indicating likely prior abuse or neglect allegations pertaining to siblings.

This may be because the system was prevented from offering services where child abuse or neglect could not be substantiated or because the infant's birth coincided with a continuing case. Whatever the underlying reasons, infants at highest risk of CPS involvement were very likely to be born into a family that had been involved in or cycling through the child welfare system prior to their birth.

Directions for Future Research

The preceding analysis shows the utility of risk modeling using birth certificate and administrative other data on maternal and child exposures, and can serve as a foundation for future predictive modeling work.

For example, the results from the infant mortality predictive model suggest newborn health is the strongest driving risk factor and that interventions must be aimed at precursors to newborn health early in pregnancy. Future risk modeling in this area could identify factors that can be measured using administrative data early in pregnancy that predict both poor newborn health and infant mortality. Such a risk model could aid in identifying populations to target for prenatal prevention efforts.

The CPS involvement model indicated that the single strongest predictor of an infant becoming part of a CPS case was previous child welfare involvement of the mother, while other maternal exposures contributed to the risk level. Future risk modeling in this area could identify a concise set of maternal exposures that could be used in real time to identify high-risk pregnant women who could be prioritized for early intervention/prevention programs such as home visiting.

The developmental delay model indicated children at highest risk of delay were those with a pervasive developmental disorder. Controlling for this strong contributing factor, poor newborn health, older maternal age, and maternal exposures all contributed to increased risk. The results suggest the need for universal screening for developmental delay with special focus on infants who had poor newborn health indicators and those with older mothers, in order to identify children who would benefit from early intervention supports.

The risk modeling in this report could be refined and expanded to identify infants most at risk of two outcomes: infant mortality and CPS involvement. For risk scoring such as this to be useful, supportive evidence-based preventative interventions must be available to offer to families at high risk. Further, these evidence-based interventions must be effective for high-risk families with multiple complex needs. The voluntary nature of many such interventions poses a challenge for DCYF, as does the need for parent-focused services which are administered outside of DCYF (e.g. mental health and substance abuse treatment, maternal support services). Ensuring children grow up safe and healthy requires multi-agency collaboration, effective interventions, and the innovative use of data for targeting interventions to families in need.

APPENDIX

APPENDIX TABLE 1.

Descriptive Statistics

	NUMBER	PERCENT
TOTAL POPULATION	259,649	100%
Adverse outcomes		
Infant mortality (per 1,000)	829	3.19
CPS involvement	44,517	17%
Developmental delay (of those with 12 mo. of Medicaid over 3 yrs. N = 251,601)	34,980	14%
Newborn health		
Pre-term birth	22,808	9%
Low birth weight	17,771	7%
Low Apgar score	12,255	5%
Drug-affected newborn diagnosis	3,297	1%
Hospital transfer	2,561	1%
Pervasive developmental disorder diagnosis	438	0%
Prenatal care		
Prenatal care began in first trimester	157,309	61%
Prenatal care began after the first trimester	83,485	32%
Prenatal care initiation was unknown	15,694	6%
Prenatal care never began	3,161	1%
Child demographics		
Female	126,281	49%
Male	133,368	51%
Multiple birth	6,881	3%
Maternal demographics		
No prior births	95,878	37%
1 prior birth	73,989	28%
2 or 3 prior births	70,852	27%
4 or more prior births	18,930	7%
Under 18	7,664	3%
18 to 20	33,361	13%
21 to 25	82,091	32%
26 to 30	72,387	28%
31 to 35	43,238	17%
Over 35	20,908	8%
White	130,977	50%
Hispanic	76,276	29%
Black	15,946	6%
Native American	6,251	2%
Asian	13,073	5%
Pacific Islander	4,543	2%
Other race	347	0%
More than one race	12,236	5%
Less than high school	67,619	26%
High school diploma or GED	85,725	33%
Some college, no degree	63,334	24%
Associate's degree or above	40,014	15%

	NUMBER	PERCENT
Unknown maternal education	2,957	1%
Unmarried	143,466	55%
Limited English proficiency (prior 12 months)	35,553	14%
Maternal exposures		
SNAP food assistance (prior 12 months)	151,740	58%
No wages (prior 5 years)	73,986	28%
Mental health condition (prior 12 months)	50,603	19%
Smoked (during pregnancy)	36,649	14%
Child welfare (prior 12 months)	22,478	9%
Substance use issue (prior 12 months)	21,745	8%
Criminal justice involvement (prior 12 months)	17,369	7%
Domestic violence (prior 12 months)	10,334	4%
Disability (prior 12 months)	6,498	3%
Homelessness (prior 12 months)	8,641	3%
Geography		
Urban high density county	162,303	63%
Low child abuse/neglect prevalence county	66,492	26%
Medium child abuse/neglect prevalence county	129,673	50%
High child abuse/neglect prevalence county	63,484	24%

TECHNICAL NOTES

STUDY DESIGN AND OVERVIEW

This study examines predictors of adverse outcomes for young children using information available at or immediately subsequent to birth. The cohort of children used in the study were born between SFY 2010 and SFY 2016. The SFY 2010 to SFY 2015 cohort was used to fit the predictive model, and the single year SFY 2016 cohort was used for identifying current concentrations of infants at risk across the state.

DATA AND MEASURES

The birth cohorts were identified through birth records contained in the First Steps Database (FSDB). FSDB contains birth certificate information from the Department of Health (DOH) linked to Medicaid claims and service information from the Health Care Authority (HCA).

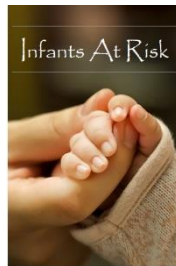
Outcome measures: FSDB contains death certificate information from DOH, which was used to identify infant mortality. Administrative data from the DSHS Integrated Client Databases (ICDB) was used to identify CPS involvement in the 3 years after birth and developmental delay diagnosis in the 3 years after birth.

Predictors: Most newborn health factors (birth weight, pre-term birth, Apgar score, hospital transfer), maternal demographics (marital status, race/ethnicity, education, age, number of prior children), initiation of prenatal care, smoking during pregnancy, and infant gender were taken directly from the infants birth certificates.

The remaining newborn health factors, maternal exposures and demographics, and county-level predictors were constructed from administrative data contained in the Integrated Client Databases (ICDB):

- **Pervasive developmental disorder diagnosis** identified infants who had a diagnosis of a pervasive developmental disorder during the first month of life, based on ICD 9 and/or ICD 10 diagnosis codes in Medicaid claims. Conditions in this diagnostic grouping include 'pervasive developmental disorders' (e.g. autistic disorder, Rett syndrome) and 'chromosomal abnormalities not elsewhere classified' (e.g. Down syndrome, trisomies, chromosomal deletions).
- **Alcohol or drug exposure** was identified using alcohol or drug disorder diagnoses for the infant in the first month of life, as well as any alcohol or drug-related treatment in the first month of life.

- **Multiple birth** was identified when two infants had the same mother and had the same birthday. Multiple births where there was only one liveborn infant or where birth spanned multiple days would be missed by this method.
- **Maternal mental health condition** was identified from mental health diagnoses, psychotropic prescriptions, and mental health treatment records from the 12 months prior to the birth.
- **Maternal substance use** was identified from substance use disorder diagnoses and treatment records, as well as substance use related arrest data from the Washington State Patrol from the 12 months prior to the birth.
- **Maternal criminal justice involvement** was identified from administrative records for arrests, convictions, and incarcerations in Department of Corrections' prisons in the 12 months prior to the birth.
- **Maternal domestic violence** was identified through records in the Automated Client Eligibility System (ACES) indicating domestic violence (DV) victimization (address confidentiality program, non-cooperation with Child Support Enforcement due to DV, DV identified in the comprehensive evaluation) and from DV-related arrests and convictions. DV-related arrests and convictions were identified based on the mother's records, so DV arrests where the perpetrator was a partner would be missed. The ACES indicators were included to try to identify DV where the mother may be the victim. All components of the DV measure were taken from the 12 months prior to the birth.
- **Maternal child welfare involvement** was identified using administrative data from the FAMILINK data system. A mother was identified as child welfare involved if she had any interaction with the child welfare system in the prior 12 months including being associated with an intake, on a case being case managed, or receiving services.
- **Maternal Basic Food receipt** was identified from ACES records from the 12 months prior to birth.
- **Maternal homelessness** was identified from ACES living arrangement codes, using codes indicating literal homelessness (e.g. in shelter, on the street) from the 12 months prior to birth.
- **Maternal limited English proficiency** was identified from ACES data where a mother was identified as speaking a language other than English and requested interpreter services. This measure identifies the subset of mothers whose primary language was not English and who had limited English skills in order to require interpretation and can be thought of as an imperfect proxy for immigrant women.
- **Maternal disability** was identified where the mothers had Medicaid eligibility categories for disabled populations or received services from DSHS's Developmental Disabilities Administration or Division of Vocational Rehabilitation. A substantial portion of this identified disabled population includes persons with a serious and disabling mental health condition.
- **Maternal lack of wages** was identified using Employment Security Department wage data for women who had no wages for 5 years previous to the birth.
- **County child abuse and neglect rates** were taken directly from the Community Outcome & Risk Evaluation (CORE) community measures available here: <https://www.dshs.wa.gov/ffa/research-and-data-analysis/community-risk-profiles>. The rates were divided into three groups: 1) low (bottom 25 percent), 2) medium (middle 50 percent) and 3) high (top 25 percent).
- **County urbanicity** was measured based on census data.



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