A Perinatal Periods of Risk (PPOR) Analysis for the Lifecourse Initiative for Healthy Families (LIHF)

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Wisconsin Department of Health Services

Acknowledgements

Infant mortality in Wisconsin

Overall, Wisconsin's population is as healthy or healthier than the United States population in various health domains. However, stark disparities have been observed in diverse health-related outcomes in Wisconsin, including birth outcomes for racial and ethnic minorities (Rohan et al., 2014). Historically, the black/white disparity ratio for infant mortality has been high, peaking at 4.3 in 2004.

From 2006-2010 babies born to non-Hispanic black women in Wisconsin were nearly 3 times as likely to die in the first year of life as babies born to non-Hispanic white women.

Given the persistent black/white disparity in infant mortality, new approaches in understanding and addressing infant deaths among Wisconsin's black population are needed. Currently, Wisconsin has many efforts in progress to address this problem.

For example, the Collaborative Improvement and Innovation Network (CoIIN) has three strategy teams targeting pre- and inter-conception health, social determinants of health, and safe sleep to address infant mortality. We also have the Title V Program, which funds Maternal and Child Health programs around the state, including work related to examining and preventing infant deaths.

Different analytic approaches, such as the Perinatal Periods of Risk (PPOR) analysis, can complement these efforts and help us get a clearer picture of what factors may be driving these deaths and the disparity between black and white moms and infants in the state.

The Lifecourse Initiative for Healthy Families (LIHF) is a collaboration between black families in Kenosha, Milwaukee, Racine, and Rock counties and the University of Wisconsin School of Medicine and Public Health. Ninety percent of black births in Wisconsin occur in these counties, so information we can provide to LIHF partners can help focus their efforts in improving birth outcomes among black Wisconsin moms and narrowing the gap between moms and infants with good outcomes and moms and infants with poorer outcomes.

An introduction to Perinatal Periods of Risk (PPOR)

What is PPOR?

PPOR is an analytic framework developed by CityMatCH (City**M**at**CH,** available at http://www.citymatch.org,) to help us identify opportunities to reduce fetal and infant death; includes **two phases:**

Phase I helps us map deaths into four periods of risk for a **reference** population (moms who have the best, and achievable, birth outcomes) and a **target** population (moms who have worse birth outcomes).

Phase II helps us identify factors that may contribute to excess deaths in the target population in the period of highest risk.
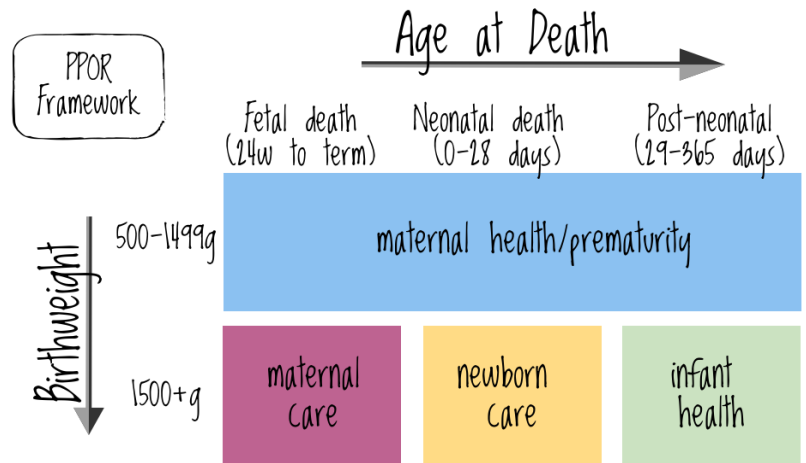
Periods of Risk

Maternal health/prematurity: Period of risk for extremely low and very low birthweight (500-1499g); includes fetal, neonatal, and post-neonatal deaths

Maternal care: Period of risk for low and normal birthweight (1500+g); includes fetal deaths

Newborn care: Period of risk for low and normal birthweight; includes neonatal deaths

Infant health: Period of risk for low and normal birthweight; includes post-neonatal deaths

Why use PPOR?

If we can identify the periods of risk that contribute to excess deaths among black moms in LIHF communities, we can identify risk factors important for that period of risk. See below for risk factors to explore for each risk period.
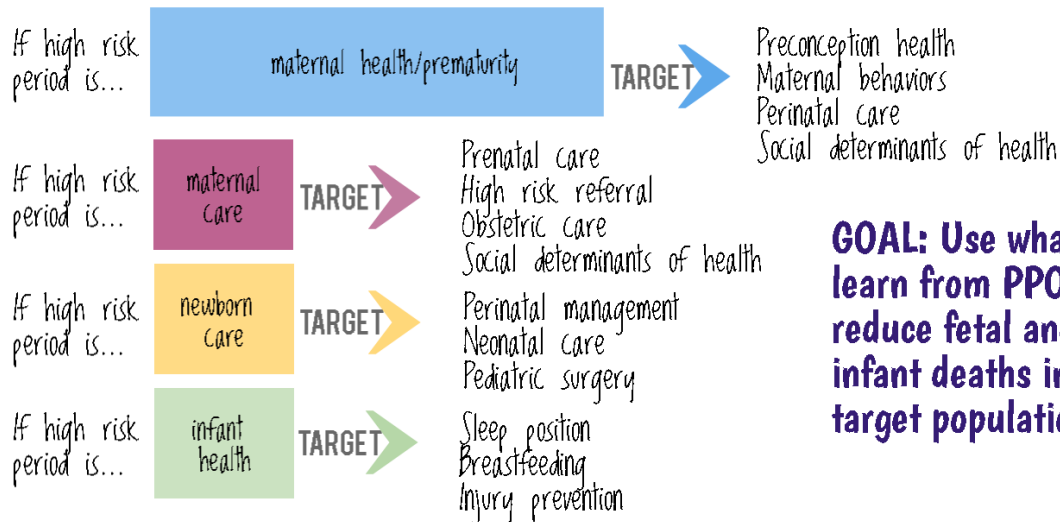
GOAL: Use what you learn from PPOR to reduce fetal and infant deaths in the target population

PPOR is about ACTION! **Identification of risk factors that drive the disparity between the target group and reference group should drive programs and interventions.**

Populations

Reference population (moms with the BEST birth outcomes): White, 13+ years of education, 20+ years of age, resident of LIHF target areas (Kenosha, Milwaukee, Racine or Rock county)
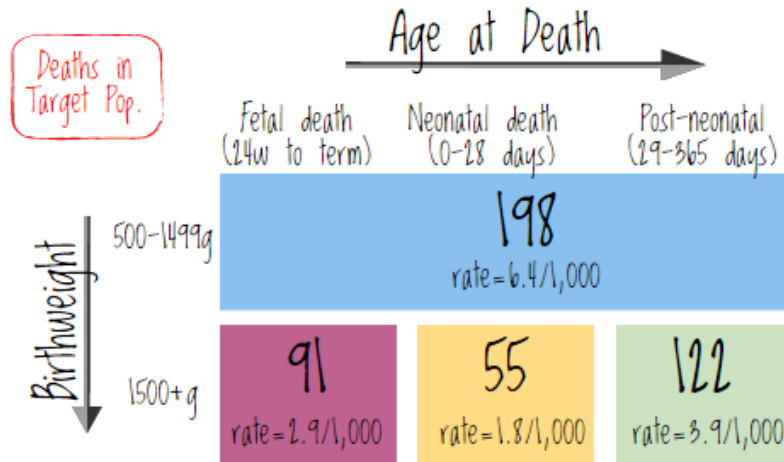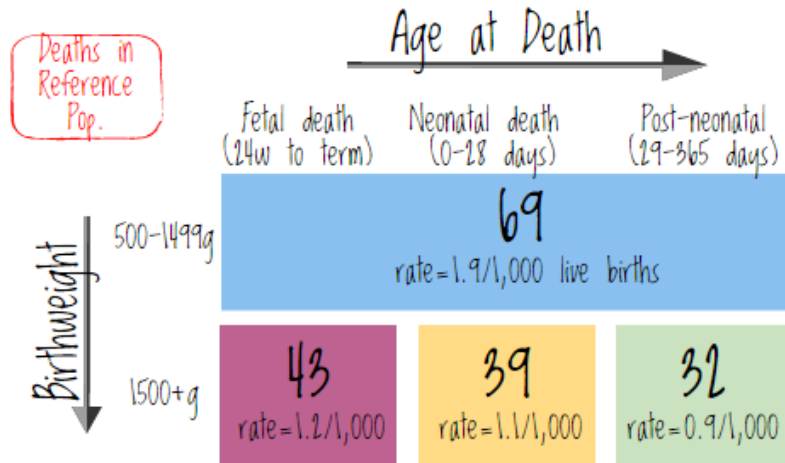
Target population (moms with POORER birth outcomes): Black, resident of Kenosha, Milwaukee, Racine or Rock county

Deaths (2006-2010)

Deaths in Reference Pop.

Age at Death →

	Fetal death (24w to term)	Neonatal death (0-28 days)	Post-neonatal (29-365 days)
500-1499g	69 — rate=1.9/1,000 live births		
1500+g	43 — rate=1.2/1,000	39 — rate=1.1/1,000	32 — rate=0.9/1,000

Birthweight ↓

Deaths in Target Pop.

Age at Death →

	Fetal death (24w to term)	Neonatal death (0-28 days)	Post-neonatal (29-365 days)
500-1499g	198 — rate=6.4/1,000		
1500+g	91 — rate=2.9/1,000	55 — rate=1.8/1,000	122 — rate=3.9/1,000

Birthweight ↓

Excess Death Rate

Subtracting the fetal and infant death rates (target - reference) gives us the excess death rate for each period of risk:

which helps us calculate the number of excess deaths that could have been prevented if rates of fetal and infant deaths were the same for the target and reference groups

4.5	1.8	0.7	3.1
139	54	22	95

These are AVOIDABLE deaths!
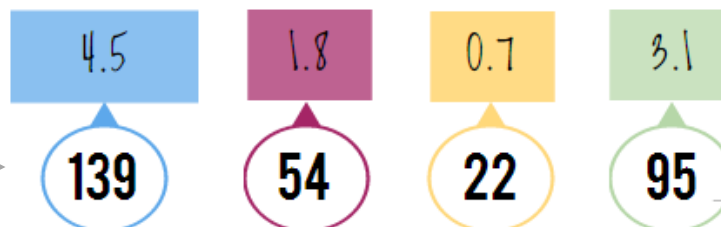
TOTAL EXCESS = 310 DEATHS OVER 5 YEARS

PPOR Phase II: Kitagawa analysis and examination of risk factors

What we learned from Phase I

Most of the excess deaths in the target population occurred in the **Maternal Health/Prematurity period of risk**. We should consider factors related to pre-conception health, maternal behaviors, and perinatal care as the drivers of disparities between the target and reference populations.

Phase II

Kitagawa analysis helps us determine whether excess deaths are due to differences in birthweight distribution (e.g., higher frequency of very low birthweight (VLBW) babies) or birthweight-specific mortality (e.g., higher mortality rate for VLBW babies due to perinatal and medical care). We can use this information to identify relevant risk factors for comparison in the reference and target populations.

Kitagawa

The risk factors that affect birthweight distribution are different from the risk factors that affect birthweight-specific mortality. We need to identify which pathway to excess mortality is important for our target moms in LIHF counties using the Kitagawa approach.
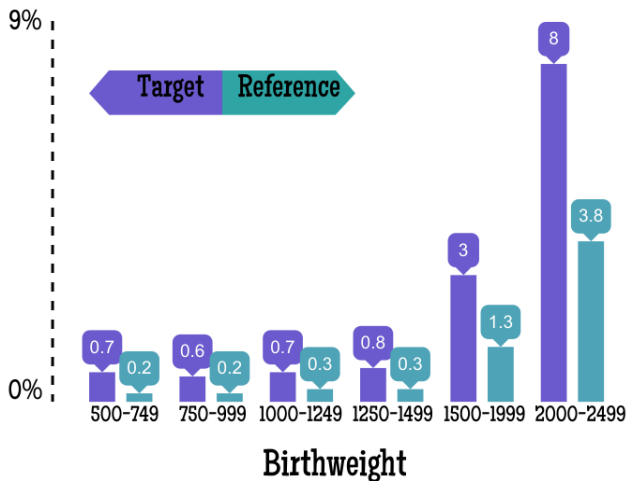
The target population in LIHF communities has a higher prevalence of very low to extremely low birthweight babies (500-1500g) compared to the reference population
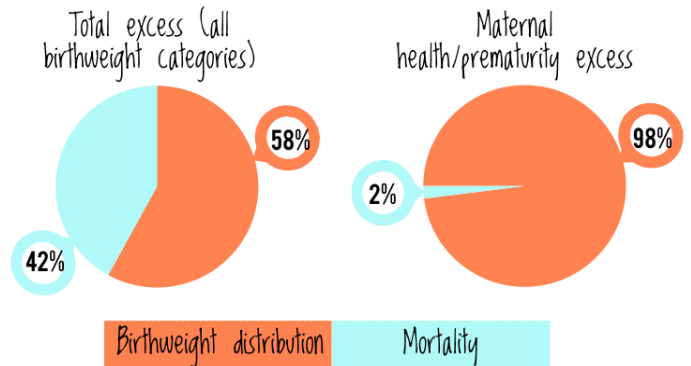
The total excess chart shows us that birthweight distribution is responsible for most of the excess deaths in the target population. The maternal health/prematurity excess chart confirms that the predominant cause for the disparity in deaths of VLBW babies in the target population is birthweight distribution

What do the results mean?

Birthweight distribution, which is tied to very low birth weight, is responsible for excess deaths in the target population. To prevent infant mortality, black moms and their babies in LIHF communities will benefit most if we can
1) **identify factors contributing to very low birth weight** and
2) **prevent very low birth weight** through targeted efforts

*We should take a closer look at factors for very low birthweight in these moms

A note about risk factors

The Phase I analysis showed us that most of the excess deaths occurred in two periods of risk: Maternal Health/Prematurity and Infant Health. We can use information from the birth certificate, Pregnancy Risk Assessment Monitoring System (PRAMS), and other sources to look at factors we know are important in those periods.

Below is a table that provides information about factors that may be examined for each period of risk as we try to determine areas where we can make a difference in reducing or eliminating deaths in the target population. Since we identified the Maternal Health/ Prematurity period of risk in the Phase I analysis and very low birth weight as an important area for prevention efforts, we will look at factors such as social determinants of health, maternal behaviors such as smoking, and maternal conditions.

NOTE: We did observe a high number of excess deaths in the Infant Health Period as well. See the Supplement at the end of this document for a closer look at infant health.

Period of Risk	Examine these factors (not an all-inclusive list)
Maternal Health/Prematurity	Maternal age, socio-economic status, parity, pre-natal care, smoking, maternal health conditions
Maternal Care	Prenatal care, high risk referral, obstetric care
Newborn Care	Pediatric surgery, neonatal care, perinatal management
Infant Health	Sleep position, breastfeeding, maternal mental health, folic acid, tobacco and alcohol use, maternal age

Social determinants and pre-pregnancy factors related to very low birth weight (PRAMS 2009-11)

REFERENCE

(White, 20+ years old, 13+ years of school)

Social determinants

TARGET

(Black)

REFERENCE	Social determinants	TARGET
6.9%	annual income less than $15k	65.5%
9.5%	insured by Medicaid	66.9%
16.2%	unmarried	86.1%
18.3%	3+ major stressors during pregnancy	49.5%
NA	felt upset due to how they were treated because of race	18.9%
NA	experienced abuse during pregnancy	9.4%

we don't have enough reference moms for a comparison due to small numbers

Pre-pregnancy factors

REFERENCE		TARGET
42.9%	overweight or obese	61.7%
46.3%	did not exercise at least 3x per week	71.2%
16.7%	smoked in 3 months	25.7%

Maternal health factors related to very low birth weight (Vital Statistics 2006-10)

REFERENCE

(White, 20+ years old, 13+ years of school)

TARGET

(Black)

REFERENCE		TARGET
3.7%	anemia	11.6%
0.5%	pre-pregnancy diabetes	0.9%
1.5%	cardiac disease	1.4%
7.0%	lung disease	12.5%
4.9%	any sexually transmitted infection	19.2%
1.6%	pre-pregnancy hypertension	3.1%

Pregnancy & birth factors related to very low birth weight (PRAMS 2009-11 & Vital Statistics 2006-10)

REFERENCE

(White, 20+ years old, 13+ years of school)

TARGET

(Black)

REFERENCE		TARGET
24.5%	unintended pregnancy*	66.4%
43.4%	first birth	35.1%
62.9%	short interpregnancy interval	59.4%
7.9%	no prenatal care in 1st trimester	25.7%
3.6%	previous preterm birth	8.1%
6.0%	smoking during last 3 months of pregnancy	16.8%

*PRAMS

Medical pregnancy-related factors related to very low birth weight (Vital Statistics 2006-10)

REFERENCE

(White, 20+ years old, 13+ years of school)

TARGET

(Black)

REFERENCE		TARGET
0.3%	uterine bleeding	0.4%
0.1%	eclampsia	0.2%
4.1%	gestational diabetes	3.3%
0.5%	incompetent cervix	0.9%
6.5%	pregnancy-induced hypertension	6.7%

Population attributable risk percent

Introduction to population attributable risk percent (PAR)

PAR relates to the prevalence of risk factors and the strength of its association with VLBW. This method helps us determine the percentage of cases that would not occur in a population if that factor was eliminated. For example, we can look at factors related to VLBW from Vital Statistics that were very different for target and reference moms; this will give us the proportion of births at VLBW that could have been avoided if we eliminate those factors.

Factors to explore with PAR

Results from Vital Statistics indicated that the following factors differ in target moms and reference moms:

- Smoking during pregnancy
- Anemia*
- Lung disease
- Pre-pregnancy diabetes
- Pre-pregnancy hypertension
- Incompetent cervix
- Sexually transmitted infections*
- Previous pre-term birth
- No prenatal care in the first trimester*

If we examine the odds of VLBW when each factor is present, we can calculate the PAR and identify factors that, if eliminated, could help to prevent VLBW. We could prevent nearly 7 percent of VLBW babies in the target population if we eliminated incompetent cervix or smoking during pregnancy in these moms. If women had not had a previous pre-term birth, we could have prevented nearly 10 percent of VLBW babies in the target population.

Factor related to VLBW	Odds ratio	PAR
Pre-pregnancy diabetes	1.9	0.8%
Pre-pregnancy hypertension	2.2	3.5%
Lung disease	1.2	1.3%
Incompetent cervix	**8.7**	**6.5%**
Previous preterm birth	**2.3**	**9.8%**
Smoking during pregnancy	**1.5**	**6.6%**

*PAR not shown; PAR <1%

Summary & highlights

Summary of Phase I and Kitagawa

Most of the infant deaths from 2006 to 2010 among black moms and their babies in LIHF counties occurred in the **Maternal/Prematurity period of risk**. There were 139 excess deaths during this period.

Birthweight distribution accounted for the largest proportion of the excess deaths; consequently, we looked at factors that may be important for a higher frequency of very low birth weight babies in the target population.

Highlights from Phase II analysis

Social determinants of health

Target moms fared worse than reference moms in social determinants of health. A higher percentage of target moms had low incomes, were on Medicaid, were unmarried, and experienced three or more major stressors during their pregnancies.

Maternal health (pre-pregnancy)

A higher proportion of target moms had chronic diseases and infections, including pre-pregnancy diabetes and hypertension, overweight/obesity, and sexually transmitted infections. Fewer target moms exercised at least three times per week prior to pregnancy, and a higher proportion of target moms reported smoking in the three months prior to pregnancy.

Pregnancy and birth characteristics

A higher proportion of target moms reported unintended pregnancies, late prenatal care, a previous pre-term birth, and smoking during their pregnancies.

Maternal health during pregnancy

A higher proportion of target moms had a pregnancy complicated by incompetent cervix.

Highlights from a closer look at the infant health period of risk

- Sleep-related and injury-related deaths accounted for the majority of excess deaths in the target group.
- A higher proportion of target moms were younger than 25 years, put their babies to sleep on a position other than the back, and lived in a home where smoking is permitted

Next steps

PPOR is about ACTION! Now that we know where target moms differ from reference moms in LIHF communities, we can target our efforts in some of these areas.

Technical Notes

Definitions

Reference moms for PRAMS. Reference moms for PRAMS are white with 13+ years of education and 20+ years of age living in Wisconsin because there were too few moms in LIHF communities for a comparison.

Low birth weight. Infant weighing less than 2500 grams at birth.

Very low birth weight. Infant weighing less than 1500 grams at birth.

Primiparous. First pregnancy or birth.

Short interpregnancy interval. Less than 18 months from last live birth to pregnancy.

Three or more major stressors during pregnancy. Woman experienced at least 3 of the following stressors during pregnancy: A close family member was sick and had to go to the hospital, separating or divorcing from husband/partner, moved to a new address, was homeless, husband/partner lost job, woman lost job, argued with husband/partner more than usual, husband/partner did not want pregnancy, had bills unable to pay, was in a physical fight, husband/partner or woman went to jail, someone close to woman had a problem with substances, or someone close to woman died.

Population attributable proportion (PAR). PAR was calculated using the formula below. Note: the odds ratio was computed with unadjusted logistic regression models (outcome=VLBW) and was assumed to estimate relative risk (RR), as the majority of births were represented in the Vital Statistics dataset.

$$PAR=P_e(RR_e-1) / [1+Pe(RR_e-1) \times 100$$

Where P_e=prevalence of the exposure (e.g., anemia) and RR_e is the relative risk of very low birth weight due to the exposure

References and Resources

Rohan AM, Onheiber PM, Hale LJ, Kruse TL, Jones MJ, Gillespie KH, Lathen LS & Katcher ML. 2014. Turning the ship: Making the shift to a life-course framework. Maternal and Child Health Journal, 18(2):423-30.

Lifecourse Initiative for Health Families: http://www.med.wisc.edu/wisconsin-partnership-program/lifecourse-initiative-for-healthy-families/502

CityMatCH Perinatal Periods of Risk: http://www.citymatch.org/projects/perinatal-periods-risk-ppor

Supplement: A closer look at the Infant Health period of risk

While the greatest number of deaths occurred in the Maternal Health/Prematurity period of risk, **we also observed a large number of excess deaths in the Infant Health period of risk.** It may help inform our efforts to prevent infant deaths in the target population if we have additional information about deaths in the post-neonatal period among babies >1500g.

Causes of death among post-neonates >1500g	Reference moms		Target moms		Excess rate per 1,000
	Deaths (n)	Rate per 1,000*	Deaths (n)	Rater per 1,000	
Sleep-related	**15**	**0.4**	**63**	**2.0**	**1.6**
Injury	**2**	**0.1**	**19**	**0.6**	**0.5**
Birth defects	4	0.1	14	0.5	0.4
Perinatal conditions	2	0.1	4	0.1	0.0
Other	9	0.3	22	0.7	0.4
Total	**32**	**0.9**	**122**	**4.0**	**3.1**

*Rate per 1,000 live births; calculated as number of deaths per cause / number of live births >1500g, surviving 28 days

The excess rates show that sleep-related causes and injury are major contributors to excess mortality among infants >1500g who died 28-365 days after birth. The chart below shows us what percent of each cause of death accounts for the excess rate. We will explore factors relating to sleep and injury in the Phase II analysis.
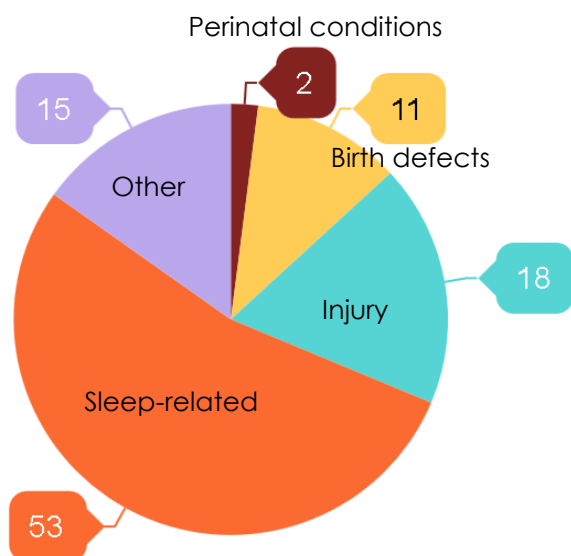
*We should explore risk factors for sleep and injury-related causes of death. Together, these causes account for over 70% of excess cases among infants >1500g in the target population

Supplement: Sleep- and injury-related factors important for infant health (PRAMS 2009-11)

REFERENCE

(White, 20+ years old, 13+ years of school)

TARGET

(Black)

Sleep-related factors

REFERENCE		TARGET
15.7%	baby most often put to sleep on position other than back	31.3%
21.9%	co-sleeping with baby at least sometimes	33.2%
88.8%	baby ever breastfed	64.3%
2.2%	smoking permitted inside home	19.3%

Injury-related factors

REFERENCE		TARGET
7.8%	postpartum depression	17.9%
12.3%	maternal age <25 years	52.3%