

# Postterm pregnancies: a population-based study of markers of potential long-term neurodevelopmental morbidity and other adverse infant outcomes in Washington State



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# Outline

- Background
- Specific Aims
- Study Methods
- Results
- Limitations
- Summary
- Questions



# Background



## Definition

- Postterm pregnancy—42+ weeks

## Prevalence

- ~6% of pregnancies progress beyond 42 weeks

# Background

## Adverse Outcomes

- Fetal death/stillbirth
- Neonatal/infant mortality
- NICU admission
- Macrosomia
- Meconium staining
- Low 5-minute Apgar scores
- Neonatal seizures
- Meconium aspiration
- Neonatal acidemia
- Perinatal asphyxia
- Neurological or developmental disorder
- Epilepsy

# Specific Aims



1. Evaluate the associations between gestational age (term and postterm) and potential markers of long-term neurodevelopmental morbidity
2. Evaluate the associations between gestational age (term and postterm) and frequently reported adverse infant outcomes

# Study Methods



- Design:
  - Population-based retrospective cohort study
- Data Sources:
  - WA birth certificate data linked to birth hospitalization discharge data (CHARS)
- Subjects:
  - Infants 38 to 45 weeks gestational age
    - term = 38-41 weeks by LMP and OE
    - postterm = 42+ weeks by LMP and/or OE
  - Born in Washington between 2003-2008
- Analysis:
  - Mantel-Haenszel stratified analysis

# Sensitivity Analyses

Alternative classifications of gestational age:

1. 38-0/7 through 41-6/7 and  $\geq 42-0/7$  weeks by *LMP only*
2. 38-0/7 through 41-6/7 and  $\geq 42-0/7$  weeks by *OE only*
3. 38-0/7 through 41-6/7 and  $\geq 42-0/7$  weeks by *both LMP and OE*
4. 38-0/7 through 40-6/7 (*excluding those born at 41 weeks*) and  $\geq 42-0/7$  weeks by LMP and/or OE

# Results



	Term	Postterm	RR [95% CI]
5-minute Apgar <4	243 (0.27)	99 (0.33)	1.18 [0.94, 1.49]
Neonatal seizures	78 (0.09)	34 (0.11)	1.22 [0.81, 1.84]
MAS	856 (0.96)	419 (1.41)	1.42 [1.26, 1.59]
HIE/Perinatal asphyxia	55 (0.06)	28 (0.09)	1.51 [0.95, 2.38]
Neonatal acidemia	113 (0.13)	51 (0.17)	1.34 [0.96, 1.96]

All risk estimates adjusted for maternal age, race, and parity



# Results

	Term	Postterm	RR [95% CI]
Neonatal death	68 (0.08)	33 (0.11)	1.48 [0.82, 2.20]
Postneonatal death	71 (0.08)	27 (0.09)	1.06 [0.68, 1.66]
Primary cesarean delivery	13,706 (15.37)	5,654 (19.05)	1.19 [1.16, 1.22]
Instrumental vaginal delivery	5,790 (6.49)	1,938 (6.53)	0.96 [0.91, 1.01]
Vacuum/Forceps failure	728 (0.82)	281 (0.95)	1.13 [0.98, 1.29]

All risk estimates adjusted for maternal age, race, and parity

# Results

	Term	Postterm	RR [95% CI]
Birth weight $\geq$ 4000g	11,652 (13.08)	4,780 (16.13)	1.29 [1.25, 1.33]
Birth weight >4500g	1,730 (1.94)	822 (2.77)	1.52 [1.40, 1.65]
Low birth weight	807 (0.91)	424 (1.43)	1.52 [1.35, 1.70]
Small for Gestational Age	7,033 (7.89)	2,353 (7.94)	0.96 [0.92, 1.00]

All risk estimates adjusted for maternal age, race, and parity

# Results

	Term	Postterm	RR [95% CI]
5-minute Apgar <7	1,373 (1.54)	525 (1.77)	1.11 [1.01, 1.23]
Receipt of antibiotics for sepsis	962 (1.09)	370 (1.27)	1.12 [0.99, 1.26]
Moderate-to-heavy meconium	4,771 (5.43)	2,089 (7.17)	1.30 [1.23, 1.36]
NICU admission	2,165 (2.46)	923 (3.17)	1.28 [1.18, 1.38]
Length of stay >5 days	970 (1.09)	513 (1.73)	1.56 [1.40, 1.74]

All risk estimates adjusted for maternal age, race, and parity

# Limitations



- Use of proxy indicators for long-term neurodevelopmental morbidity
- Use of last menstrual period to measure gestational age (and categorize term and postterm) may have influenced some results

# Summary



- Significant association observed between postterm birth and MAS, with non-significant increased risks of other potential markers of long-term neurodevelopmental morbidity
- Confirmation of increased risks of other adverse infant outcomes among postterm infants
- Need for longitudinal studies to evaluate association with long-term morbidity

# Acknowledgments

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  - Marcia Williams—Advisor and Chair
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- Data
  - Washington State DOH
  - Bill O'Brian
- Family
  - Mom, Dad, Lyndsey, and Chris

# THANK YOU!

## QUESTIONS?



# Results (LMP only)

	Term	Postterm	RR [95% CI]
5-minute Apgar <4	247 (0.27)	85 (0.33)	1.16 [0.91, 1.48]
Neonatal seizures	78 (0.09)	30 (0.12)	1.23 [0.80, 1.89]
MAS	876 (0.97)	362 (1.39)	1.40 [1.24, 1.59]
HIE/Perinatal asphyxia	58 (0.06)	24 (0.09)	1.43 [0.89, 2.32]
Neonatal acidemia	118 (0.13)	38 (0.15)	1.11 [0.77, 1.60]

All risk estimates adjusted for maternal age, race, and parity



## Results (LMP only)

	Term	Postterm	RR [95% CI]
Neonatal death	68 (0.08)	32 (0.12)	1.66 [1.08, 2.53]
Postneonatal death	72 (0.08)	25 (0.10)	1.13 [0.71, 1.77]
Primary cesarean delivery	14,031 (15.52)	4,828 (18.58)	1.16 [1.13, 1.20]
Instrumental vaginal delivery	5,878 (6.50)	1,702 (6.55)	0.97 [0.92, 1.02]
Vacuum/Forceps failure	751 (0.83)	228 (0.88)	1.03 [0.89, 1.19]

All risk estimates adjusted for maternal age, race, and parity

# Results (LMP only)

	Term	Postterm	RR [95% CI]
Birth weight $\geq$ 4000g	12,014 (13.30)	3,962 (15.26)	1.20 [1.16, 1.24]
Birth weight >4500g	1,809 (2.00)	640 (2.47)	1.31 [1.20, 1.43]
Low birth weight	811 (0.90)	378 (1.46)	1.57 [1.39, 1.77]
Small for Gestational Age	7,131 (7.90)	2,048 (7.89)	0.96 [0.91, 1.00]

All risk estimates adjusted for maternal age, race, and parity

# Results (LMP only)

	Term	Postterm	RR [95% CI]
5-minute Apgar <7	1,396 (1.55)	460 (1.77)	1.11 [1.00, 1.24]
Receipt of antibiotics for sepsis	973 (1.09)	334 (1.31)	1.16 [1.02, 1.31]
Moderate-to-heavy meconium	4,918 (5.52)	1,765 (6.91)	1.23 [1.17, 1.30]
NICU admission	2,200 (2.47)	823 (3.22)	1.30 [1.20, 1.40]
Length of stay >5 days	986 (1.09)	449 (1.73)	1.56 [1.40, 1.75]

All risk estimates adjusted for maternal age, race, and parity

# Results (OE only)

	Term	Postterm	RR [95% CI]
5-minute Apgar <4	321 (0.28)	17 (0.46)	1.44 [0.89, 2.35]
Neonatal seizures	105 (0.09)	5 (0.14)	1.30 [0.52, 3.28]
MAS	1,169 (1.03)	95 (2.60)	2.11 [1.72, 2.61]
HIE/Perinatal asphyxia	76 (0.07)	6 (0.16)	2.15 [0.92, 5.03]
Neonatal acidemia	146 (0.13)	14 (0.38)	2.52 [1.45, 4.37]

All risk estimates adjusted for maternal age, race, and parity

# Results (OE only)

	Term	Postterm	RR [95% CI]
Neonatal death	95 (0.08)	3 (0.08)	1.04 [0.32, 3.35]
Postneonatal death	96 (0.08)	2 (0.05)	0.63 [0.16, 2.57]
Primary cesarean delivery	18,096 (15.92)	1,027 (28.06)	1.40 [1.34, 1.48]
Instrumental vaginal delivery	7,402 (6.51)	260 (7.10)	0.95 [0.84, 1.07]
Vacuum/Forceps failure	944 (0.83)	56 (1.53)	1.62 [1.24, 2.11]

All risk estimates adjusted for maternal age, race, and parity

## Results (OE only)

	Term	Postterm	RR [95% CI]
Birth weight $\geq$ 4000g	15,291 (13.46)	1,083 (29.61)	2.27 [2.16, 2.39]
Birth weight >4500g	2,294 (2.02)	239 (6.54)	3.40 [2.99, 3.88]
Low birth weight	1,008 (0.89)	15 (0.41)	0.41 [0.24, 0.68]
Small for Gestational Age	8,971 (7.90)	309 (8.48)	0.97 [0.87, 1.09]

All risk estimates adjusted for maternal age, race, and parity

# Results (OE only)

	Term	Postterm	RR [95% CI]
5-minute Apgar <7	1,781 (1.57)	80 (2.19)	1.22 [0.98, 1.52]
Receipt of antibiotics for sepsis	1,246 (1.10)	79 (2.16)	0.91 [0.66, 1.24]
Moderate-to-heavy meconium	6,366 (5.60)	449 (12.27)	1.95 [1.78, 2.13]
NICU admission	2,808 (2.47)	109 (2.98)	1.10 [0.91, 1.33]
Length of stay >5 days	1,264 (1.11)	61 (1.67)	1.36 [1.05, 1.75]

All risk estimates adjusted for maternal age, race, and parity

# Results (LMP & OE)

	Term	Postterm	RR [95% CI]
5-minute Apgar <4	243 (0.27)	9 (0.52)	1.57 [0.81, 3.04]
Neonatal seizures	78 (0.09)	3 (0.17)	1.71 [0.53, 5.55]
MAS	856 (0.96)	61 (3.54)	3.06 [2.37, 3.96]
HIE/Perinatal asphyxia	55 (0.06)	3 (0.17)	2.39 [0.74, 7.71]
Neonatal acidemia	113 (0.13)	6 (0.35)	2.14 [0.95, 2.84]

All risk estimates adjusted for maternal age, race, and parity



# Results (LMP & OE)

	Term	Postterm	RR [95% CI]
Neonatal death	68 (0.08)	3 (0.17)	2.38 [0.72, 7.80]
Postneonatal death	71 (0.08)	1 (0.06)	0.71 [0.10, 5.12]
Primary cesarean delivery	13,706 (15.37)	514 (29.83)	1.50 [1.40, 1.61]
Instrumental vaginal delivery	5,790 (6.49)	122 (7.08)	0.90 [0.76, 1.07]
Vacuum/Forceps failure	728 (0.82)	86 (4.99)	1.29 [0.84, 1.96]

All risk estimates adjusted for maternal age, race, and parity

## Results (LMP & OE)

	Term	Postterm	RR [95% CI]
Birth weight $\geq$ 4000g	11,652 (13.08)	511 (29.66)	2.37 [2.20, 2.55]
Birth weight >4500g	1,730 (1.94)	106 (6.15)	3.45 [2.85, 4.18]
Low birth weight	807 (0.91)	5 (0.29)	0.29 [0.12, 0.69]
Small for Gestational Age	7,033 (7.89)	138 (8.02)	0.91 [0.77, 1.07]

All risk estimates adjusted for maternal age, race, and parity

# Results (LMP & OE)

	Term	Postterm	RR [95% CI]
5-minute Apgar <7	1,373 (1.54)	40 (2.32)	1.26 [0.92, 1.72]
Receipt of antibiotics for sepsis	962 (1.09)	23 (1.36)	1.07 [0.71, 1.61]
Moderate-to-heavy meconium	4,771 (5.43)	234 (13.80)	2.20 [1.95, 2.49]
NICU admission	2,165 (2.46)	54 (3.19)	1.13 [0.87, 1.48]
Length of stay >5 days	970 (1.09)	23 (1.33)	1.12 [0.74, 1.69]

All risk estimates adjusted for maternal age, race, and parity

# Results (excluding 41 weeks)

	Term	Postterm	RR [95% CI]
5-minute Apgar <4	186 (0.26)	85 (0.33)	1.22 [0.95, 1.57]
Neonatal seizures	62 (0.09)	30 (0.12)	1.20 [0.77, 1.87]
MAS	614 (0.85)	362 (1.39)	1.58 [1.39, 1.80]
HIE/Perinatal asphyxia	41 (0.06)	24 (0.09)	1.59 [0.95, 2.64]
Neonatal acidemia	93 (0.13)	38 (0.15)	1.11 [0.77, 1.62]

All risk estimates adjusted for maternal age, race, and parity

# Results (excluding 41 weeks)

	Term	Postterm	RR [95% CI]
Neonatal death	53 (0.07)	32 (0.12)	1.71 [1.10, 2.67]
Postneonatal death	59 (0.08)	25 (0.10)	1.08 [0.68, 1.73]
Primary cesarean delivery	10,432 (14.39)	2,448 (9.42)	1.22 [1.18, 1.25]
Instrumental vaginal delivery	4,537 (6.26)	1,702 (6.55)	0.97 [0.92, 1.03]
Vacuum/Forceps failure	559 (0.77)	228 (0.88)	1.08 [0.93, 1.26]

All risk estimates adjusted for maternal age, race, and parity

# Results (excluding 41 weeks)

	Term	Postterm	RR [95% CI]
Birth weight $\geq$ 4000g	8,456 (11.67)	3,962 (15.26)	1.39 [1.34, 1.44]
Birth weight >4500g	1,233 (1.70)	640 (2.47)	1.58 [1.44, 1.74]
Low birth weight	728 (1.00)	378 (1.46)	1.37 [1.21, 1.55]
Small for Gestational Age	5,654 (7.80)	2,048 (7.89)	0.95 [0.91, 1.00]

All risk estimates adjusted for maternal age, race, and parity

# Results (excluding 41 weeks)

	Term	Postterm	RR [95% CI]
5-minute Apgar <7	1,064 (1.47)	460 (1.77)	1.15 [1.04, 1.29]
Receipt of antibiotics for sepsis	758 (1.09)	334 (1.31)	1.17 [1.03, 1.33]
Moderate-to-heavy meconium	3,373 (4.72)	1,765 (6.91)	1.43 [1.35, 1.51]
NICU admission	1,774 (2.48)	823 (3.22)	1.27 [1.17, 1.38]
Length of stay >5 days	795 (1.10)	449 (1.73)	1.54 [1.37, 1.73]

All risk estimates adjusted for maternal age, race, and parity

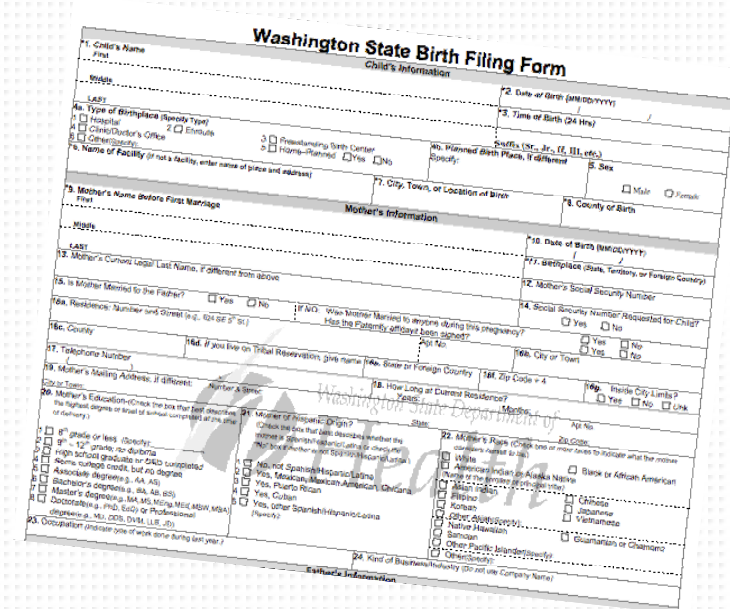
# Variables

## Predictor

- Gestational age
  - term (38-41 weeks)
  - postterm (42-45 weeks)

## Primary Outcomes

- Neonatal seizures
- 5-minute Apgar score <4
- Meconium Aspiration Syndrome (MAS)
- Hypoxic Ischemic Encephalopathy (HIE)/Perinatal asphyxia
- Neonatal acidemia



The image shows a 'Washington State Birth Filing Form' from the Washington State Department of Health. The form is divided into several sections: 'Child's Information', 'Mother's Information', and 'Father's Information'. It contains various fields for data entry, including names, dates of birth, addresses, and contact information. There are also checkboxes for specific details like 'Type of Birthplace (Specify Type)', 'Placental Birth Center', and 'Home-Born'. The form is a standard document used for recording birth data in Washington state.



# Variables

## Other Independent Variables

- Neonatal death
- Postneonatal death
- Primary cesarean delivery
- Instrumental vaginal delivery
- Vacuum/Forceps failure
- Birth weight >4000g
- Birth weight >4500g
- Small-for-gestational age
- 5-minute Apgar <7
- Antibiotics for sepsis
- Moderate-to-heavy meconium staining
- NICU admission
- Long length of hospital stay (>5 days)

# Variables

- Potential confounders

- Maternal age, race, education, marital status
- Parity
- Prenatal care
- Maternal smoking
- Prepregnancy weight
- Hx of Diabetes/Hypertension

- Method of delivery

- Infant birth weight
- Infant gender
- Fetal presentation
- Urban/rural birthplace
- Physician birth attendant
- Hospital birth
- Medicaid

- Potential effect modifiers

- Parity

- Induction of Labor