

# Integrated Approaches to Improve Birth Outcomes: Perinatal Periods of Risk, Infant Mortality Review, and the Los Angeles Mommy and Baby Project

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**Abstract** This article provides an example of how Perinatal Periods of Risk (PPOR) can provide a framework and offer analytic methods that move communities to productive action to address infant mortality. Between 1999 and 2002, the infant mortality rate in the Antelope Valley region of Los Angeles County increased from 5.0 to 10.6 per 1,000 live births. Of particular concern, infant mortality among African Americans in the Antelope Valley rose from 11.0 per 1,000 live births (7 cases) in 1999 to 32.7 per 1,000 live births (27 cases) in 2002. In response, the Los Angeles County Department of Public Health, Maternal, Child, and Adolescent Health Programs partnered with a community task force to develop an action plan to address the issue. Three stages of the PPOR approach were used: (1) Assuring Readiness; (2) Data and Assessment, which included: (a) Using 2002 vital records to identify areas with the highest excess rates of feto-infant mortality (Phase 1 PPOR), and (b) Implementing Infant Mortality Review

(IMR) and the Los Angeles Mommy and Baby (LAMB) Project, a population-based study to identify potential factors associated with adverse birth outcomes. (Phase 2 PPOR); and (3) Strategy and Planning, to develop strategic actions for targeted prevention. A description of stakeholders' commitments to improve birth outcomes and monitor infant mortality is also given. The Antelope Valley community was engaged and ready to investigate the local rise in infant mortality. Phase 1 PPOR analysis identified Maternal Health/Prematurity and Infant Health as the most important periods of risk for further investigation and potential intervention. During the Phase 2 PPOR analyses, IMR found a significant proportion of mothers with previous fetal loss (45%) or low birth weight/preterm (LBW/PT) birth, late prenatal care (39%), maternal infections (47%), and infant safety issues (21%). After adjusting for potential confounders (maternal age, race, education level, and marital status), the LAMB case-control study (279 controls, 87 cases) identified additional factors associated with LBW births: high blood pressure before and during pregnancy, pregnancy weight gain falling outside of the recommended range, smoking during pregnancy, and feeling unhappy during pregnancy. PT birth was significantly associated with having a previous LBW/PT birth, not taking multivitamins before pregnancy, and feeling unhappy during pregnancy. In response to these findings, community stakeholders gathered to develop strategic actions for targeted prevention to address infant mortality. Subsequently, key funders infused resources into the community, resulting in expanded case management of high-risk women, increased family planning services and local resources, better training for nurses, and public health initiatives to increase awareness of infant safety. Community readiness, mobilization, and alignment in addressing a public health concern in Los Angeles County enabled

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The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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the integration of PPOR analytic methods into the established IMR structure and [the design and implementation of a population-based study (LAMB)] to monitor the factors associated with adverse birth outcomes. PPOR proved an effective approach for identifying risk and social factors of greatest concern, the magnitude of the problem, and mobilizing community action to improve infant mortality in the Antelope Valley.

**Keywords** Perinatal periods of risk (PPOR) · Community health planning · Feto-infant mortality · Preconception health · Health disparities

### Purpose

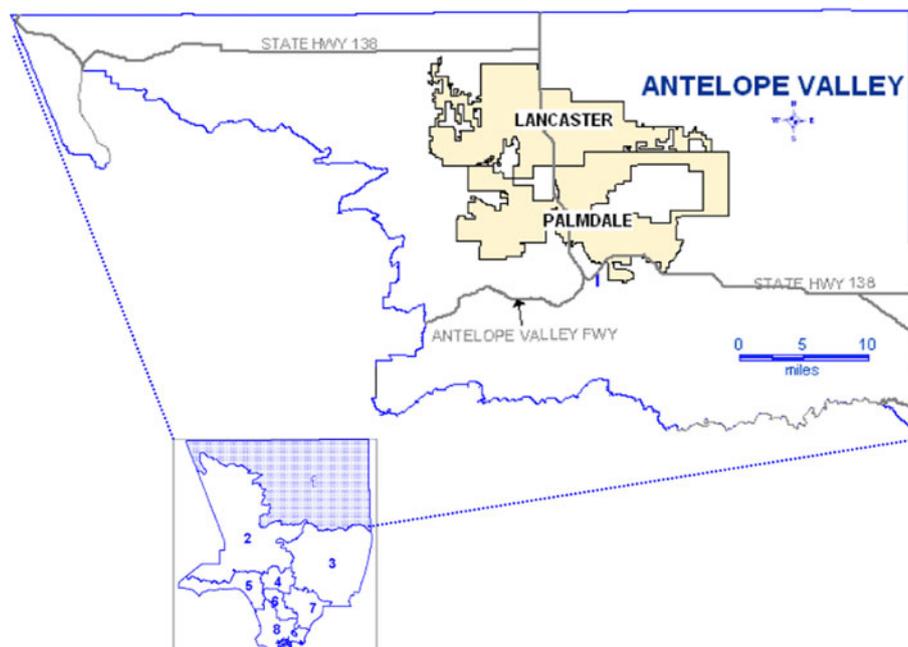
Fetal and infant mortality continue to be a public health concern in Los Angeles County, even as medical technology advances and an increased understanding of the factors influencing perinatal health have resulted in significant reductions in fetal and infant mortality [1]. There were 152,167 live births in Los Angeles County in 2002. Of these, 825 infants died before their first birthday, resulting in an overall infant mortality rate of 5.5 deaths per 1,000 live births, a 12.2% increase since the lowest rate of 4.9 per 1,000 live births observed in 1999. Compared to the overall county rate, the 2002 infant mortality rate for African Americans was significantly higher, at 13.1 deaths per 1,000 live births. Among the eight geographic regions within Los Angeles County, the Antelope Valley region has had the highest infant mortality rate beginning in 2000. In 2002, with 53 total infant deaths, the rate peaked at 10.6

infant deaths per 1,000 live births, after rising from 6.2 in 2000 to 9.4 in 2001. Additionally, racial and geographic disparities in fetal and infant mortality and adverse birth outcomes persist. The infant death rate for African Americans in the Antelope Valley increased from 11.0 per 1,000 (7 cases) in 1999 to 32.7 per 1,000 (27 cases) in 2002, while rates for other racial/ethnic groups rose only slightly. The numbers are small, but the increase was consistent with an ongoing rising trend.

The Antelope Valley is a rapidly growing area of approximately 2,200 square miles encompassing the northeast region of Los Angeles County and southeast region of Kern County (Fig. 1). It also is the most geographically isolated and sparsely populated section of the county, with fewer than 250 people per square mile. In 2003, the US Census reported a population of 341,000 for the Los Angeles County section of the region that included 14% African Americans, 31% Hispanics/Latinos, and 48% whites [2]. Approximately one in eight residents (12%) had a household income less than the Federal Poverty Level. While the median age of Antelope Valley residents was similar to that of the county overall [3], the availability of middle-income housing had enticed many new, young families to the area. Families moving into the community usually had to seek new health care providers, including providers for prenatal care, causing a disruption in the continuity of care [4]. Some also found that accessing services entailed long commutes, because resources tended to be centralized rather than distributed throughout the area.

When the 2002 spike in infant mortality among African Americans in Antelope Valley was noted in 2004, the Los

**Fig. 1** Service Planning Area (SPA) 1, Antelope Valley, Los Angeles County 2005



Angeles County Department of Public Health, Maternal, Child, and Adolescent Health (MCAH) Programs partnered with a community task force to develop an action plan to determine the magnitude of the problem and work together to address the issue. The 2002 increase in infant mortality was not identified and confronted until 2004 because of the two-year delay needed to obtain the completed death file from the state, but Los Angeles County MCAH Programs and members of the Antelope Valley community had already been taking steps to improve birth outcomes and community health several years before 2004.

Starting in the early 1990s, Los Angeles County MCAH Programs implemented several programs to improve birth outcomes through outreach, education, or review of fetal/infant death cases, such as California's Black Infant Health program (which provides perinatal services) and the Fetal Infant Mortality Review (FIMR) project [5, 6], MCAH noticed a rising trend in infant mortality among African Americans in Antelope Valley in 2001 and responded by expanding Antelope Valley Black Infant Health services in 2002 to African American mothers. During the same year, programmatic and technical staff associated with Los Angeles County MCAH received formal training on Perinatal Periods of Risk (PPOR) methods from CityMatCH, the national home for local PPOR practice, to develop skills in integrating the PPOR into the existing FIMR structure. PPOR is an approach to help communities analyze patterns of fetal and infant mortality, plan ways to respond, and monitor progress over time. Antelope Valley Partners for Health (AVPH) was formed in 2000 to identify and address community health concerns and service needs of Antelope Valley residents. AVPH is a community collaborative of local residents, organizations, and the Los Angeles County Department of Public Health. In 2004, AVPH would form the basis of the community task force formed to study and address the infant mortality problem.

In Antelope Valley, full community involvement in planning, execution, and accountability facilitated the integration of PPOR into the County's long-established Infant Mortality Review (IMR) structure and stimulated new community-based investigation. We describe key PPOR Stages utilized in Antelope Valley: (1) Assuring readiness, (2) Data and Assessment, and (3) Strategy and Planning. A description of stakeholders' commitments to improve birth outcomes and monitor infant mortality follows below.

## Description and Assessment

### Stage 1 PPOR: Assuring Readiness

The six stage PPOR Approach starts with community readiness [7]. Peck and colleagues note that the community

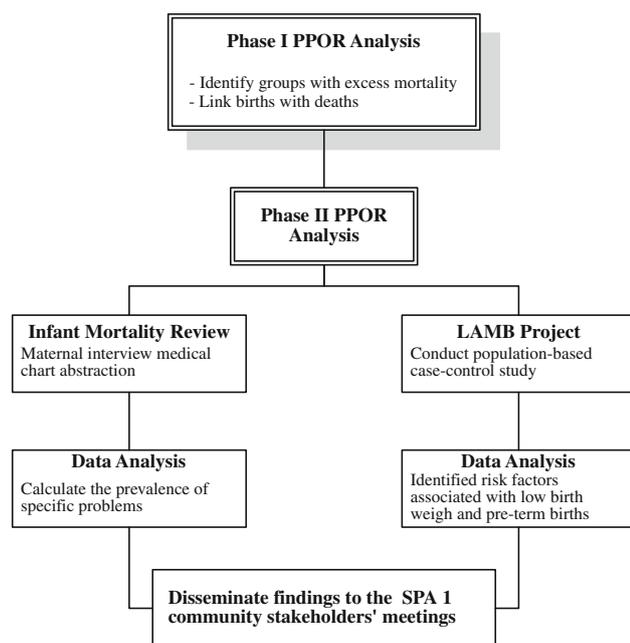
must be ready to undertake PPOR before initiation to assure early community engagement and participation. Community engagement, mobilization, and alignment begin before perinatal health planning. AVPH had been one of the largest community stakeholders in Antelope Valley since 2000 and the local Health Officer of the Department of Public Health had established a long-term working relationship. A task force was convened based on the existing AVPH group to study the increased rate of infant mortality and develop recommendations to improve birth outcomes in Antelope Valley. Members of the task force included (1) community based and faith-based organizations providing social support to pregnant women and their families; (2) local hospital and health care providers; (3) family planning program staff; (4) health care planning staff; (5) county health and social service program staff; (6) local politicians; and (7) local media (newspaper reporters).

At the task force meetings, infant mortality data and recommendations to improve birth outcomes using the PPOR approach were presented. Although a formal community readiness assessment was not conducted, results from several meetings and prior knowledge of the community revealed that sufficient elements were present to ensure the readiness of the Antelope Valley community to engage in PPOR. Successful implementation of PPOR urban communities is most likely when the components of community readiness—reasoning, results, roles, risks and rewards, and resources—are aligned and have shared certainty [8].

In Stage 1 PPOR, once the community is ready to move ahead, an assessment of *analytic* readiness is undertaken to assure public health capacity to carry out PPOR data and assessment methods. Dedicated technical staff working with the Antelope Valley community were ready, willing and able to carry out key Stage 2 PPOR data and assessment steps.

### Stage 2 PPOR: Data and Assessment

As described by Peck et al., and Sappenfield and colleagues elsewhere in this Journal [9, 10], PPOR analytic methods encompass two phases of analyses [7]. In our Phase 1 assessment, we identified the periods of risk with excess fetal/infant deaths. Our subsequent Phase 2 PPOR work explored the reasons for excess mortality in those periods of risk, using (a) an IMR to examine the social and medical factors associated with infant mortality; and (b) a population-based case control study to identify potential risk factors for low birth weight/pre-term births—the Los Angeles Mommy and Baby (LAMB) Project. Figure 2 shows how the two phases of PPOR complement each other.



**Fig. 2** Analytical phases of PPOR used in Los Angeles County, 2004–2005

### Phase I PPOR Analysis

For PPOR analyses, the target group consisted of 2002 live births and fetal deaths, in which the mother was a resident of the Antelope Valley and the fetus was at least 20 weeks gestational age or at least 500 g. Our Phase I parameters differed from the national protocol [9] in several ways, so results are not directly comparable to PPOR results from other communities. We included all infant deaths (rather than infant deaths that were at least 500 g birthweight) and fetal deaths that were at least 20 weeks gestation or 500 g (rather than 24 weeks and 500 g). All infant deaths are reportable in the State of California. Fetal deaths are reportable if the fetus has reached 20 weeks of gestation, or weighs at least 500 g. Therefore, using those parameters, we assume that we have complete reporting for the fetal deaths. In Los Angeles County, analyses using the national protocol, which excludes fetal deaths between 20 and 24 weeks, exclude a disproportionate number of African American fetal deaths, which is a major group of interest in targeting communities with a disproportionate number of poor birth outcomes. For the infant death review, we used the decedent infant's residence for classification because the Los Angeles County 2002 birth cohort dataset was not available at the outset of our investigation. The birth cohort dataset is a cohort of all births during the year, followed for 365 days. We also initially subdivided the Maternal Health/Prematurity Period of Risk by age at death to examine potential concentrations of adverse events.

To estimate the “opportunity gap” in the Antelope Valley, we selected an internal reference group representing the lowest fetal-infant mortality rate for Los Angeles County, composed of all infant deaths and all fetal deaths (>20 weeks *or* >500 g) whose mother was a non-Antelope Valley resident of Los Angeles County and a non-Hispanic White woman over 20 years of age with more than 12 years of education. The analysis compared the target group and the reference group by fetal-infant age categories (fetal, neonatal, and post-neonatal), and by birth weight (less than 1500 g at birth versus 1500 g or more). All cases in which the fetus or infant weighed less than 1500 g were classified as cases in which maternal health and/or pre-maturity was an issue. For those cases that were over 1500 g, the fetal deaths were classified as potential problems with maternal care, the neonatal deaths were classified as potential problems with newborn care, and the post-neonatal deaths were classified as potential problems with infant health. Comparison of the target and reference group rates in the individual cells allowed for determination of the periods of risk in which excess deaths occurred that might have been preventable.

### Phase I PPOR Analysis: Results

There were 53 infant and 31 fetal deaths in the Antelope Valley in 2002. Twenty percent of the mothers were under 20 years of age; 39% were African American, 39% were Latino, and 13% were white. Table 1 compares the demographics of the mothers with infant loss with mothers with live births from the vital statistics data files. The mothers' age distribution and the source and onset of prenatal care did not differ from the distribution of live birth mothers. However, the distribution of race/ethnicity of mothers and multiple-births from the two groups was significantly different.

The overall feto-infant death rate in the Antelope Valley in 2002 was 17 deaths per 1,000 live births plus fetal deaths (Fig. 3). The Maternal Health/Prematurity period of risk, defined by very low birthweight (VBLW), or less than 1500 g at birth, had the highest number of deaths and the highest fractional mortality rate. In this period of risk there were 48 fetal and infant deaths (57% of the total number of deaths) and 9.7 deaths per 1,000 live births plus fetal deaths, respectively.

When compared to a rate of 6.8 for the Los Angeles County reference group (Fig. 3), the total excess rate in the Antelope Valley was 10.2 deaths per 1000. PPOR analysis demonstrated that the highest rate of estimated *excess* deaths was in the Maternal Health/Prematurity period (VBLW fetal and infant deaths, with 5.6 excess deaths per 1000). The second leading period of risk in terms of excess

**Table 1** Characteristics of mothers who experienced infant loss compared with mothers of live birth infants Antelope Valley, Los Angeles County, 2002

	Mothers with infant deaths (N = 51)		Mothers with live births (N = 4903)		Chi Sq P-value	Rate (per 1,000 live births)
	Frequency	%	Frequency	(%)		
<b>Mothers age at delivery</b>						
<20 years <sup>a</sup>	10	20.4	639	13	0.236	15.6
20–34 years	35	71.4	3635	74.1		9.6
>35 years	4	8.2	629	12.8		6.4
<b>Mothers' race/ethnicity</b>						
White	7	13.7	1628	33.2	<0.0001	4.3
Latino	20	39.2	2264	46.2		8.8
Black	20	39.2	825	16.8		24.2
Other/refused	4	7.8	154	3.1		
<b>Medi-cal- paid prenatal care</b>						
Yes	28	54.9	2682	54.7	0.97	10.4
No	23	45.1	2221	45.3		10.4
<b>Type of birth (N = 53)</b>						
Singleton	45	84.9	4755	96.9	<0.0001	9.5
Twin	5	9.4	126	2.6		39.7
Triplet	3	5.6	22	0.5		136.4

Two sets of twins are in the total sample. Therefore, the total N for mothers is 51, while the total N for infant deaths is 53

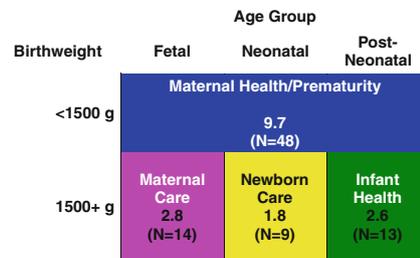
<sup>a</sup> 2 records were missing the mother's age

**Fig. 3** Perinatal Periods of Risk Phase I Analysis of Fetal and Infant Deaths, Antelope Valley, Los Angeles County, 2002.

\* *Reference group*: LA County non-Hispanic white residents aged 20 and above with more than 12 years of education who gave birth or had a fetal death.

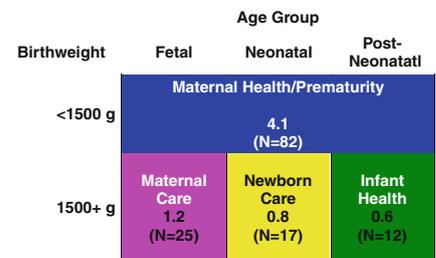
*Data Source*: 1. Birth, Fetal Death, and Death data, California Department of Health Services, Center for Health Statistics, Vital Statistics, 2002. 2. Birth Cohort data, California Department of Health Services, Center for Health Statistics, Vital Statistics, 2002

**Antelope Valley**



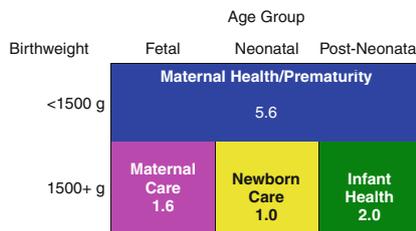
Total fetal/infant mortality rate: 17.0/1,000 (n=84)  
(Total live births + fetal deaths = 4934)

**Reference Group\***



Total fetal/infant mortality rate: 6.8/1,000 (n=136)  
(Total live births + fetal deaths = 20,139)

**Excess Fetal/infant Mortality Rates**



Total Excess Rate: 10.2/1,000

deaths was the Infant Health period (post-neonatal infants who were not VLBW, with 2.0 excess deaths per 1000). These periods of risk were the most important areas to investigate further in Phase 2 analyses, so that goals and target interventions to reduce the incidence of fetal and infant mortality in the community could be identified.

*Phase 2 PPOR Investigations*

Standard Phase 2 analysis consists of determining primary causes for excess mortality, estimating the prevalence of risk and protective factors in the population and calculating population attributable risks for these factors [10].

However, we lacked adequate location-specific data, such as PRAMS or California's Maternal and Infant Health Assessment (MIHA) Survey. The State of California's birth cohort data, containing fetal death and linked infant birth and death certificate data was unavailable; therefore, the Kitagawa analysis could not be performed. In lieu of the standard Phase 2 analysis and based in part on Phase 1 findings, Antelope Valley's Phase 2 investigations utilized results from two readily available data sources to better understand the Antelope Valley's excess deaths. These approaches were an IMR and a population-based survey of mothers who had recently given birth (LAMB).

### Infant Mortality Review

IMR investigations were conducted during the 6 months from July 2004 to January 2005. All 53 infant deaths that occurred in Antelope Valley in 2002 were reviewed using the FIMR protocols approved by the State of California [11]. We excluded fetal deaths from this review due to time and resource limitations. Data were collected by adapting the National Fetal and Infant Mortality Review (NFIMR) instruments and using medical chart abstraction modules that examine prenatal care, labor and delivery, and newborn and infant medical records [12]. When applicable, autopsy records were obtained from the Los Angeles County Coroner's office. Trained Public Health nurses reviewed medical charts and conducted maternal interviews. The Los Angeles County FIMR coordinator abstracted the Coroner's autopsies, the death scene investigations, and the Sudden Infant Death Syndrome (SIDS) Program nursing referral case notes. The FIMR Coordinator also reviewed the medical records abstracts and distilled the information into a case summary form. The data presented in this report are based on the findings from this summary form.

In total, 8 of the deaths were from multiple gestation pregnancies (15%). Of the infant deaths, there were five infants that were a twin and three infants that were a triplet. There were two sets of twins, i.e., both twins died, with 51 mothers for the 53 infant death cases. In the other twin or triplet cases, the remaining births either lived or were fetal deaths and excluded from the IMR. Fifty-two birth records, 35 prenatal care records, 43 labor and delivery records, and 43 newborn records were located and abstracted. In addition, autopsies and SIDS Program investigations provided extensive information, particularly for the post-neonatal infant deaths.

Table 2 characterizes the major findings from the infant death review for all 51 mothers and 53 infant deaths. Among the mothers, 45.1% had a previous fetal loss, 21.6% had their first pregnancy before 18 years of age, and 21.6% had 4 or more live births. Having a previous preterm

**Table 2** Maternal child health findings from infant death review Antelope Valley, Los Angeles County, 2005

Maternal health/prematurity ( $N = 51$ ) <sup>b</sup>	Frequency	%
Preconception health condition		
Previous fetal loss <sup>a</sup>	23	45.1
First pregnancy before 18	11	21.6
4 or more live births	11	21.6
Previous preterm	10	19.6
Previous LBW	9	17.6
Prenatal care issues (PNC)		
PNC started after 12th week	20	39.2
Multiple PNC providers	8	15.7
No prenatal care	5	9.8
Maternal medical conditions during pregnancy		
Obesity	12	23.5
Anemia	7	13.7
Incompetent cervix	7	13.7
Infection	24	47.1
Sexual transmitted infections	6	11.8
Urinary tract infection	5	9.8
Labor and delivery issues		
Placenta problem	21	41.2
Chorioamnionitis	7	13.7
Placental bleed	13	25.5
Premature rupture of membranes	16	31.4
Emergency C-section	11	21.6
Umbilical cord problem	10	19.6
Infant health ( $N = 53$ ) <sup>c</sup>		
Infection	12	22.6
Congenital birth defects		
Listed as cause of death on death certificate	7	13.2
Heart defects	11	20.8
Infant safety issues	11	20.8

<sup>a</sup> Including elective or spontaneous abortion

<sup>b</sup> 51 Mothers

<sup>c</sup> 53 Infants

(19.6%) or low birth weight (17.6%) delivery was common as well.

Major prenatal care (PNC) issues included starting prenatal care after the 12th week (39.2%), having multiple PNC providers (15.7%) and having no PNC (9.8%). Medical conditions that contributed to difficult pregnancies included obesity (23.5%), anemia (13.7%), history of incompetent cervix (13.7%), and infections (47.1%) such as sexually transmitted disease and urinary tract infections. More than 80% (data not shown) of the mothers had labor and delivery complications including problems with the placenta (41.2%) and premature rupture of membranes (31.4%), an emergency Cesarean Section (21.6%), and complications related to the umbilical cord (19.6%).

In the infants, 23% had infections either at birth or later, and 32% had a congenital birth defect. Thirteen percent of the congenital abnormalities were fatal and listed as the cause of death on the death certificates. In the post neonatal infants, safety issues such as having been left unattended and unsafe sleeping positions were documented. Also noted were family and parenting issues related to domestic instability or violence, substance abuse, and lack of supervision.

*LAMB Project*

The LAMB survey includes five domains: preconception health, prenatal care, maternal medical conditions during pregnancy, risk-taking behaviors, and psychosocial factors. Three focus groups of different racial/ethnic composition were conducted to ensure the survey questions were linguistically and culturally appropriate. The survey was translated into Chinese and Spanish; LanguageLine translation services were used for additional languages.

The LAMB surveys were mailed to a random sample of recently delivered mothers living in the Antelope Valley. LAMB followed the CDC Pregnancy Risk Assessment Monitoring System protocol [13], and used proven methods to maximize response rates including tailored cover letters, incentives, multiple mailings and nonrespondent follow-up [14, 15]. Adjusted odds ratios were calculated using logistic regressions to determine the strength of association after controlling for potential confounders: maternal age, education level, race/ethnicity, and marital status. For detail methodologies of LAMB please refer to LAMB website [16].

Three hundred sixty-six women completed the LAMB survey (55% adjusted response rate). Comparisons between survey respondents and non-respondents indicated that they were similar in age, time of entry into prenatal care, and birth outcome. Among survey respondents, 34 had LBW and 67 had PT babies (Cases), and 279 delivered normal birth weight and gestational age babies (Controls). Table 3 shows that the majority of LBW (67.7%) and PT (62.1%) occurred to women between the ages of 20–34. Mothers with less than 12 years of education had more LBW (63.6%) and PT (59.7%) babies than mothers with more years of education.

As shown in Table 4 after adjusting for maternal age, race, education level, and marital status, several risk factors were significantly associated with LBW: previous LBW/PT infant (OR = 5.2, 95% CI = 1.6–16.7), high blood pressure before (OR = 8.7, 95% CI = 1.9–40) and during pregnancy (OR = 4.3; 95% CI = 1.4–13.3), and pregnancy weight gain not falling within the recommended range according to Institute of Medicine 1992 guidelines (OR = 4.6; 95% CI = 1.6–13.2). LBW birth was also associated with smoking during pregnancy (OR = 7.2; 95% CI = 1.6–33.9) and feeling unhappy during pregnancy (OR = 7.6; 95% CI = 2.2–25.8).

Preterm birth was significantly associated with having a previous LBW/PT birth (OR = 3.9; 95% CI = 1.6–9.8), not taking multivitamins before pregnancy (OR = 2.4; 95% CI = 1.1–5.3), and feeling unhappy during pregnancy (OR = 2.3; 95% CI = 1.1–4.9) after controlling for the four socio-demographic factors. Factors such as being uninsured before pregnancy, inadequate prenatal care, unintended pregnancy, and perceived neighborhood as

**Table 3** Characteristics of LAMB survey participants (*n* = 366) in Antelope Valley by low birth weight and preterm birth outcomes, Los Angeles County, 2004

	Low birth weight or preterm				Overall	
	Low birth weight		Preterm		Frequency	%
	Frequency	(%)	Frequency	(%)		
Mothers age at delivery*						
<20 years	4	12.9	7	10.6	44	12.5
20–34 years	21	67.7	41	62.1	257	73.0
>35 years	6	19.4	18	27.3	51	14.5
Marital status when baby was born						
Married	15	48.4	32	49.2	208	58.4
Not married	16	51.6	33	50.8	148	41.6
Mothers' race/ethnicity						
White	5	14.7	10	14.9	112	30.9
Latino	16	47.1	43	64.2	165	45.5
Black	10	29.4	12	17.9	68	18.7
Asian/Pacific Islander	3	8.8	2	3.0	18	5.0
Mothers' education level <sup>a</sup>						
≤12	21	63.6	40	59.7	227	62.5
>12	12	36.4	27	40.3	136	37.5

<sup>a</sup> Excludes mothers under the age of 18 years

**Table 4** Multivariate analysis of LAMB mothers with low birth weight and preterm babies Antelope Valley, Los Angeles County, 2004

	Low birth weight			Preterm		
	<i>P</i> -value	Adjusted OR	95% CI	<i>P</i> -value	Adjusted OR	95% CI
Uninsured before pregnancy	0.41	1.7	(0.5, 5.8)	0.35	1.5	(0.6, 3.5)
Previous LBW/PT infant <sup>a,b</sup>	0.006*	5.2	(1.6, 16.7)	0.003*	3.9	(1.6, 9.8)
High blood pressure before pregnancy	0.006*	8.7	(1.9, 40.0)	0.075	3.7	(0.9, 15.6)
Did not take multivitamin before pregnancy	0.99	1.0	(0.4, 2.8)	0.035*	2.4	(1.1, 5.3)
Inadequate prenatal care <sup>c</sup>	0.61	1.4	(0.4, 5.6)	0.12	2.0	(0.8, 5.1)
Did not meet ideal weight gain <sup>d</sup>	0.005*	4.6	(1.6, 13.2)	0.11	1.9	(0.9, 4.2)
High blood pressure during pregnancy	0.013*	4.3	(1.4, 13.3)	0.37	1.5	(0.6, 3.7)
Ever smoke during pregnancy	0.011*	7.2	(1.6, 33.9)	0.12	2.9	(0.8, 10.7)
Unhappy during pregnancy	0.001*	7.6	(2.2, 25.8)	0.035*	2.3	(1.1, 4.9)
Unintended pregnancy	0.97	1.0	(0.4, 3.0)	0.10	1.9	(0.9, 4.1)
Perceived neighborhood as unsafe	0.13	2.7	(0.8, 9.4)	0.099	2.4	(0.9, 6.5)

<sup>a</sup> These numbers exclude new mothers

<sup>b</sup> LBW/PT = Low birth weight/preterm

<sup>c</sup> Adequacy of Prenatal Care Utilization Index (APNCUI). Includes factors of timing of care and the number of visits

<sup>d</sup> According to IOM 1992 guidelines

<sup>e</sup> >3 weeks before due date

<sup>f</sup> OR = odds ratio

<sup>g</sup> CI = confidence interval

<sup>f</sup> Adjusted for mother's age, race, education level, and marital status

\*  $P < 0.05$

unsafe were not significantly associated with LBW or PT birth.

### Stage 3: Strategy and Planning

After the completion of PPOR Phase 2 analyses, community stakeholders from the initial task force held a half-day meeting to review the newest PPOR findings and develop strategies to improve birth outcomes in the Antelope Valley. All categories of stakeholders were invited to the meeting to ensure broad participation. PPOR was the guiding tool used to organize the meeting. PPOR findings were initially shared, followed by a review of the "From Data to Action" map, in which participants were asked to focus on the areas with the highest excess death rates for potential prevention and intervention strategies. Small group discussions comprised the second part of the meeting. Each group brainstormed to identify potentially effective strategies to improve birth outcomes based on their review of the map.

Results from PPOR analyses were shared with the community at several meetings. Since PPOR Phase 1 identified Maternal Health/Prematurity and Infant Health as having the highest excess rates, the community group followed the "Data to Action" map to identify effective intervention and prevention strategies (Fig. 4). Community

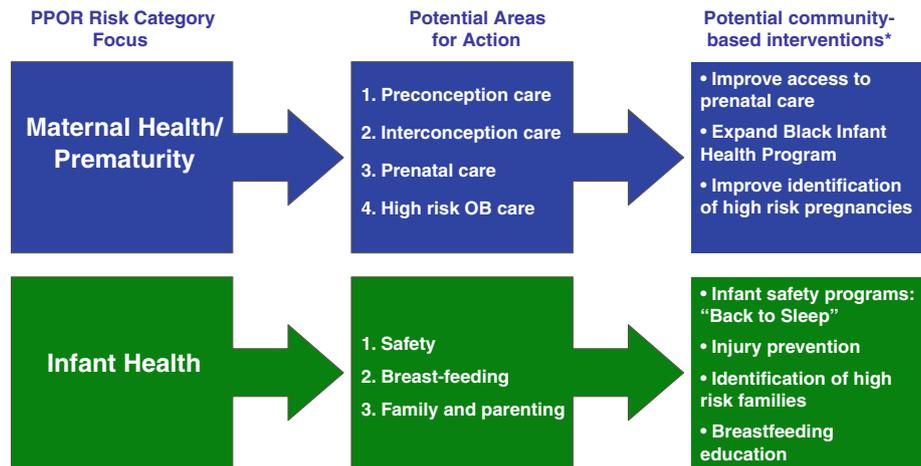
consensus yielded several recommended actions: (1) Seek funding to expand high-risk family support programs for African American women and their families; (2) Improve access to care by helping more women and infants obtain medical insurance; (3) Work with local health care providers to ensure that more African American women and infants will have quality care; (4) Provide education and outreach for African American women regarding healthy life practices; and (5) Further investigate the underlying risk factors contributing to infant mortality in Antelope Valley [17].

Over 40 local agencies, health care providers, the faith community, residents, the Antelope Valley Area Health Office, MCAH Program staff, and staff from the LA Best Babies Network formed the Antelope Valley Healthy Births Learning Collaborative, the Coalition Committee of AVPH to continue promoting healthy birth in Antelope Valley to help implement these recommendations [17].

### Conclusion

In the Antelope Valley area of Los Angeles County, the infant mortality rate in 2002 was more than double the overall county rate. In response, community engagement, readiness and sustained involvement in addressing a public

**Fig. 4** Phase I and II PPOR process: mapping data to community action, Los Angeles County, 2005. \* These potential interventions are an example of a number of proposed solutions that were advanced during several brainstorming sessions with community groups. Eventually, 12 short-term interventions and 4 long-term interventions were identified



health concern in Los Angeles County was facilitated by the PPOR approach. The integration of PPOR analytic methods with the County’s established IMR structure stimulated implementation of the LAMB project, a population based case-control study to investigate factors associated with adverse birth outcomes.

Our successful implementation of the PPOR approach in the Antelope Valley area began with community readiness. Though we did not formally follow the PPOR assessment tool to assess community readiness, the Antelope Valley community demonstrated readiness as recommended by PPOR, including clear reasoning and results of our work, agreed upon roles and associates, risks and rewards, and sufficient resources to do the job. For example, the group reached agreement to adopt PPOR to investigate the infant mortality problem and become part of a newly formed community collaborative, the Antelope Valley Best Babies Collaborative (AVBBC). The AVBBC works with the Antelope Valley Healthy Babies Initiative to improve Antelope Valley perinatal health and improve the quality of services (Reasoning) [18]. Participants understood that the process would require years of commitment from all stakeholders (Results). Key community and religious leaders invited MCAH to present the data and vocally expressed support and commitment to find solutions. There was a collective sense of urgency as participants and leaders reviewed data and took ownership of the problem. Working group meetings were designed to be open and inclusive. Local politicians attended meetings, sent staff, or provided resources for the process (Roles). The situation provided a powerful impetus to implement PPOR. All stakeholders were motivated to find solutions (Risks and Rewards). Working with an engaged, supportive political leadership, the community demonstrated a tremendous ability to build on established relationships to address the problem (Resources).

Our PPOR Phase 1 analysis showed that the Antelope Valley feto-infant mortality rate was 2.5 times the rate of a reference group of infants born to educated, non-Hispanic white women at least 20 years of age who were residents of Los Angeles County. While excess fetal and infant death occurred in all PPOR categories (Fig. 3), 75% were in VLBW neonatal deaths and among the post-neonatal infants who were LBW or normal weight at birth. The PPOR Phase 1 analysis quantified the problem and immediately identified two critical areas for further investigation and potential intervention: maternal health/prematurity and infant health.

It was this community’s readiness to improve birth outcomes that paved the way for speedy completion of PPOR Phase 2 analyses. Within the Maternal Health/Prematurity period of risk, Phase 2 PPOR analyses (IMR and LAMB approaches) concluded that having a previous fetal loss or LBW/PT birth in the past, having inadequate prenatal care, and/or having pre-existing medical conditions, such as obesity or hypertension, contributed to adverse birth outcomes. These findings coincide with existing literature in maternal and child health. Current research shows that prior pre-term births, young maternal age, low pre-pregnancy weight, previous abortion, and uterine and cervical anomalies are related to low birth weight and pre-term births [19]. Additional factors related to pre-term births include in vitro fertilization, multiple gestations, African-American mothers, low socio-economic status, and smoking [20]. We confirmed all the risk factors in the Antelope Valley population except assisted reproductive technology, where good data were not readily available. In addition, LAMB identified high blood pressure during pregnancy to be significantly associated with LBW/PT.

It is notable that about half (43%) of the LAMB respondents reported being depressed during pregnancy. In the IMR, we noted a significant prevalence of depression and anxiety conditions as well, although medical records

probably do not provide a complete assessment of the prevalence of mental health issues. Still, this finding highlights the possible need for additional medical care and social support for mothers who have self-reported postpartum depression.

In the Infant Health period of risk, Phase 2 PPOR analyses, the IMR identified more than 32.1% of the examined infant deaths in Antelope Valley documented congenital birth defects and 23% related to infection, though these conditions were not necessarily listed as the final or contributing cause of death. We noted infant safety issues in 54% of the post-neonatal infant deaths. The area of infant safety has the greatest potential for community-level interventions leading to improvement in infant care, infant safety, and parenting. Subsequent evidence, of the success of programs such as Back to Sleep, car seat usage, and the Antelope Valley Black Infant Health Program in reducing post-neonatal infant death was unequivocal. Therefore, we facilitated the expansion and promotion of existing programs targeting post-neonatal health such as the Antelope Valley Black Infant Health Program, the Back to Sleep program and such safety measures as increasing car seat usage.

While PPOR Phase 1 analysis provided the general direction of where to focus attention, Phase 2 PPOR presented the opportunity to paint a broader and more comprehensive picture of maternal and infant health issues. They allowed the further identification of specific risk and preventive factors and areas to intervene while PPOR Phase 1 analysis provided the general direction of where to focus attention. The IMR provided valuable descriptive information on medical circumstances related to infant deaths. Historically, there has been a lack of data with respect to the lifestyle and risk factors of mothers. Although the IMR collected information on psychosocial conditions during pregnancy, its use was hampered by chart review data limitations. The LAMB survey on the other hand, asked standardized questions of all respondents therefore quantifying health outcomes such as psychosocial conditions in a manner not possible through chart reviews.

The PPOR approach provided an effective framework for the development of community-based strategic actions for targeted prevention. Community leaders identified key areas for intervention and planned activities to address disparities, based on PPOR Phase 2 analysis and the PPOR Data to Action Map.

Community engagement and readiness and stakeholder investment components of the PPOR approach have been institutionalized locally. The Antelope Valley Network for Healthy Families (formerly known as the AVBBC) continues its commitment as a grass roots collaborative, to oversee the monitoring of infant mortality data and

implementation of recommendations. The ongoing network of agencies that supports healthy birth outcomes in Antelope Valley will continue to be the primary point of collaboration and support from the Los Angeles County Department of Public Health, including the MCAH Programs and the Area Health Office for the Antelope Valley [17].

#### Postscript

The initiation of the Antelope Valley Black Infant Health Program in 2002 brought the first infusion of resources to address adverse birth outcomes among African Americans. In 2005, key funders began infusing additional resources into the community, resulting in more case management of high-risk women, better training for nurses and an increased awareness of the need to instruct families on issues such as infant safety and risk behaviors, improved awareness of available resources, and increased family planning services because women who had unplanned pregnancies were more likely to have poor birth outcomes. The Antelope Valley Black Infant Health Program developed a preconception health curriculum and brochure for African-American women in the Antelope Valley. In addition, faith-based leaders came together to incorporate health education to youth within faith-based youth services through a March of Dimes grant. PPOR was a component of the successful grant application. The March of Dimes now encourages *all* grant applicants to include PPOR analyses in their applications, when possible.

It should be noted that while the overall infant mortality rate in the Antelope Valley declined from 10.6 deaths per 1,000 live births to 9.7 per 1,000 live births between 2002 and 2003, the infant mortality rate among African Americans in the Antelope Valley significantly dropped from 32.7 deaths per 1,000 live births to 16 per 1,000 live births during the same period. A possible contributing factor in this reduction was the Antelope Valley Black Infant Health Program. The State of California enacted the Black Infant Health Program to address the high rates of infant mortality and adverse birth outcomes among African Americans. The Black Infant Health program provides care coordination, education, and social support services to pregnant and parenting African American women who are at risk of a poor birth outcome. It operates in 17 local jurisdictions in the State of California; the Antelope Valley Program was initiated in 2002 [5, 17]. Analysis of 2004 and 2005 data showed that infant mortality among African Americans in the Antelope Valley continued to decline after implementation of PPOR, from 14.3 deaths per 1,000 live births (12 cases) to 9.5 per 1,000 live births (9 cases).

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