From Data to Action

A Background Paper on Infant Mortality in Arkansas

Arkansas Department of Health

March 2012

Acknowledgements

The primary author, Richard R. Nugent, MD MPH, expresses appreciation to many individuals who participated in the development of this background paper, *From Data to Action.* The paper, an attempted overview of statewide activities, would have been impossible without the rich networks of communication among all the involved parties that so strikingly unfold in Arkansas.

Paul Halverson, DrPH, Joseph Bates, MD MS and the Executive Staff of the Arkansas Department of Health established infant mortality reduction as a priority for the Agency's strategic plan. The Health Statistics Branch provided the Arkansas data and a great deal of statistical support in analyzing it. In the Family Health Branch, David Grimes, MD MPH, Bob West, MD MPH, and Bradley Planey, MS MHA, carried the lion's share of integrating the efforts of state programs for mothers and children. Many program directors in the Department, especially those in MCH programs, shared their expertise describing Arkansas activities that add to the state's efforts to reduce infant mortality. Also at ADH, Terri Wooten, MPH provided epidemiologic and statistical support for the analysis. Cindy Brown coordinated countless meetings and shared minutes for many contributory forums. The question and answer format and section headings for the paper were developed by the Science Advisory Council.

At the University of Arkansas for Medical Sciences, College of Medicine, Department of OBGYN, additional assistance was provided by Curtis Lowery, MD, Chair, who supported the effort financially; by Janet Bronstein, PhD and members of the ANGELS Evaluation Team who reviewed various draft versions of the documents; by T. Mac Bird, PhD, who performed the statistical significance testing for both papers; and by Donna Eastham, BS who provided administrative assistance.

At the Department of Human Services, Division of Medical Services (Medicaid), William Golden, MD provided important information regarding the many activities of Medicaid in addressing infant mortality in Arkansas, and continues to play a statewide role in bringing issues of perinatal health into health care reform planning.

At Arkansas Children's Hospital, Jonathan Bates, MD provided statewide leadership for child health systems of care through the Natural Wonders Planning Council and gave generous support to the issue of infant mortality within that overview. Mr. Scott Gordon provided administrative leadership in coordinating many grant applications initiated in both Children's Hospital and the Department of Health. Mr. Fidel Samour made major contributions through organizing meetings of the Natural Wonders Council, especially those relating to infant mortality.

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Executive Summary Part I: The Data

Infant health improves if the *number* of deaths goes down. Health also improves if the infant mortality *rate* goes down. In addition, health also improves if the *percentage* of birth with complications and high-risk factors goes down. When the percentage of births with a high risk factor goes down, prevention has helped. When the infant mortality rate associated with a specific risk factor goes down, better medical care has been given. This document compares data from 2003 (a high death rate year) to calendar year 2009 (the latest). That selection of years was made to study the observed decline between those years.

<u>The good news:</u> (See Figures S1, S2 and S3)

A smaller *number* of deaths occurred to babies who:

- Were born before 28 weeks or weighed less than 1000 grams (2.2 pounds), or
- Had birth defects.

Importantly, fewer African American babies died within the first month of their lives.

Mortality *rates* declined* (better care was given) for babies who:

- Were born before 28 weeks or weighed less than 1000 grams,
- Had birth defects, or
- Were born to mothers who had no prenatal care.

Importantly, the death rate declined for African American babies during the first month of life. The death rate decline for African American births was accompanied by reduction in the disparity in infant death rate between Black and White births.

Smaller *percentages* of births with certain risk factors occurred (better prevention) for babies who:

- Were born before 28 weeks or weighed less than 1000 grams,**
- Had birth defects, or
- Had a wide variety of other relatively common conditions.

<u>The concerns:</u> (See Figures S4, S5 and S6)

- Babies who were born between the start of the 32nd and the end of the 36th week of pregnancy increased in number and percentage. The death rate for these babies failed to decline.
- Babies who weighed 1000 to 1499 grams (2.2 to 3.3 pounds) increased in number and percentage. The death rate for this group also failed to decline.
- Babies whose mothers began prenatal care early in pregnancy decreased in number and percentage.

<u>On balance:</u>

- Infant health has improved over all, but prematurity is still a growing problem for a small group of babies, and early prenatal care needs attention.
- Many public and private efforts to improve the health of pregnant women and infants are already at work or are planned.
- Arkansas should keep striving toward improvements in both prevention of and better medical care for premature births.

* Though not always with statistical significance

** For births < 28 weeks or 1000 grams, the numbers, rates *and* percentages improved.

Figures, Part I

The Good News

Figure S1.

DECLINES IN THE NUMBERS OF DEATHS

A. Babies born before 28 weeks of gestation

Year	Infant Deaths
2003	148
2004	113
2005	115
2006	124
2007	126
2008	118
2009	99

B. Babies born weighing less than 1000 grams

Year	Infant Deaths
2003	121
2004	99
2005	83
2006	104
2007	80
2008	86
2009	84

C. Babies with birth defects

Year	Infant Deaths
2003	53
2004	45
2005	36
2006	40
2007	27
2008	41
2009	31

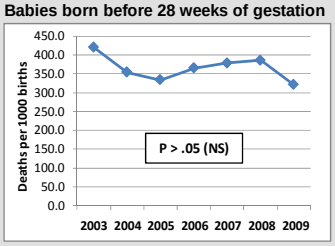
D. African American Newborns

Year	Newborn Deaths
2003	63
2004	56
2005	73
2006	76
2007	69
2008	62
2009	51

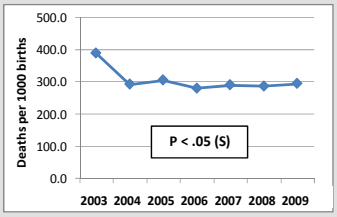
Figure S2.

DECLINES IN THE MORTALITY RATE

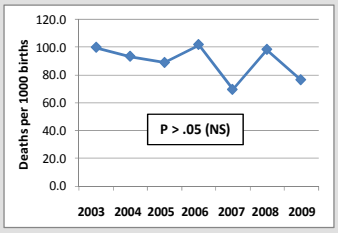
A. Babies born before 28 weeks of gestation



B. Babies born weighing less than 1000 grams



C. Babies with birth defects



D. African American Newborns

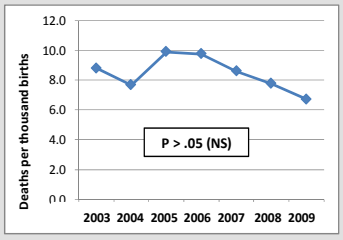
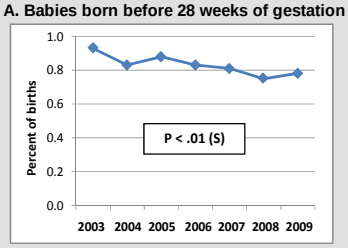


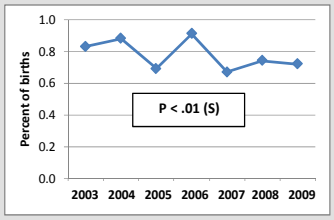
Figure S3.

DECLINES IN THE PERCENTAGE OF BIRTHS AT RISK

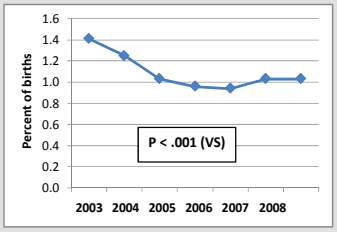
A. Babies born before 28 weeks of gestation



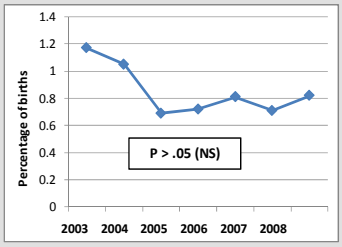
B. Babies born weighing less than 1000 grams



C. Babies with birth defects



D. African American Newborns with Birth Defects



Notes on statistical significance

1. At state level, numbers of births are large and numbers of deaths are relatively small, so trends in births at risk tend to be statistically significant, whereas trends in deaths may be not significant or borderline.
2. Apart from statistical significance, a steady secular trend such as seen in Figure S2, D is still of program significance. It is likely that when national data comparing states on this trend are available, many other states will be showing the same trend, and when aggregated over the US, the trends will be statistically significant.
3. S = significant NS = not significant VS = very significant

Figures, Part I (Continued)

The Concerns

Figure S4.

INCREASES IN THE NUMBERS OF DEATHS

A. Babies born during the 32nd to 36th week

Year	Infant Deaths
2003	42
2004	49
2005	52
2006	60
2007	46
2008	42
2009	53

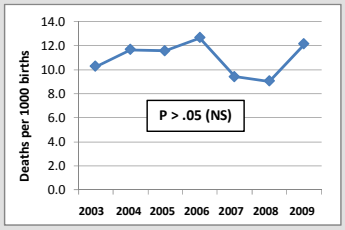
B. Babies born weighing 1000-1500 grams

Year	Infant Deaths
2003	12
2004	20
2005	21
2006	26
2007	15
2008	24
2009	22

Figure S5.

DEATH RATES NOT DECLINING

A. Babies born during the 32nd to 36th week



B. Babies born weighing 1000-1500 grams

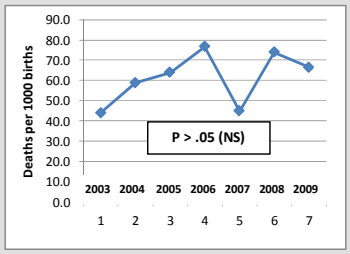
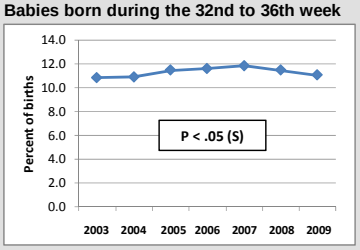


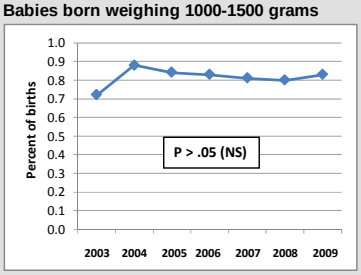
Figure S6.

INCREASES IN PERCENTAGE OF BIRTHS AT RISK

A. Babies born during the 32nd to 36th week

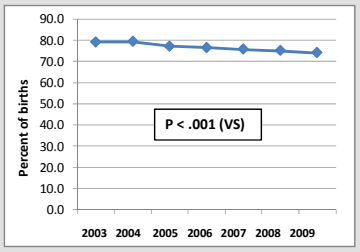


B. Babies born weighing 1000-1500 grams



DECREASES IN EARLY PRENATAL CARE STARTS

Babies with first trimester prenatal care



Executive Summary Part II: The Recommendations

A Menu of Recommended Activities

1. **Direct Services:**

   a. Through quality improvement initiatives, regionalize perinatal care by:
   - Defining three levels of perinatal hospital care in state policy & designating hospitals by level
   - Promoting appropriate referrals through professional education and public awareness
   - Building a reimbursement system that will incentivize good perinatal outcomes

   b. Through a quality improvement initiative, assure appropriate use of labor inductions and cesarean sections to avoid unnecessary premature delivery

   c. Enhance professional education regarding
   - Screening, consultation and referral of high risk pregnant women and infants
   - Flu shots in pregnancy
   - Giving progesterone to prevent preterm birth

2. **Enabling Services:**

   a. Enhance prenatal care in more communities by implementing "Centering Pregnancy."
   b. Enhance prenatal care in more communities by implementing prenatal care coordination
   c. Enhance pre/postnatal care in more communities by using evidence-based care models.
   d. Continue enhanced post neonatal care in a project called "Following Baby Back Home."

3. **Population Based Services**

   a. Enhance Family Planning services with pre- and inter-conception health counseling.
   b. Continue the Women's Health Waiver or even expand the Waiver if health care reform allows.

4. **Infrastructure**

   a. Expand community based efforts for public awareness
   - Sudden infant death syndrome
     - o "Safe Sleep Saves Lives"
     - o Infant death scene investigations
   - Infant death reviews
   - Injury prevention ("First Ride, Safe Ride")
   - Early Prenatal Care ("Healthy Baby/Happy Birthday Baby Book")
   - Teen Pregnancy Awareness and Prevention, community based efforts
   - Neural Tube Defects Prevention (Folic acid awareness)
   - Obesity Prevention
     - o Nutrition and physical activity campaigns (School and community based)
     - o Professional education of doctors *re* successful weight-loss interventions
   - Smoking screening and referral

   b. Expand state level efforts to support community based activities
   - Infant death scene investigations and infant mortality reviews
   - Injury prevention for infants (Safe Motherhood)
   - Tobacco Cessation and Prevention
   - Obesity prevention

   c. Continue the ADH Statewide Health Plan Priority to coordinate all the above activities (IMAG)

   d. Continue the Pregnancy/NICU Payment Improvement Initiative led by DHS and Medicaid

From Data to Action, March 2012

I. What is infant mortality?

An infant death occurs when a live born baby dies before its first birthday. The infant death rate, commonly called the infant mortality rate, is the number of infant deaths in a year per 1000 live births. Epidemiologists define infant deaths as "neonatal" (occurring in the first 28 days of life) and "post-neonatal" (occurring in the next 11 months.) Rowley and colleagues at CDC discussed neonatal and post-neonatal mortality using national data and examples of several states.[1] (See Endnotes.) Although congenital anomalies are prominent among infant deaths at any age during the first year, neonatal deaths are more commonly caused by prematurity and medical complications of the pregnancy and newborn periods; while post neonatal deaths are due to sudden infant death syndrome, unintentional injuries and diseases of the post-neonatal period.

II. Why is infant mortality a public health priority?

Every infant death is one too many. For a family it is a tragedy and for communities it represents the loss of a lifetime of productivity. The infant mortality rate of a nation or state is frequently in the news because it is recognized as an important indicator of a community's overall health. The most important single cause of infant death is prematurity, being born too soon or too small. "Too soon" means before 37 weeks of pregnancy and "too small" means weighing less than 5½ pounds at birth. In fact, nearly all mildly premature babies survive, but the most severely premature may die or go on to survive at great health care expense, some of whom still suffer life-long disabilities. With infant mortality rates twice that of whites, African American babies experience the most excess deaths.

III. What is the magnitude of infant death in Arkansas and has it changed in recent years?

In calendar year 2009, 290 babies died before their first birthday, for an infant mortality rate of 7.3 deaths per 1000 live births.[2] The provisional rate for 2010 was 7.0.* The infant mortality rate trend for Arkansas is shown in Figure 1 as it compares to the US trend. The National Center for Health Statistics reported a 2005-2007 combined infant mortality rate for Arkansas as 6.8.[3] That rate ranked Arkansas as 8th highest among all states, with only 7 states having worse rates. In 2006 the US, at 6.7, ranked worse than 31 other developed nations.[4] In 2009 the Arkansas neonatal death rate was 4.1 per thousand births, and the post-neonatal death rate was 3.2. These rates are compared to those for the US in Figure 2. Arkansas's neonatal mortality rate was close to that of the nation (in fact slightly below for this year); but the state's post-neonatal mortality was considerably higher than the US rate. The most frequent causes of neonatal death in 2009 appear in Figure 3, and those for post-neonatal death in Figure 4. The most commonly cited cause of infant death, low weight birth (less than 5.5 pounds or 2500 grams), had trended upward in Arkansas until 2004, but leveled thereafter. That trend appears in Figure 5. The trend for very low birth weight (less than 1,500 grams or 3.3 pounds) also increased slightly until 2004 then declined slightly until 2009. See Figure 6.

The burden of infant death was not shared equally among Arkansas residents. The distribution by county of five-year infant mortality rates is mapped in Figure 7. Higher rates occurred in counties with rural, poor and minority populations, especially in the Mississippi Delta, a longstanding situation. Figure 8 shows a significant improvement in African American (AA) infant death rate, explained by a decline in AA neonatal mortality rate in Figure 9. However in Figure 10, the trend for AA post neonatal death rate was "flat." Black infants die at greater rates than whites in part because their low birth weight rates are twice as high, as shown in Figure 11. Black neonatal mortality declined more rapidly than black post-neonatal mortality suggesting better care for premature AA infants.

* Provisional as of March 15, 2012

IV. What does science tell us about infant mortality?

A. General considerations

Influences leading to infant death are many and complex. They range from broad national economic[5] and lifelong issues,[6] to general maternal risk conditions/behaviors, structural obstetric conditions, obstetric history, chronic diseases and disorders, infectious diseases, and infant-related conditions.[7] This paper explores a narrower range of evidence that can be scientifically assessed by reviewing the classified causes of death reported on infant death certificates, reviewing medical complications and other risk factor data reported on birth certificates, and developing discussions of the medical and social literature around selected topics of importance related to infant death.

Taking a broad look at biomedical sciences, researchers are investigating at least ten broad questions related to infant death and preterm birth. From causes most proximal to the infant death to those that are more distant, they include: 1) the epidemiology of SIDS, [8,9] 2) unintentional injury and homicide,[10] 3) the causes of preterm and low weight birth,[11] 4) the physiology of labor and patho-physiology of preterm labor,[12] 5) the patho-physiology of pre-eclampsia[13,14] and attempts to prevent it,[15,16,17] 6) the nature and effects of stress and depression during pregnancy,[18,19] 7) intimate partner violence,[20] 8) obesity,[21] 9) gene-environment interactions,[22,23] and 10) racial disparities in pregnancy outcome.[24]

B. Classified causes of death reported on Arkansas infant death records and their management

The International Classification of Diseases is a comprehensive taxonomy of medical conditions used to assign causes of death. For infants these causes include 1) sudden infant death syndrome (SIDS), 2) congenital anomalies (heart and neural tube defects), 3) serious illnesses in the newborn due mostly to prematurity (respiratory distress syndrome, neonatal hemorrhage and sepsis), and 4) unintentional injuries, due mostly to automobile accidents. SIDS is diagnosed only when other causes of death are ruled out by autopsy, and a thorough death scene investigation reveals no evidence of environmental or intentional causes. SIDS presents as a sudden death of unknown cause, so treatment is rarely possible. The physiologic cause of death in SIDS is not well understood. Besides safe sleeping environments, little is known about preventing SIDS. In contrast, the other direct causes of infant death are often amenable to intensive medical care. The medical disciplines of neonatology and pediatric surgery are available at major medical centers in Arkansas. Recently, Arkansas has begun to develop a statewide system of trauma care that should help to reduce infant deaths due to unintentional injuries. Intensive care services are referred to as “tertiary prevention,” understood as intervening in cases of serious illness and injury to prevent death.

C. High-risk factors reported on birth certificates and their management in Arkansas

Well-known risk factors collected from linking birth and infant death records are helpful in identifying community-based services that show some evidence of making a difference. The most commonly studied birth certificate risk factors are listed in Figure 12 for the years 2001-2009. The risk factors are grouped as 1) gestational age, 2) birth weight, 3) birth defects, 4) twins and triplets, 5) prenatal care start, 6) medical complications of labor and delivery, 7) maternal age, 8) medical condition during pregnancy, 9) race and ethnicity, 10) smoking, 11) marriage, and 12) education. Figure 12 indicates these numbered groupings in the left hand column. Figures 13 and 14 show the numbers, percentages and rates for births and deaths for 2003 and 2009. The paragraphs below all refer to Figures 12 through 14 in their explanations. These tables arrange risk factors in groups of measures. Within each group the measures are listed from highest to lowest infant mortality rate. Then the groups are listed in the order of mortality rate for the measure of greatest risk within it. The risk factors of highest risk are highlighted in red, followed in order of descending risk highlighted in orange, yellow and white. For stability, the ranges of infant mortality rate assigned to the various colors were determined by reviewing the risk factors for calendar years 2001-2009 taken together. The paragraphs below contain statements

of program efforts within Arkansas to address these factors; and also indicate trends over time between 2003 (a peak in infant death rate during the last decade) and 2009 (the latest finalized data available for detailed analysis).

Knowledge of medical complications challenges health care providers to identify them before or early in pregnancy and apply clinical interventions to reduce their impact. This process is called "secondary prevention." Intervening before the onset of any medical high risk factor (keeping people healthy) includes "primary prevention" (health care services) and "health promotion" (public awareness and life style change). Racial and ethnic disparities in infant mortality arise from profound differences in US life. Much research is devoted to understanding the causes of disparities in hopes that primary prevention can make a difference. Recent work has shown that the use of 17 alpha-hydroxyprogesterone (secondary prevention) can reduce preterm birth in women with a previous preterm delivery, and now micronized progesterone is being used for those with a shortened cervix. See part C1 of this section. Documentation of the effects of these treatments at the community level is just beginning. Yet spontaneous preterm labor remains frequent, because early delivery arises from a bewildering complexity of patho-physiologic, psychosocial, and health system issues. Addressing this broad causation requires resources that go beyond the clinical health care system. Using combined community approaches, as described by Aquino in Brazil[25], may work better, and is further described in section VI of this background paper.

Arkansas infants born in 2009 at gestational ages less than 28 weeks ("extremely" preterm births) had a mortality rate of 320.4, the highest in Figure 14. That rate compares to 7.3 for all Arkansas births. "Very" preterm births (28-31 weeks) had an infant mortality rate of 36.5, and "moderately" preterm babies (32-36 weeks) had a rate of 12.1. Those rates compare to 3.4 for those born at term (37-41 weeks). Curtis L. Lowery, MD and R. Whit Hall, MD at UAMS direct the ANGELS (Antenatal and Neonatal Guidelines, Education and Learning Systems) program to assure that mothers in labor at these very early gestational ages are referred for delivery to hospitals with neonatal intensive care units. Providing consultation for both obstetrical and neonatal care, ANGELS operates from the UAMS Departments of Obstetrics and Gynecology (OBGYN) and Pediatrics with funding and regulatory guidance from Medicaid in the Department of Human Services.[26] The program helps doctors identify medical complications of pregnancy and seek consultation when needed. ANGELS consultation and referral services are enhanced by conferences and consultations over telephone and television hookups. ANGELS has a telephone hotline for doctors and patients (the Call Center) that answers questions and arranges consultations and other services like smoking cessation. ADH works in partnership with UAMS in this program, referring the high risk women seen in the public health clinics to these services. ANGELS, as a DMS-UAMS partnership, includes consensus guidelines for high risk perinatal care, telehealth consultation sites for high risk pregnant women in rural areas, televideo continuing medical education activities to disseminate evidence based guidelines for care, and research on perinatal risks and outcomes. ANGELS is a model for other states in using telemedicine. A comprehensive program evaluation is now under way as described in section VIII of this paper.

Regarding preterm births Arkansas data show that between 2003 and 2009 the number and percentage of births before 28 weeks (extremely preterm) declined from 353 (0.9%) to 309 (0.8%). This decline in prevalence represents better prevention. Regarding extremely preterm deaths, the number and percentage declined from 148 (44.6%) to 99 (34.1%), and the extremely low gestational age specific mortality rate declined from 419.3 per thousand to 320.4. These declines in deaths and death rates reflect better care. While extremely preterm births declined, the number and percentage of births at 32 to 36 weeks (moderately preterm) actually grew. In 2003, 4093 moderately preterm births occurred, comprising 10.8% of all births. In 2009, the number and percentage rose to 4374 and 11.0%. The increase in prevalence of moderately preterm births is a disturbing trend because the number and percentage of deaths increased from 42 (12.7% of infant deaths) to 53 (18.3%). Further, the gestational age specific mortality rate for these moderately premature babies increased from 10.3 to 12.1.

The increasing numbers reflect worsening prevention and care, and put "upward pressure" on the state's infant mortality rate. Note that the overall decline in infant deaths in Arkansas between 2003 and 2009 actually hides the unfavorable trends for moderately preterm births. In fact, the increase in moderately preterm births outnumbers the decline in extremely preterm births. The result is a slight increase in overall preterm birth rate from 12.99 in 2003 to 13.04 in 2009. Growing preterm birth rate, a long-term trend, is discussed below in part C1 of this section.

Arkansas infants with birth weights less than 2.2 pounds (1000 grams) ("extremely" low weight births) in 2009 had a mortality rate of 293.7, the next highest rate in Figure 14. Currently Arkansas is working to regionalize the care of these babies. Providing professional education and consultation, and assisting with stabilization and transport can increase the number served in hospitals with neonatal intensive care units. Cifuentes *et al* showed that infants with low birth weight under 2000 grams, and especially under 1500 grams have better survival when they receive neonatal intensive care in larger regional centers with more extensive experience in serving these tiny babies.[27] ANGELS develops and promulgates evidence-based guidelines for physicians, and helps with stabilization and transport of very low weight babies to neonatal intensive care services. The number and percentage of births under 1000 grams fell from 312 (0.8%) in 2003 to 286 (0.7%) in 2009, reflecting better prevention. The weight specific mortality rate for these extremely low birth weight babies declined from 387.8 per thousand to 293.7, marking improvements in care. However, like moderately preterm births, those at very (but not extremely) low weight (1000 to 1499 grams) actually increased in prevalence from 7.2 in 2003 to 7.3 in 2009. Also, babies weighing 1000 to 1499 grams experienced a weight specific mortality rate rise from 44.0 to 66.5, confirming the unfavorable trends in preterm births. The significance of these unfavorable trends is further assessed by detailed regression analyses to sort out the impacts of socio-demographic change as well as completeness of care. Those analyses are presented in Figure 12. A discussion of the literature on low weight birth, along with preterm birth, appears in part C1 of this section.

Arkansas infants with birth defects had a mortality rate of 76.2 in 2009. Better prevention of birth defects (congenital anomalies) has been sought for many years. Between 2003 and 2009 the number and percentage of Arkansas births with any congenital anomaly declined from 532 (1.4%) to 407 (1.0%). The decline was also prominent among AA births. The mortality rate for AA defects dropped from 99.6 per thousand to 66.5 (not shown in the table), a gratifying trend. Which birth defects declined and why? Further study is needed to provide these answers. A brief discussion of the literature on birth defects appears in part C2 of this section.

Arkansas Twins, triplets, and higher multiples of births are at great risk**.** Arkansas triplets had an infant mortality rate of 66.7 in 2009 and for twins it was 26.3. Fortunately, the factor specific mortality rate for triplets dropped from 204.5 in 2003 to 66.7 in 2009, and for twins from 36.0 to 26.3. While the numbers of births and deaths for triplets are small (and thus rates are unstable), the numbers of births and deaths for twins are larger and their trends are more convincing. As part of the moderately preterm birth rate rise, multiple pregnancies had been increasing as more people took advantage of assisted reproductive technology (ART) services. Between 2003 and 2009, the number of triplet deliveries in Arkansas declined from 44 to 30 and the number of triplet infant deaths dropped from 9 to 2. The number and percentage of twin births actually rose from 1,082 (2.9) to 1,179 (3.0), but twin infant deaths dropped from 39 to 31. Taking twins and triplets together, this risk factor specific mortality rate declined from 42.6 to 27.3. These data reflect better care. The rise in twins (98) contributes only about a third to the rise in moderately preterm births (291). Part C3 of this section carries a discussion of multiple births and ART.

Arkansas infants whose mothers had no prenatal care had a mortality rate of 22.1 in 2009, compared to 7.3 for all births, and 6.8 for those with prenatal care. Between 2003 and 2009, the percentage of births with no prenatal care declined slightly from 1.6 to 1.5, and the infant mortality rate for mothers without prenatal care actually declined from 43.3 to 22.1. The numbers of these deaths declining from 27 to 13 is important and probably reflects the declines in extremely preterm and low weight births. ADH Local Health Units (LHUs) have for a long time provided publicly subsidized

prenatal clinics. As of November 2010, 58 LHUs in 56 counties provided these services, increasing from lows of 54 sites and 51 counties in the middle of the decade. The Medicaid Program has provided statewide pregnancy coverage for women with incomes up to 200% of poverty since November 2002 and coverage for Hispanic immigrants since 2003. The favorable trend in births with *no* prenatal care probably reflects these program developments. However, despite these efforts, the Arkansas trend for *early* (first trimester) prenatal care is getting worse, as shown in Figure 15. The percentage of births with first trimester care declined from 79.1 in 2003 to 74.0 in 2009, a finding of concern. Like the trends for moderately preterm and very low weight births, this trend is hidden within the overall decline in infant mortality for the state. A discussion of the literature on prenatal care appears in part C4 of this section.

Arkansas infants whose mothers experienced medical complications of labor and delivery had an infant mortality rate of 13.4 in 2009, down from 17.0 in 2003, reflecting better care. The number and percentage of such births declined from 11,421 (30.2) to 11,052 (27.9) reflecting better prevention. Board certified specialists in family practice who have had additional training in obstetrics, and certified specialists in obstetrics and gynecology are trained to handle most of these complications. Most infants in Arkansas are born in hospitals delivering over 500 babies a year by specialty-trained physicians. ANGELS supports better quality of care in these services through medical education, evidence based clinical consensus guides, consultation and referral. Outcomes for women with medical complications are discussed in part C5.

Arkansas infants whose mothers were 40 years of age or older when they delivered had a mortality rate of 12.6 per thousand in 2009, down from 14.3 in 2003. The number and percentage of these births declined from 488 (1.3%) in 2003 to 477 (1.2%) in 2009. These data suggest that more women are opting not to have babies later in life, and those that still bear children at that age are experiencing better infant survival. Figure 16 shows that for older mothers 35-44, the percentage of births has been "flat," but may have dropped in 2009. Figure 18 shows that the mortality rate trend for older mothers had been "flat" until recently. See part C6.

Arkansas infants whose mothers had at least one medical risk factor in the prenatal period had an infant mortality rate of 11.4 per thousand in 2009, down from 12.5 in 2003. Figures 13 and 14 show that the percentage of these births declined from 24.1% in 2003 to 23.1% in 2009. If reporting of medical conditions is consistent from year to year, these trends reflect a lower risk prenatal population. It is known that birth certificates under-report medical conditions. Classically, the medical illnesses of refractory anemia, urinary tract infections, hypertension and diabetes; and pregnancy complications like severe pre-eclampsia, fetal growth restriction, and premature rupture of the membranes before 34 weeks are addressed by efforts to enhance regionalized consultation and referral. As ANGELS telemedicine sites have increased, more distance consultations are occurring. However, consultation and referral rates in Arkansas need improvement. Please return to part C5 for further discussion.

Arkansas African American non-Hispanic infants experienced an infant mortality rate of 11.3 in 2009, down from 13.7 in 2003. Disparities in mortality rate between African American and Caucasian infants in this state are discussed above and mapped in Figure 7. African American (AA) infant mortality rates twice that of whites had occurred in Arkansas over the years until recently. Nationally, CDC has shown that disparities of this magnitude have been experienced for decades, for the total US population and the states[28] and for cities.[29] Since 2003, the Arkansas infant mortality rate for AA births dropped more quickly than that for Caucasian births, so the disparity in infant mortality rates between the races declined. That was unexpected, because of the duration and widespread nature of this comparison. Among African American infant deaths, the decline was most striking for neonatal deaths. Among neonatal deaths, those with birth defects declined. A special discussion of racial disparities is presented below in part C7.

Arkansas infants born to mothers who smoked more than a pack of cigarettes per day had an infant mortality rate of 10.2 in 2009, down from 11.6 in 2003. The Arkansas Department of Health has a special quit-line program for pregnant women and a pilot financial incentive project encouraging

pregnant tobacco users to quit. The STOP outreach program focuses on providers to ask, advise and refer smokers. As reflected in birth records, there has been a gradual decline in the percentage of mothers who reported smoking during pregnancy. ADH prenatal clinics and other providers of prenatal care are working to find and refer pregnant smokers. Between 2003 and 2009 the number and percentage of births to women smoking more than one pack per day dropped from 1,385 (3.5%) to 1,173 (3.0%), reflecting large efforts at helping women to quit smoking before and during their pregnancies. The literature on smoking in pregnancy is growing, and several indicative studies are discussed in part C8.

Arkansas infants whose mothers were 15 to 19 years old had an infant mortality rate of 9.1 per thousand in 2009, down from 11.8 in 2003. Teen birth prevention is a major priority for the Arkansas Department of Health. Eighty percent (80%) of these births are "unintended" as defined by PRAMS survey questions. Teen sexual activity as reported in Youth Behavior Risk Surveys (YRBS) has not declined since 2000.[30] Figure 16 shows that the percentage of all births that occurred to teens (the teen birth fraction) declined slightly from 14.8% in 2003 to 14.5% in 2009. Teen birth rates, shown in Figure 17, declining from 2000 to 2005, have remained level since then. Figure 18 shows that the decade-long infant mortality rate trend for teen births has been "flat," though the drop from 2007 to 2009 seems encouraging. Targeting teens, Arkansas has pursued special community-based projects for Abstinence Education ("abstinence only") and Unwed Birth ("abstinence plus"). Weed and colleagues (*et al*) conducted a rigorous evaluation of Arkansas's Abstinence Education projects showing only temporary impacts on sexual activities and intentions in self-report studies. An initial favorable impact on a series of beliefs, intentions and behaviors measured by self-report, returned to previous levels a year beyond the ending of the educational contacts.[31] No attempts were made to count teen pregnancies in these projects. National studies of adolescent birth prevention are discussed in part C9.

Mothers who were not married at the time of the birth had an infant mortality rate of 8.5 in 2009, down from 12.0 in 2003. The number and percentage of such births actually rose fairly dramatically from 14,353 (38.0%) to 18,015 (45.4%) continuing and accentuating a long-term trend. The number of infant deaths to unmarried couples declined from 172 in 2003 to 154 in 2009, again implying better care. Rather than marriage, some epidemiologists are looking at the presence of a father's signature on the birth record as evidence of paternal support. See part C10.

Births to mothers who had less than a 12th grade education have, as a rule, experienced significantly higher infant mortality rates. Where Arkansas numbers were large enough in a single year to be meaningful, educational factors retained a risk impact, but it was small. Between 2003 and 2009, births to mothers with less than a 12th grade education declined in number and percentage from 8272 (21.9%) to 7897 (19.9%), consistent with many other declines in the prevalence of risk factors for Arkansas births. Deaths among those with low education declined from 96 to 56, mostly better care.

Obesity as a diagnosis is not reliably recorded in birth records. An opportunity to record height is not present in the old national birth certificate model that Arkansas will be using until either the start or end of CY 2012. However, both measurements are available in PRAMS, and the medical literature discusses obesity as an important risk factor. See part C 11 for this discussion.

Post neonatal mortality in Arkansas is reliably reported on infant death records. Though the largest component of infant mortality in Arkansas is death during the first month of life (neonatal mortality), never the less, it is Arkansas's post neonatal mortality rate that exceeds the US rate to a larger degree. Post neonatal mortality causes are first SIDS, then birth defects, then illnesses during the last eleven months of infancy. As a component of Arkansas's renewed efforts at home visiting, the "Following Baby Back Home" project is managed by the UAMS Department of Pediatrics and emphasizes follow-up care for high risk and vulnerable infants. It provides family supports for infant visits to the primary care physician, complete immunization, minimizing hospitalizations for preventable illnesses, assessment of developmental progress, and monitoring of family function. It also offers opportunities to educate about safe sleep and car safety seats.

D. Discussions of the medical literature by birth certificate risk factors and national examples of interventions that show promise

1. Low weight and preterm birth

Regarding low weight birth, Moore, Michielutte, Meis and colleagues in the northwestern region of North Carolina developed a population-based study of low birth weight birth, referenced above.[11] They described premature birth as having four major groupings of cause called "proximal etiologies": term low birth weight, preterm premature rupture of the membranes, medical complications and idiopathic preterm birth. *Term low birth weight* was diagnosed upon delivery if the baby was born after 37 weeks and weighed less than 2500 grams (5.5 pounds). *Preterm premature rupture of the membranes* was diagnosed for births prior to 37 weeks in which rupture of the membranes preceded the onset of labor contractions. *Medically indicated preterm birth* resulted from obstetrical complications such as preeclampsia and placental problems, and medical illnesses such as diabetes, hypertension and kidney disease. Idiopathic preterm labor was diagnosed when delivery occurred prior to 37 weeks with no mention in the medical record of premature rupture or medical complications. Their first finding was the prominent disparity between white and black births, discussed further in section C7. Preterm births occurred twice as commonly among black mothers compared to whites, which held across all etiology groups. Across races, term low birth weight rates were highest at the extremes of age, and preterm premature rupture of the membranes was more common among adolescents. Lower education and unmarried status were also associated with low birth weight (LBW) births across all etiology groups. Women with no prenatal care had LBW rates three times as high as those with first trimester care. In the presence of prenatal care, the earliness of care was *not* strongly associated with low weight birth. Total LBW rates were lowest in rural counties, where residents were mostly white, but *term* LBW rates were *highest* in the rural counties. These findings illustrate the complexity of causation leading to premature birth, and the strong interaction between social, demographic and medical aspects of health. Over the last decade, the topic of preterm birth, as distinct from low weight birth, has become of increasing interest.

Arkansas infants experiencing preterm birth deserve special discussion. Figure 19 shows that the most common week of delivery has shifted away from 40 weeks. Figure 20 shows that the percentage of births between 37 and 38 weeks rose steadily since 2000 and the proportion of births occurring between 32 and 36 weeks has increased since 2004. Figure 20 also shows the degree to which the percentage of births at gestational ages of 40 and 41 weeks has declined. Figure 21 shows that trends in birth weight specific infant mortality rates have been variable. There was a slight but sustained decline only in the rate for births in the 500-999 gram range. Figure 22 shows that Arkansas infants born at 38 weeks have a higher infant mortality rate than those born at 39 or 40 weeks, a finding of concern since deliveries at 38 weeks are increasing. A brief review of the collection of gestational age data in Arkansas hospitals revealed variability of reporting, but did not explain the shift.

Most Arkansas pregnant women receive care from physicians trained in obstetrics and gynecology. In the state's most rural communities that care is given by physicians trained in family medicine, often with special training in obstetrics. Several relatively new or developmental aspects of obstetrical care are now available that could be more regularly used in community practice. Considering preterm birth, doctors have known that women who have had a spontaneous preterm birth are at greatly increased risk for preterm delivery in subsequent pregnancies. Meis *et al*, in a randomized trial, documented that weekly injections of progesterone (17 alpha-hydroxyprogesterone caproate) can reduce the likelihood of repeat preterm delivery by about one-third with an odds ratio (OR) equal to 0.66 having a 95% confidence interval (95% CI) of 0.54 to 0.81.[32] At this time the US pharmaceutical system is working out a commercially viable way to supply that medication. Some local compounding pharmacies are willing to formulate the preparation. As with so many issues in obstetrics today, it is complicated by potential litigation. The main limitation of this treatment is that first-time preterm births are not prevented. Even so, a reduction of 15-20% of Arkansas preterm births might be achieved. Fonseco *et*

al, based on a randomized trial among women with a short cervix measured by ultrasound, showed a 44% reduction in preterm births before 34 weeks following the use of vaginal progesterone capsules.[33] Subsequently, other authors have shown that the reduction in preterm births is also associated with improvement in neonatal outcome. Hassan *et al* have shown that micronized vaginal progesterone gel can also prevent preterm birth in women with a short cervix.[34] Micronized progesterone vaginal gel is already available. In that study a short cervix was measured in only 2.3% of all pregnancies so not all preterm labors can be predicted by this measure. On another preterm birth prevention issue, Omer *et al*, in a retrospective cohort study, found that during local, regional and widespread H1N1 influenza epidemics, influenza immunization reduced the preterm birth rate.[35] The adjusted OR for immunized pregnant women during local H1N1 activity was equal to 0.44 (95% CI: 0.26-0.73), and during widespread flu activity the OR was 0.28 (95% CI: 0.11-0.74). A concomitant decline in SGA infants also occurred, OR equal to 0.31 (95% CI: 0.13-0.75).

A serious national discussion is occurring on the frequency with which doctors and their patients choose induction of labor and cesarean section delivery. While a large proportion of preterm births result from spontaneous preterm labor, evidence exists that medical interventions to effect delivery are increasing. Figures 23 and 24 show that cesarean sections and inductions have markedly increased in Arkansas since 2000. Are physicians performing elective interventions too often or too early? The National Foundation March of Dimes is calling for further investigation of these issues.[36] Practice Bulletins and Committee Opinions of the American College of Obstetrics Gynecology list multiple medical indications to effect delivery. Indications for labor induction are listed in Bulletin No. 10.[37] Other Committee Opinions address early delivery to protect the mother and the fetus. Ananth *et al* analyzed Missouri's birth certificate data for the presence of medical conditions necessitating medical intervention for preterm birth.[38] They concluded that severe preeclampsia, fetal distress, small-for-gestational-age and placental abruption were among the most common conditions indicating medically-necessary preterm deliveries, and were implicated in over half of those indicated deliveries. Offspring of many mother-infant pairs who face these urgent medical complications may have a high risk for *fetal* as well as neonatal death. The fetus may do better after medically indicated delivery, even in the face of high infant death rates associated with preterm birth. For this reason, some studies have used perinatal (fetal and neonatal) death rates for analysis. KS Joseph discusses a new epidemiologic framework to identify fetuses at risk and the optimum gestational week for their delivery.[39] Joseph's framework, exemplified in Figure 25, represents an additional approach to guide obstetricians in identifying conditions of risk and recommending to patients the nature and timing of medical interventions. In any case, ACOG Opinion 321 holds that the wishes, rights and bodily integrity of the pregnant woman must be respected, even in situations where the physician's medical assessment would predict poor outcome for the infant.[40] Apart from inductions and cesarean sections for clear medical indication, concerns are rising related to elective procedures. Fisch *et al* showed that a quality improvement approach and careful adherence to ACOG guidelines reduced the overall induction rate at their institution, particularly for interventions before 39 weeks gestation.[41] The percentage of cesarean sections to patients with first pregnancies also declined significantly. In another important study, Kahn *et al* linked Georgia birth certificates to maternal hospital discharge records, finding that certificates greatly under-reported the presence of medical complications. When data from both sources were considered, the percentage of "no apparent risk" cesarean sections decreased to 3.9%.[42] However, not all high risk conditions indicate cesarean section.

2. Birth defects

Bailey *et al* detailed the impact of folic acid supplementation and fortification in reducing neural tube defects (anencephaly and spina bifida).[43] Arkansas has worked with national campaigns to increase public awareness of the need to take folic acid vitamin supplements every day, starting well before any pregnancy. Despite several Arkansas campaigns reinforcing the national effort, only about half of Arkansas women reported taking a folic acid tablet every day.[44] Atrash *et al* made the case for preconception and inter-conception health counseling around folic acid supplementation and other

health issues[45]; and Korenbrot *et al* documented effectiveness for several of these health counseling projects.[46] Associations between birth defects and smoking and obesity are beginning to receive attention. Hobbs *et al* documented associations between congenital heart disease in the infant and genetic polymorphisms, showing interactive effects among those who were obese and smoked.[47] Because birth certificate data under-reports birth defects, the Arkansas Center for Birth Defects Research and Surveillance is reviewing its clinical data to see if this apparent reduction is confirmed.

3. Twins, triplets and higher multiples

Nationally, the prevalence of both twin and triplet births has been increasing over the years. A part of this trend has been the growth in assisted reproductive technology (ART). Ragni *et al* indicated that mothers could be helped to achieve a pregnancy with reduced risk of triplets and higher order multiples.[48] The Society for Obstetricians and Gynecologists of Canada (SOGC) has published National guidelines for ART.[49] Sunderam *et al* at CDC documented that as ART outcomes have improved, the number of embryos transferred during *in vitro* fertilization has tended to drop from three to two, especially among younger women.[50]

4. Prenatal care

Scientific evidence of the effectiveness of prenatal care *per se* in addressing prematurity has been sought for many decades, but the complex nature of the services it includes and the methodological difficulties in mounting efficacy trials have so far largely prevented satisfactory measurement. Fiscella, in a thorough review, cites ethical issues in randomization, the variability of the content of prenatal care in different settings and for women with different risks, and the difficulties of controlling for short pregnancy and selection bias.[51] Still, he calls for further attempts at randomized trials as the only means of determining the qualities and quantities of prenatal care services that are truly necessary to reduce prematurity. By contrast, Rooney showed that the value of prenatal care in improving the health of *women* during and beyond their pregnancies is well established.[52]

Improvements in utilization and quality of prenatal care have also been sought as ways to more favorably impact pregnancy outcomes. In 1973 Kessner *et al* created the "Adequacy of Prenatal Care Index," based on data from New York City (NYC) birth certificates.[53] Frequently called the "Kessner Index," it explored the association between adequacy of prenatal care and infant mortality. In part because it took into consideration the length of pregnancy in estimating the number of visits that would be considered "adequate," it represented an important analytic advance, and became widely used. However, modifications were common and doubts about the associations between prenatal care and infant mortality remained. In 1994 Kotelchuck reanalyzed the NYC birth certificate database and reassessed the index, pointing to some important weaknesses.[54] He proposed a new "Adequacy of Prenatal Care Utilization (APNCU) Index." This measure addressed weaknesses in Kessner, focused more clearly on utilization and not quality, measured the completeness of care after care began, and added an "adequate plus" category for describing care. Other approaches followed. Alexander and Kotelchuck reviewed five different methods for determining the adequacy of prenatal care.[55] While individual methods showed different effects, all methods demonstrated an association between low adequacy of prenatal care and preterm birth. However, adequate control of preterm birth bias remains elusive, and selection bias is still a problem. Since the Fiscella article, the literature does contain evaluations of the expansions of Medicaid prenatal coverage, and several randomly assigned trials comparing outcomes from different qualities of prenatal care. These studies address additional content of prenatal care.

Expansions of Medicaid eligibility for pregnant women in other states, similar to the expansion in Arkansas in 2002-03, have been closely evaluated using linked birth and infant death data. Anum *et al* reviewed these evaluations, concluding that when corrected for risk variables, outcomes are not different for private insurance and Medicaid patients. With respect to comprehensive prenatal care programs, outcomes varied across states and regions.[56] Others have shown that enhancements to

certain qualities of prenatal care have met with greater success. Olds *et al,* in a now-famous randomly assigned trial of nurse home visiting on maternal life course and child development through age 6, documented many positive effects for low-income mothers and their children.[57] Among positive effects, visited mothers had fewer subsequent pregnancies, longer intervals between births, and fewer months on welfare and food stamps. Nurse-visited children had more formal child care, higher intellectual functioning and fewer behavior problems. Ickovics *et al,* in a randomly assigned clinical trial, studied women at psychosocial risk but without medical high risk conditions. They showed that prenatal group care (Centering Pregnancy) added to basic services resulted in fewer preterm births and lower infant mortality compared to women receiving usual care in clinics at Yale University.[58] Buescher *et al* in a carefully designed observational study on Medicaid patients in North Carolina, found that maternity care coordination including home visiting and provided by public health nurses, added to basic care, was associated with fewer preterm births and lower infant mortality. Further, cost savings were achieved due to fewer infants requiring neonatal intensive care.[59] Hollowell *et al*, in a review of antenatal programs to reduce infant mortality and preterm birth in socially disadvantaged and vulnerable women in high-income countries, said that the Ickovics evaluation represented level I (the best) evidence of improved outcomes, and that the Buescher study was considered "promising."[60] Wells *et al* conducted a community-based retrospective cohort study of African American women in Maryland. They found that mothers who received case management with home visitation were only 0.37 (CI: 0.15-0.94) times as likely to deliver preterm.[61] Willems Van Dijk *et al*, in a cross-sectional design, studied 45,406 Medicaid births, among which 10,715 (23.6%) had received prenatal care coordination (PNCC).[62] This intervention involved assessment and care planning with enriched counseling as needed, provided by nurses, social workers or nutritionists. Home visiting was not mentioned. PNCC services were associated with significantly reduced odds of low and very low birth weight and preterm deliveries, and fewer infants transferred to the neonatal intensive care nursery. Brooten *et al* at the University of Pennsylvania studied 173 women at very high social and medical risk among whom 85 women and 94 infants were randomly assigned to the intervention group.[63] The intervention involved nurse specialist (advance practice nurse) home care, including electronic monitoring, fetal activity testing, behavioral counseling, and individual monitoring of medication use. The home-visited patients had lower fetal/infant mortality, fewer preterm births, fewer prenatal and infant hospitalizations, and more twin pregnancies carried to term. The treatment saved an estimated 750 hospital days and $2,880,000 among the studied women.

5. Medical complications of labor and medical risk factors in pregnancy

Medical risk factors in pregnancy and complications of labor and delivery are the province of the specialties of Family Medicine (with obstetrical training) and Obstetrics and Gynecology, and the subspecialty of Maternal Fetal Medicine. Prenatal medical high-risk conditions are extensively described in many obstetrical texts including *High Risk Pregnancy, Management Options 4th Edition*, edited by Steer *et al*.[64] In Arkansas, ANGELS, working with family physicians and obstetrician gynecologists throughout the state, developed consensus guidelines for the identification and management of these conditions, including recommendations for consultation and referral of those mothers and infants most at risk. Those guidelines are available to participating physicians on the ANGELS Internet website.

6. Teen births and mothers of other ages

A review by Thomas of national abstinence education projects concluded "up to the present time (2000 publication date), no evaluated program with an exclusive abstinence message has been evaluated in such a way as to show a significantly positive impact on behavior, though some have shown a desirable effect on attitude."[65] In contrast, a study by Rosenthal *et al* of comprehensive teen pregnancy prevention (abstinence plus) showed immediate cost savings which gained further strength as the participants approached 30 years of age.[66] However, an evaluation by Cowden *et al* of Medicaid payment for teen births in Alabama cautioned planners not to see reduction of infant mortality as a short term goal.[67]

Considering women of all reproductive ages, family planning services can be effective. The Guttmacher Institute made the case that family planning can reduce infant death.[68] Tsui *et al* reviewed the impacts of national family planning programs finding a number of favorable trends including reducing infant mortality risk.[69] An observational study by the College of Public Health at UAMS of the Arkansas Family Planning (Women's Health) Waiver documented reductions in unwanted births by delaying first births, increasing birth interval, and reducing the percentage of teen births occurring among all participating women.[70] The evaluation estimated substantial cost savings due to averted births.

7. Racial and ethnic disparities in infant mortality

It is well known that African American births contribute disproportionately to preterm births. Fiscella reviewed the literature on potential causes of racial disparities and concluded "…these disparate outcomes result from two distinct, but potentially converging pathways: infection and vascular."[71] Erenthal *et al* looked at the contribution of medical co-morbidities (diabetes, smoking, hypertension, underweight) controlling for these high risk conditions in the comparison of black and white premature births.[72] They concluded that "though there is a greater burden of health risk among black women, this did not account for their higher rates of prematurity." Vintzileos *et al* looked at pregnancy outcomes by receipt of prenatal care. They found that neonatal deaths were higher for African American infants in both the presence and absence of prenatal care.[73] The beneficial effect of care was more pronounced *at term* and when major medical complications were present. CJR Hogue *et al* also noted that most of the excess risk for preterm delivery among African American births remained unexplained. They recommended that future research explore contextual and social conditions that might be altered to reduce the African American rates.[74]

The pervasiveness and strength of many associations of risk with black race is highly evident in the literature. Maternal stress, especially among black women is frequently mentioned as a risk factor for spontaneous preterm birth. For example, Copper *et al*, in an NIH-funded prospective study, assessed trait anxiety, self-esteem, mastery, depression, and stress using a previously validated scale for their associations to preterm birth, low birth weight, and intrauterine growth retardation (IUGR).[75] Black race, fewer years of education and high stress were statistically associated with spontaneous preterm birth. For low birth weight black race, maternal age and low education showed significant associations. For IUGR black race, tobacco use, and single head of household showed significant associations. Black race and stress held when many other psychological measures in the validated scale were controlled in the regressions.

Other studies have raised and begun to explore the issue of racism as it contributes to maternal stress, and subsequently preterm birth. Hausmann *et al* dealt with the issue of perceived discrimination as reflected in Behavioral Risk Factor Surveillance System (BRFSS) data.[76] In particular, they studied the perception of racism as experienced in health care settings by Caucasians, Hispanics and African Americans. They found that perceived racial discrimination in health care is much more prevalent for African Americans than for other demographic groups. They associated the reported experience of discrimination with poorer health for both Caucasians and African Americans. Collins *et al*, in a case control study of 104 African American women, inquired about lifetime exposure to interpersonal racism in 5 domains – at work, getting a job, at school, getting medical care, and getting service at a restaurant or store.[77] They found that odds ratios for very low birth weight infants for maternal lifetime exposure to interpersonal racism in three or more domains were two to three times higher than for those not so exposed. These ratios were statistically significant. Rich-Edwards *et al* described psychosocial stressors, the "weathering" hypothesis, and socio-economic position in addition to racism and neighborhood context.[78] They attempted to link these factors to preterm labor. They pointed to elevated corticotrophin releasing hormone (CRH) levels under various stressful conditions, and differing CRH elevations among mothers of different races. Rich-Edwards and colleagues also described evidence for other vascular and infectious pathways. Ultimately, they commented that these studies are limited in number and rigor, and leave many gaps in suspected causal pathways. Misra *et al* found

evidence of a three-way interaction between reported lifetime experiences of racism, depressive symptoms during pregnancy and stress during pregnancy related to preterm birth.[79] Kramer and Hogue focused on very preterm birth among African American women and made a sweeping search of the medical and social literature for a wide variety of antecedents to this outcome.[80] They concluded "the literature to date suggests a complex, multi-factorial causal framework for understanding racial disparities in very preterm birth, with maternal inflammatory, vascular or neuro-endocrine dysfunction as proximal pathways." They cited maternal exposure to stress, racial differences in preconception health, and genetic, epigenetic and gene-environment interactions as more distal mediators. They also indicated that interpersonal and institutional racism are mechanisms that may drive racially patterned differences.

At the broadest socio-economic level of analysis, Tacke and Waldmann showed that a nation's income distribution and health care expenditure are strongly associated with infant mortality, where high income disparity and low public health expenditure co-exist.[81] Regarding income, the US Bureau of the Census records that in 2006, 53.1% of black households had an income below $34,999, compared to 45.8% for Hispanics and 23.3% for whites.[82] From that same database black household median income (among all households) was $31,969 compared to $37,781 for Hispanics and $50,673 for whites. Regarding public health expenditures, and compared to European economies, the United States still lacks national health policy that develops an effective system of health care for all citizens. These economic data help to explain the poor showing of US infant mortality rate compared to other developed countries.

The experience of Hispanic mothers and their infants in Arkansas is also of interest. Strikingly, despite the stresses of immigration, barriers in access to prenatal care and, no doubt, ethnic discrimination, Hispanic births in Arkansas suffer infrequently from infant mortality as reflected in Figure 8. In the national literature, Reed *et al* characterized birth outcomes in Colorado's undocumented immigrant population.[83] These mothers were younger, less educated, and more likely to be single. They had higher rates of anemia, were less likely to gain enough weight, and were less likely to receive early prenatal care. They also had higher rates of labor complications like excessive bleeding and fetal distress. Despite these findings, undocumented women had lower rates of low birth weight and preterm births. In a paper remarkable for its documentation and follow-up of risk conditions, Ricketts *et al* evaluated Colorado's Prenatal Plus (PP) program.[84] PP offered enhanced prenatal care through care coordination with special attention to smoking, inadequate weight gain, and psychosocial problems. Uniquely, patients with prenatal problems like these were carefully followed, their care of psychosocial and nutritional problems documented, and a professional counselor's assessment made regarding the resolution of these problems. Women who resolved all their identified problems had a low birth weight rate of 7.0% compared to 13.2% who resolved no risks. Women who had at least 10 Prenatal Plus visits were more likely to resolve their risks. Observational studies such as this one should be confirmed with randomly assigned trials.

8. Smoking and pregnancy

Lightwood *et al* documented the association between smoking and preterm birth and, through mathematical modeling, predicted that an annual drop of one percent in the US smoking prevalence could prevent 1300 low weight births and save 21 million dollars in direct medical costs in the first year of the program.[85] Kim *et al* developed a hypothetical cohort of pregnant women from PRAMS survey data linked to birth certificates.[86] Using PRAMS responses, Kim and colleagues estimated that among the mothers of 4 million live births in the US in 2005, 944,240 were smokers at the time they became pregnant. From other reviews an estimated 23% of self-reported female smokers indicated that they stopped smoking on learning they were pregnant. From the 2004 Cochrane Review the pooled relative risk (RR) for continued smoking in a variety of interventions was 0.94. Using these data, Kim and colleagues estimated that of 944,240 pregnant smokers, 23% would quit spontaneously, an additional 6.3% would quit with usual prenatal care, and a further 3.3% would quit because of a cessation intervention, leaving 67.4% as continuing smokers. The calculated smoking prevalence in late

pregnancy would decrease from 16.4% to 15.6% because of the interventions. These data indicate the great difficulty faced by efforts to quit smoking in pregnancy. Never the less, several studied factors seemed promising. Windsor *et al*, in a randomized trial, showed that among pregnant women who received *A Pregnant Woman's Self-Help Guide to Quit Smoking,* 14% quit and 17% reduced their levels of a blood marker for smoking (thiocyanate).[87] Buja *et al* found that pregnant women, compared to their non-pregnant counterparts, were more likely to be in an advanced (more desirable) stage of behavioral change for smoking.[88] Ruger *et al,* also using a randomized design, showed that motivational interviewing can help avoid postpartum relapse.[89] Tong *et al* noted that younger women were much more likely to smoke than older women, and called for age-appropriate tobacco control interventions to be incorporated in reproductive health settings.[90] Nguyen *et al* identified ways in which a newly postpartum mothers' existing social networks could prompt quitters to start again, thereby raising the possibility that interventions to restructure social support networks can help sustain smoking abstinence.[91]

9. Marriage and evidence of male partner involvement

The percentage of women giving birth in Arkansas who were unmarried increased to 45% of all births. Thus non-marital child bearing is less concentrated among those at low income. Gaudino *et al* documented the association between lack of father's signature on the birth record and infant mortality in Georgia.[92] The ANGELS evaluation is using the absence of a father's signature on the birth certificate as evidence for lack of paternal support, and is also finding associations to poor outcomes.

10. Education

Low education level is a well-known risk factor that is evident in Arkansas data. Low education as a birth certificate variable can be understood as a marker for low health literacy, although educational level does not always determine literacy level. Levandowski *et al* evaluated a Healthy Start program (SHS) in Syracuse, NY, which applied an evidence-based health literacy intervention as a "large part" of that program.[93] They assessed a comprehensive series of health education materials for reading level, white space, culturally appropriate pictures, and length (number of pages). They initiated five levels of intervention: the materials; a health education campaign using many strategies including radio, television and posters; ensuring that adolescents complete their schooling; screening and referring parents to adult literacy programs; and encouraging paternal involvement. SHS was significantly protective (relative risk (RR) = 0.25 (95% CI: 0.07-0.93) for post-neonatal death, though not significant for neonatal or infant mortality in univariate cross-tabulations.

11. Obesity and pregnancy

The Maternal Fetal Medicine Committee of the Society of Obstetricians and Gynaecologists of Canada (SOGC) prepared A Clinical Practice Guideline regarding best practices in care with respect to obesity.[94] Prior to pregnancy doctors should advise women to enter pregnancy with a body mass index (BMI) of less than 30 kilograms per meter squared, ideally less than 25 kg/m^2. Obese pregnant women should be counseled about weight gain, nutrition and food choices. Obese women should be advised that they are at risk for medical complications such as cardiac disease, pulmonary disease, gestational hypertension, gestational diabetes and obstructive sleep apnea. Regular exercise during pregnancy may help to reduce some of these risks. Obese women should also be advised that they are at increased risk for cesarean section, and their fetuses are at increased risk for congenital abnormalities. The guidelines provide definitions for underweight and for normal weight, overweight, and three classes

of obesity. They describe the risk of developing health problems in the mother or baby to be the least for normal weight women, and successively increased for underweight, overweight and three classes of obese patients. Patients with class III obesity have risks described as "exceedingly high." The guidelines advise weight gain ranges that are healthiest according to pre-pregnancy BMI category. The greatest advisable weight gains are recommended for underweight women who should gain 12.5 to 18

kg (27.5 to 39.6 pounds). Normal weight women should gain 11.5 to 16 kg (25.3 to 35.2 pounds). Overweight women should gain 7 to 11.5 kg (15.4 to 25.3 pounds). Obese women of any class should gain no more than 7 kg (15.4 pounds). The impacts on pregnancy outcomes and special considerations for medical screening and treatment are discussed. The level of evidence supporting each recommendation is presented.

Crane *et al*, in a population-based cohort of births in Newfoundland, compared maternal and neonatal outcomes based on gestational weight gain for women whose pre-pregnancy weights were normal, overweight, obese and morbidly obese as defined by guidelines similar to the above.[95] They concluded "The effects of gestational weight gain on pregnancy outcome depend on the woman's pre-pregnancy BMI. Pregnancy weight gains of 6.7 to 11.2 kg (15-25 pounds) in overweight and obese women, and less than 6.7 kg (15 pounds) in morbidly obese women are associated with a reduction in the risk of adverse outcome." This paper supported the SOGC guidelines.

Wadden *et al*, in a randomized trial of obesity treatment in primary care practice including men and non-pregnant women at the University of Pennsylvania, randomized patients to 1) usual care, 2) usual care plus brief lifestyle counseling or 3) usual care plus enhanced lifestyle counseling.[96] Medical care was provided at quarterly primary care provider visits with the same frequency for the three groups. Trained medical assistants called "lifestyle coaches" provided the counseling during 10-15 minute sessions on a monthly basis. Enhanced lifestyle interventions included medications and meal replacements. Of 390 participants, 86% completed the 2-year trial. Among each of the three groups (usual care, brief counseling and enhanced counseling) initial weight loss of at least 5% was achieved by 21.5%, 26.0% and 34.9% respectively. Enhanced life style counseling was superior to usual care by this measure with no other differences among the groups. Similar results occurred for mean weight loss. They concluded "Enhanced weight loss counseling helps about one third of obese patients to achieve long-term, clinically meaningful weight loss."

12. Regionalization of perinatal care

Guidelines for Perinatal Care, 6th Edition, published by the American College (now Congress) of Obstetricians and Gynecologists and the American Academy of Pediatrics, describes the concept and importance of defining levels of hospital service for obstetrical delivery and newborn care. In this construct (ideally), the Level I hospital is community-based (often rural) and has a predominance of Family Practice and Generalist physicians providing the perinatal care. These hospitals, valued as being closest to home for most rural residents, care for mothers and babies experiencing a normal course of pregnancy and the first month of life. They also care for emergent conditions that require immediate medical attention such as resuscitation and stabilization. They are especially effective at identifying complications, obtaining consultation and making referrals of high-risk patients to larger and more specialized services. The Level II hospital, also community based (usually urban), delivers a large number of babies each year, is staffed by physicians who specialize in obstetrics/gynecology and pediatrics, and has physicians in other specialties like internal medicine, surgery, radiology and pathology. These hospitals serve normal mothers and babies in their communities, but are also equipped and staffed to care for those with the most common and moderately severe medical complications. They may have a catchment area for referral of moderate risk patients that extends beyond their own community. The Level III hospital is either a very large urban hospital or a university-based teaching hospital. These hospitals have special intensive care capabilities, support nursing care at a level of one nurse for every one or two sick mothers or babies around the clock, and have sub-specialty trained physicians in the disciplines of maternal fetal medicine, neonatology and pediatric surgery, among others. These hospitals often have a regional distribution of referrals for high-risk care. They include teaching hospitals whose faculties participate actively in outreach professional education. Cifuentes *et al*, referenced above, have shown that very low birth weight babies are best cared for in neonatal intensive care nurseries. Yu and Dunn described the leadership and training programs that are successful in regionalizing systems of perinatal care to bring tiny babies to facilities best able to handle their care.[97] Lasswell *et al* reviewed hospital services across the US to determine how well

states and regions had implemented regionalized care as described above.[98] They documented that neonatal mortality among babies born weighing less than 1500 grams (3.3 pounds) is reduced by about a third when their births take place in a Level III hospital. They also noted that Arkansas, among very few other states, lacks clear public policy to guide its hospitals according to this plan. Nugent *et al* reported that in 2009 the Arkansas proportion of births under 28 weeks gestational age or under 1000 grams that were delivered in Level I hospitals was 34.4%.[99] Medical leaders in Arkansas are now considering ways to further enhance its existing but incomplete implementation of regionalization. Efforts to apply quality improvement principles to these changes at hospital and office levels are under way. ANGELS and AFMC are well suited to carry out a program of professional education and public awareness toward this end; but to achieve it will require a collaborative effort from physicians and patients alike.

13. Follow-up of vulnerable infants

Willis emphasized the importance of family-centered care in the neonatal intensive care unit, and continuity of such care beyond the NICU.[100] She described a program called "Parenting Preemies" as an easily replicated post discharge program to ease transition from hospital to home, especially targeting premature, low birth weight and special needs infants. The American Academy of Pediatrics, Committee of the Fetus and Newborn, updated its guidelines on discharge of high-risk neonates.[101] Nordhov, *et al*, in a randomized controlled trial, showed that an Early Intervention program called the Mother-Infant Transaction improved cognitive outcomes at corrected age 5 for children with birth weights of less than 2000g.[102] While this study was not designed to measure impact on post neonatal deaths, it showed favorable impacts on developmental outcomes.

V. Are there some evidence-based solutions to the infant mortality problem that are or could be applied in Arkansas?

While biomedical and psychosocial researchers look into patho-physiologic and social complexities, community-based interventions that have statistical associations to lower infant death rates also appear in the literature. Among them are putative solutions currently in effect, some as yet incompletely applied, and some that are novel.

A. Solutions currently in effect in Arkansas

In addition to ANGELS, solutions currently applied offer the opportunity to enhance their distribution and quality. Public health "core services," including family planning, basic prenatal care, WIC, high risk obstetrical and newborn care, newborn screening, and immunizations are already available in widespread fashion throughout the state. State general funds and federal funding sources including Medicaid, Title X (Family Planning), Title V (MCH), CDC (Immunizations and Newborn Screening), and special project grants support all these core services. Still, gaps in access to prenatal care exist. Not all counties have an ADH supported prenatal clinic located in the county, and limited public and private prenatal care capacity in some counties also adds to the gaps. Additional special project funds could help fill these gaps and provide experience in Arkansas with newer enhancements to prenatal care that are being tried elsewhere.

B. Solutions incompletely applied

Solutions tried in the past but discontinued despite evidence of effect or not tried at all offer other opportunities to reduce infant death through prevention. New community projects to enhance public awareness of healthy behaviors could address many important health issues. Sudden Infant Death Syndrome can be reduced if mothers and other care-givers will consistently lay their babies on their backs to sleep, and assure a safe sleep environment.[9] Pregnancy Risk Assessment and Monitoring System (PRAMS) data reveal that only 58% of mothers in Arkansas observe this behavior, with lower proportions in the Mississippi River Delta.[103] Neural Tube Defects can be reduced if all women would

take daily folic acid supplements prior to getting pregnant. Since pregnancies are not always anticipated, a routine daily dose is needed throughout the woman's reproductive years. Behavioral Risk Factor Survey data for Arkansas in 2000 (the latest) showed that 46% of women took folic acid supplements.[104] Public awareness efforts to alert communities to the benefits of back-lying sleep position and folic acid supplements have been carried out on an occasional basis but need constant renewal. Other public awareness efforts in Arkansas include the "Arkansas Time Bomb" (teen pregnancy prevention) and the "Healthier Babies" (early prenatal care) campaigns. Another special project, begun in Arkansas but dropped for lack of funds was the Nurse Family Partnership pilot. With a new federal grant, led by ADH and Children's Hospital, evidence-based home visiting interventions have been started in 7 counties. They are heavily influenced by Olds-model home visiting. Donovan *et al*, in a retrospective case-control study, evaluated a project of intensive home visiting, following the Nurse Family Partnership and Healthy Families America models. They found that infants whose families did not participate were 2.5 times more likely to die compared to those whose families participated.[105] With new federal funding in this area, many newer models of intervention are being tested for applicability in rural areas. The Arkansas project will innovate in this area.

C. Novel solutions for Arkansas

Solutions, in addition to home visiting, that are untried or recent innovations for Arkansas offer other opportunities to reduce preterm birth and infant death. New research into the content and quality of prenatal care is promising, as described above. Only in infrequent and inconsistent projects has Arkansas implemented case management and care coordination interventions evaluated in the literature cited. Interest exists in this state to implement programs to address low literacy for several health problems especially among chronic diseases.

Several important studies point to the notion that preconception and inter-conception health counseling could lead to identification before pregnancy of the presence of chronic disease such as obesity, diabetes or high blood pressure, or risky behaviors such as smoking, which may be amenable to education and prompts for behavior change. Haas, studying women from the San Francisco Bay Area, showed that for nearly 40% of preterm births, their mothers had identifiable risk factors *before* that pregnancy.[106] Atrash and Korenbrot, mentioned above, have advocated for preconception and inter-conception health counseling, and Frey *et al* recommended preconception care for men.[107] Johnson *et al* at CDC and the Agency for Toxic Substances and Disease Registry (ATSDR) collaborated to produce Recommendations to Improve Preconception Health and Health Care.[108] D'Angelo *et al* at CDC discussed in detail the preconception and inter-conception health status of women who had recently given birth (PRAMS data from selected states, weighted to reflect the US population).[109] Since access to health care in rural Arkansas is more difficult, opportunities for young women to receive good preconception and inter-conception health counseling are few. Increasing their availability could help to improve life-style factors such as diet, exercise and avoidance of smoking, alcohol and drug use. Too, health counseling can help with the management of chronic diseases such as obesity, diabetes and hypertension, all before a pregnancy occurs. With an emphasis on inter-conception care, Dunlop *et al* in Atlanta enrolled African-American women who qualified for indigent care and delivered a very low birth weight baby. The researchers prospectively provided coordinated primary health care and social support for 24 months following the birth. These women represented the intervention cohort. The researchers assembled a retrospective cohort of women meeting the same eligibility criteria who delivered a VLBW baby during July 2001 through June 2002, as a comparison group. Dunlop and colleagues found that the control cohort had 2.6 (95% CI: 1.1-5.8) times as many pregnancies within 18 months of the first delivery, and 3.5 (95% CI: 1.0-11.7) times as many adverse pregnancy outcomes as women in the intervention cohort.[110]

With respect to stress and racism, Benkert *et al*, using qualitative techniques, studied African American experiences of lack of personal resources for health care and treatment by health care workers.[111] They identified many coping strategies used by these patients, some helpful and others not. They identified

broad categories of "problem focused" or "emotion focused" responses. Future "promising practices" may explore the use of Benkert's material to lessen the experiences of discrimination for African Americans. CP Jones opens a new discussion of racism that leads not to recriminations, but to problem solving conversations. She presented a theoretical framework for understanding racism as "institutionalized," "personally mediated," and "internalized."[112] Her "Gardener's Tale" personifies the ways in which benefits are distributed among society's subgroups according to social choice rather than intrinsic worthiness or genetics. These choices can be changed. Knowledge of these concerns and reactions can help a clinician respond more caringly. Perhaps more importantly, approaching the dialogue about racism in problem-solving terms might do much to advance communication between racial and ethnic subgroups on this important issue. ADH trainers present the essentials of "culturally competent" services during in-service education for ADH employees. The agency produces educational materials in Spanish and at appropriate literacy levels in English. Spanish translators are available in counties with high migrant services and ADH staff in the Minority Health Office speak Spanish fluently or are native Spanish speakers. Translators for the Marshallese are also available in Northwest Arkansas.

Preconception and inter-conception care offer opportunities for caregivers to work closely with patients to address interpersonal issues. In a planning work, Richard Aronson cited the Institute of Medicine's "Unequal Treatment" as indicative of the problems of inter-racial and cross-gender communications.[113] He emphasized that "women of color often perceive that their health concerns are dismissed and are not treated with respect and dignity." He catalogued special projects in many states that had been undertaken with special attention to minority issues in health, and summarized their documented assessments. He recommended many actions that can be taken to reduce the impact of racism.

D. Interventions recently undertaken in Arkansas to reduce infant mortality

In recent decades and with major federal funding, the ADH has developed many basic public health services carried out at both state and local levels. These include Family Planning, Prenatal Care, WIC, Immunization, Chronic Disease Prevention and Tobacco Prevention, all of which have benefits leading to reductions in infant death. Since the days in which Fay Boozman, MD, MPH, was Director of ADH, the agency has understood and addressed the importance of the community in health planning and interventions. Dr. Boozman built strong partnerships between the state health agency and community leaders in each county, implemented in the Hometown Health Improvement (HHI) initiative. At the same time he built strong partnerships with other state agencies, and especially with UAMS and Arkansas Children's Hospital. Under his direction, and with UAMS Colleges of Medicine, Nursing, Pharmacy and Health Related Professions, ADH helped to found the College of Public Health. During this era, Medicaid and the Departments of OBGYN and Pediatrics had begun the program called ANGELS. In response to the subsequent Direction of Paul Halverson, MHSA, DrPH, and with active support of the faculties of the Colleges of Medicine and Nursing and the new College of Public Health, ADH developed a major state health plan that included a priority for reducing infant mortality. That planning process led to the initial writing in 2009 of the White Paper and the Background Paper to reduce infant mortality. Since then a number of efforts directed to that end have unfolded.

HHI Coalitions now exist in each of the 75 counties in Arkansas. With guidance and funding from ADH, these Coalitions have become very active in promoting health issues of interest to their communities. Funding from the Tobacco Settlement that supported the College of Public Health has also empowered major health promotion efforts at tobacco prevention, obesity prevention and coordinated school health. The HHI coalitions have made major contributions to community efforts in support of these health promotion activities.

Since 2003 the ANGELS program has developed and promoted evidence based guidelines for medical care of pregnant women and infants with consensus from community doctors. ANGELS has also developed a clinical presence in 47 sites around the state for telemedicine consultations and has

already had impacts in enhancing referral of high risk pregnant women and infants to institutions that provide intensive perinatal care. ANGELS leaders are particularly aware of Arkansas's needs to improve the system of care for these high risk perinatal patients. They are working with Governor Beebe, the Department of Human Services, the Arkansas Foundation for Medical Care, the Hospital Association, and the Arkansas Medical Society toward improvements in public health policy to regionalize perinatal care. Since 2009, ANGELS leaders have also been active in forwarding the objectives of the Infant Mortality Action Group (IMAG) led by Jennifer Dillaha MD at ADH. The IMAG is a committee of the Natural Wonders Partnership, led by Arkansas Children's Hospital, which has made major strides toward statewide health planning for children, and preventively for adolescents and pregnant women. The IMAG is an outgrowth of effective partnering relationships between major state health and administrative agencies and institutions.

At a more specific programmatic level, Arkansas re-invigorated its "Campaign for Healthier Babies," a public awareness initiative to enhance utilization of basic prenatal care early in pregnancy, led by the ADH, the Department of Human Services and Medicaid within DHS. ADH has received federal funding to restart the Olds-model Nurse Family Partnership home visiting program for low-income pregnant adolescents providing them with mentoring, consultation and care coordination through pregnancy and until the second year of life of the offspring. That effort is under way in 7 counties. ADH also developed a special project called "STAR.Health" the Mississippi Delta counties of Lincoln, Desha and Chicot. Following a model of care coordination and primary care for women who have delivered a very low birth weight baby, this project will provide these mothers with inter-conception care to lower the high risk of a subsequent preterm birth. The Tobacco Control program at ADH has matured its service to make smoking cessation counseling and treatment available to youth and pregnant women. The Coordinated School Health initiative has developed model school health projects in 31 school districts guiding school health committees to make assessments and improvements in their health care efforts. Many school districts have initiated activities to prevent teen pregnancy and better care for those who are pregnant. As one of the IMAG activities, Carl Riddell, MD of ADH has begun an effort to raise awareness among his OBGYN Colleagues of avoiding unnecessary inductions and cesarean sections.

Recently, the Department of Human Services, with leadership from the Arkansas Medicaid Program, has begun a series of efforts under the title of "Health Care Payment Improvement Initiatives." New workgroups focus on six clinical areas that comprise large annual expenditures in the reimbursement program. They include forums on Upper Respiratory Infection, Cardiovascular Disease, Musculo-skeletal Problems, Developmental Disabilities, Behavioral Issues, and Pregnancy/NICU Issues. The Pregnancy/NICU Workgroup is discussing payment methodologies that will prompt health care providers and their patients to apply appropriate perinatal regional referral practices, and to avoid unnecessary cesarean sections and inductions before 39 weeks. This discussion incorporates national performance measures into the statewide hospital pay for performance program targeting early induction of labor, obstetrical deep vein thrombosis prevention, and increasing breastfeeding. Among a considerable variety of activities, Medicaid has further expedited Medicaid eligibility for newly diagnosed pregnancies, funded projects with Arkansas Children's Hospital to disseminate information on infant safety, collected HEDIS measures for perinatal care, funded a care coordination project called BirthWait in the Mississippi Delta, and initiated substance abuse treatment programs for expecting mothers.

In close cooperation, UAMS and ACH, with funding support from ADH, have begun community projects to conduct infant mortality reviews, and to raise awareness and train regarding death scene investigations for infant deaths. ACH maintains ongoing efforts to raise awareness among recently delivered women regarding injury prevention, SIDS prevention, and good parenting for health.

VI. Is there a model for community based, mutually enhancing strategies?

Because infant mortality has such a complex set of causes, it is very likely that no single approach will make measurable differences in a jurisdictional population. A set of interventions, coordinated and mutually supportive, is more likely to "move the needle" of the infant mortality rate for a community. In the Health Resources and Services Administration (HRSA) of the US DHHS, the Maternal Child Health Bureau's "Pyramid of MCH Services" [114] offers an important guide not only for the use of MCH Block Grant dollars, but also a multi-layered approach to a community project. This Pyramid is depicted in Figure 26.

The MCH Pyramid

The base of the MCH Pyramid, called "infrastructure building," emphasizes needs assessment, planning, policy development, coordination and training, among other guides for communities. In Arkansas, these aspects of public health are already emphasized by the state's Hometown Health Improvement Coalitions, operating in all counties. To start a project, it will be essential to find a community that is already interested in the problem of infant mortality and ready to make some community-wide commitments. The first step is to approach a Hometown Health Coalition to see if interest and readiness exist, then to *build the collaborative efforts* needed to initiate and sustain community action. The STAR.Health project followed this track.

The next lowest layer of the MCH Pyramid, called "population based services," includes services that are extended to all people at particular moments in life; e.g., newborn screening, well child care, immunization, oral health care, and family planning; or to all people with a particular health need such as enhanced prenatal care or family oriented services for children with special health care needs. A community based effort to *increase public awareness* of the value of and need for these services will be necessary to achieve a scope of activity that is community-wide.

The next layer of the MCH Pyramid, called "enabling services," includes transportation, translation, outreach, health education, family support services, health insurance coverage, and case management. An operational emphasis on neighborhood *outreach and recruitment* is necessary to find and link individuals to preventive services that are especially suited to their life stage or health need. By targeting as many low income neighborhoods as possible, enabling services also work toward a population-wide effect. This pyramid layer also includes an activity called "case management," sometimes implemented as "targeted case management" or "care coordination." Care coordination can be defined as a relationship between a care coordinator and a client that offers regular communication, an initial home visit, care planning, health counseling and continuing follow-up through a course of service such as family planning or prenatal care. Care coordination refers clients to any needed community health and social service. It not only strengthens the client's relationships to his or her clinical caregivers, but offers a relatively long-term personal relationship in which to provide health counseling regarding all the issues encompassed by "preconception" and "inter-conception" health. *Family planning care coordination* funded by Medicaid has been implemented in Alabama with better continuity of care. The Family Planning (Women's Health) Waiver in Arkansas has proven effective in delaying first and subsequent pregnancies, and achieving large cost savings through averting unwanted births. These services afford communities many opportunities to improve health and save money. The care coordination service also provides an opportunity to offer mentoring, found so successful in the Nurse Family Partnership program initiated and rigorously evaluated by Dr. David Olds. *Prenatal care coordination* has been associated with lower low birth weight rates and cost savings in North Carolina. If the care coordination service follows a young woman through a year or two of family planning, to and through an anticipated and desired pregnancy, then back to family planning, a durable pathway for health counseling is created, within which many "key health messages" can be given at the client's most "teachable moment."

The top layer of the MCH Pyramid, called "direct health services," includes basic preventive services, which encompass family planning, prenatal care, WIC, well child care, immunizations and develop-

mental screening. When quality and capacity for basic services are adequate, community-based enhancements such as *reminders and recalls* for visits have proven effective in assuring their provision. In Arkansas, and except for prenatal care and developmental assessments, every county makes these preventive services available in an ADH local health unit. Organizational capacity to assure quality and continuous service in ADH already exists. Though not in every county, ADH prenatal clinics are offered in local health units in 56 of the 75 counties, and among the remaining 19 some have either an adequate number of private physicians or Community Health Centers supplying the care. ADH strives to assure that counties with low rates of early prenatal care have one of its maternity clinics. Developmental assessments for children, when done, are provided by primary care physicians in their offices. New efforts in Arkansas to expand developmental assessments using validated tools are being made through several new partnerships. The top layer of the pyramid also contains sub-specialty services for high-risk mothers and infants such as ANGELS.

VII. Are there recommendations for future activities arising from this scientific review?

Internally to ADH, a group of health program leaders who reviewed this paper, assembled to identify recommendations for further activities. The following outline expresses the items that this group chose as actions to be recommended in Arkansas. These items were selected because 1) they already enjoy interest and effort in Arkansas, 2) evidence exists in the scientific literature that they can be effective and 3) among them they address all layers of the MCH Pyramid. In theory, if a given community mounts effective efforts at a majority of these menu items, they should be mutually supportive, enhancing the chances to observe a decline in the community's infant mortality rate. The listed items are not presented in any priority order. They are presented on page xi of the summary to this document, and repeated on the page subsequent to this one with references.

A Menu of Recommended Activities

1. **Direct Services:**

   a. Through quality improvement initiatives, regionalize perinatal care by:
   - Defining three levels of perinatal hospital care in state policy [1] and designating hospitals by level Promoting appropriate referrals through professional education and public awareness [2-5]
   - Building a reimbursement system that will incentivize good perinatal outcomes [6]

   b. Through a quality improvement initiative, assure appropriate use of labor inductions and cesarean sections to avoid unnecessary premature delivery [7-10]

   c. Enhance professional education regarding
   - Screening, consultation and referral of high risk pregnant women and infants [11]
   - Flu shots in pregnancy [12]
   - Giving progesterone to prevent preterm birth [13-15]

3. **Enabling Services:**

   a. Enhance prenatal care in more communities by implementing "Centering Pregnancy." [16]
   b. Enhance prenatal care in more communities by implementing prenatal care coordination [17-20]
   c. Enhance pre/postnatal care in communities using evidence-based home visiting care models. [21]
   d. Continue enhanced post neonatal care in a project called "Following Baby Back Home." [22]

4. **Population Based Services**

   a. Enhance Family Planning services with pre- and inter-conception health counseling [23-26]
   b. Continue the Women's Health Waiver or even expand the Waiver if health care reform allows [27]

5. **Infrastructure**

   a. Expand community based efforts for public awareness
   - Sudden infant death syndrome
     - "Safe Sleep Saves Lives" [28]
     - Infant death scene investigations [29,30]
   - Passenger safety ("First Ride, Safe Ride Campaign") [31]
   - Infant death reviews (FIMR) [32]
   - Early prenatal care ("Healthy Baby/Happy Birthday Baby Book") [33]
   - Teen pregnancy awareness and prevention (An AR example of a community based effort) [34]
   - Neural tube defects prevention (Folic acid awareness) [35]
   - Obesity prevention
     - Nutrition and physical activity campaigns (School and community based) [36,37,38]
     - Professional education of doctors *re* successful weight-loss interventions [39]
   - Smoking screening and referral (Tobacco Cessation and Prevention) [40,41]

   b. Expand state level efforts to support community based activities
   - Pre conception/interconception counseling and home visiting [42]
   - Infant death scene investigations and infant death reviews [43]
   - Injury prevention including "Safe Sleep[44]
   - Tobacco cessation and prevention[45]
   - Obesity prevention [46]

   c. Continue the ADH Statewide Health Plan Priority to reduce infant mortality) [47]

   d. Continue the Pregnancy/NICU Payment Improvement Initiative led by Medicaid [48]

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VIII. How is progress to be evaluated in Arkansas?

A. Evaluation of new projects

Implementation of new public health services in these times of funding scarcity requires proof of health benefit and cost savings. First, with each intervention the community's actions should be assessed for changes in service to patients, and new efforts in professional education and public awareness. Next, the changes should be assessed for intermediate impacts such as personal behavior change, increased use of preventive and enabling services, or referral to services with risk-appropriate levels of care. Then, these interventions need to be assessed with respect to their impacts on preterm births, low-weight births and infant deaths. Of perhaps the greatest importance, careful qualitative assessments of patients' experiences are paramount. These evaluations are rigorous and require the use of adequate funding, in the hands of professional evaluators.

B. Infant death reviews

Infant death reviews have been used to identify examples of existing problems in health systems. Review of medical and other individual records related to an infant's death is advocated by CDC and HRSA and promulgated as Fetal and Infant Mortality Reviews. Koontz *et al* of the MCH Bureau described programmatic development of infant death reviews in many community based projects in the US.[115] Misra *et al* conducted a national evaluation of 74 community based projects that performed infant mortality reviews.[116] The authors described these reviews as "useful," but also saw the strenuous nature and expense of performing them, ultimately recommending that the effort be combined with maternal mortality and child death reviews. Fogerty *et al* conducted a particularly well-done infant death review in Minneapolis-St Paul, highlighting teen pregnancy, late prenatal care (barriers), violence (suicide and homicide), substance use and abuse (tobacco, alcohol, drugs), and unwanted or mistimed pregnancies.[117] Such a review was done in Arkansas between 1997 and 2000, revealing much the same concerns, but especially emphasizing the lack of community availability of grief counseling services. Disparities in mortality and preterm births might be further illuminated by a renewed effort at death reviews. Since 2009, Arkansas has been working actively toward restarting an infant death review process. Within the past year ADH has contracted with UAMS Department of Pediatrics to coordinate establishment of local infant and child death review teams. To date three such teams encompassing five counties have been created, and more are planned.

C. Evaluation of the ANGELS Program and the Telemedicine System

A rigorous scientific evaluation, mentioned above, of the impact of the ANGELS program is unfolding. That evaluation is led by Janet Bronstein and a professional team including members from the University of Alabama at Birmingham, APS Health Care in Madison, Wisconsin, the Arkansas Division of Medical Assistance in Little Rock, the Arkansas Department of Health in Little Rock, and the Departments of OBGYN and Pediatrics at the University of Arkansas for Medical Sciences. As data have been accumulated since before (2001-2003) and after (2003 onward) the start of ANGELS, the evaluation team has published papers on separate aspects of the regionalization process. Bronstein *et al* described issues and biases in matching Medicaid pregnancy episodes to vital records data.[118] Bird *et al* described Arkansas late preterm infant (LPI) outcomes and service utilization in the first year. After matching LPIs with term infants, they showed that LPIs were at increased risk of poor health-related outcomes during the birth hospitalization and increased health care utilization during their first year.[119] Bronstein and colleagues described the initial impact of the ANGELS intervention in its attempt to improve regionalization of care for preterm babies.[120] Methodologies employed in these papers are comprehensive, including the application of propensity scoring to minimize the impact of selection bias, and difference-in-difference designs to assess more global aspects of infant mortality reduction in cross-state, cross-risk, and time series dimensions.

D. The data assessments contained in this background study

Distinct from the ANGELS evaluation, the data assessment that occupies these pages focuses on the total population of births in Arkansas from about 2001 onward. First, we looked at individual risk factors and associated mortality rates in bivariate analyses. As such, the comparisons of the relative effects of different risk factors are only roughly quantifiable. Then we looked at a regression analysis of birth certificate risk factors to determine those with highest odds ratios for infant death. Finally we followed some important trends in Arkansas data to see if any reached statistical significance over a short period of time. A reliable assessment of trend significance is best carried out using a longer term data period (more than 10 years), and, especially for infant death data, needs larger numbers than those in Arkansas on an annual basis. In time, as data from subsequent years can be incorporated, the research will strengthen. In the interest of incorporating new databases into the analysis, ANGELS has requested data from the ADH maternity hospital discharge database, and the PRAMS database, hopefully to include CY 2010 data.

IX. The public policy and research "backdrop" of infant mortality

A. Public and private policy and program leadership at national and state levels

The public health history of efforts to reduce infant mortality and more generally to improve the health of women and children is rich and of long duration. The timeline of federal legislation for mothers and children is set out in "Learn More Title V History" published on the website of HRSA: Maternal and Child Health Bureau.[121] Going back as far as 1912, the Children's Bureau was created by Congress. In 1935 Congress passed Title V of the Social Security act that still guides the program. Title V was originally administered by the Children's Bureau. In 1981 the Omnibus Budget Reconciliation Act converted state and territorial grants to MCH Services Block Grants. In 1990 the Maternal and Child Health Bureau was established in the Health Resources and Services Administration. Dr. Peter Van Dyck directed the MCH Bureau during most of the era since 1990, making major contributions to strategic planning and evaluation of MCH programs until his recent retirement. Under his leadership the MCH Pyramid became a key concept in the management of Title V MCH Block Grants.

B. Comments on public health research

The health literature related to infant mortality depends mainly on observational studies. Their strength is the comprehensiveness and variety of their descriptions. Their weaknesses include heterogeneity, lack of standardization of methodology and failure to control for selection bias. In some cases, for example the studies by Olds and Ickovics, randomized designs have given us a Level 1 quality of evidence, but their expense and difficulty make them rare. A great need exists to enhance the public health database with randomized trials. Many practices that were begun based on "promising" observational studies may in fact have little real effect. Such knowledge may help to "weed out" unproductive effort. In any case, a realistic view of randomized designs involves understanding that they provide evidence of *efficacy*. The study of *effectiveness* must ultimately be a test of population-based impacts at the community level. There, legal and ethical dilemmas as well as expense remain as challenges; but quasi-experimental designs can help reduce confounding. In the meantime, the Boozman College of Public Health has developed a strong research program in community-based participatory research and some of these projects are designed as randomly assigned trials.

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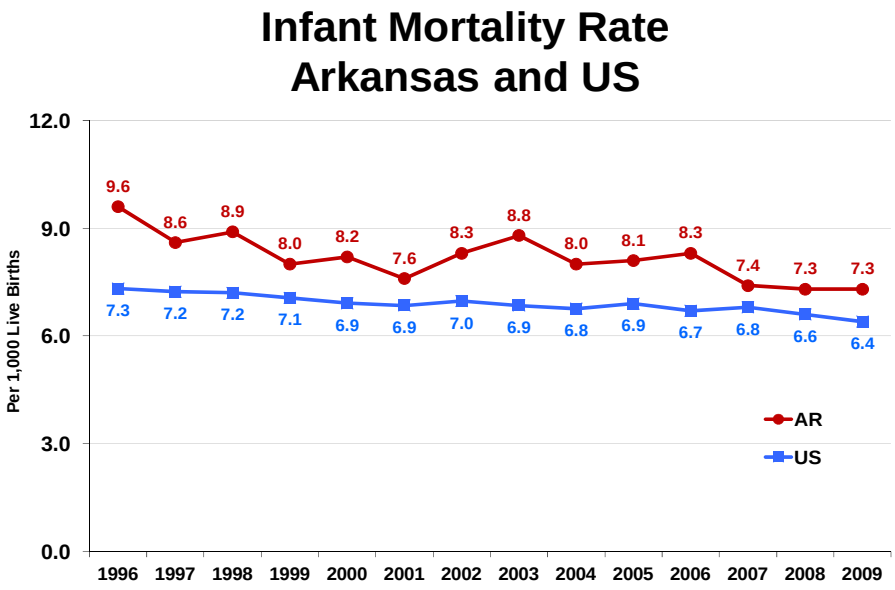
Figures

Figure 1



Source: National Center for Health Statistics (NCHS) and Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 2

Infant Deaths and Rates
Arkansas and US, 2009

Age at Death	Arkansas Number	Arkansas Rate	US Rate
Infant	290	7.3	6.4
Neonatal	163	4.1	4.2
Postneonatal	127	3.2	2.2

Source: National Center for Health Statistics (NCHS) and Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 3

Neonatal Deaths
Top Five Causes, Arkansas 2009

- Congenital malformations 45
- Short gestation and low birth weight 18
- Maternal complications of pregnancy 11
- Respiratory distress 9
- Neonatal hemorrhage 8

Source: 2007 Death Certificates, Health Statistics Branch, Center for Public Health Practice, Arkansas Department of Health

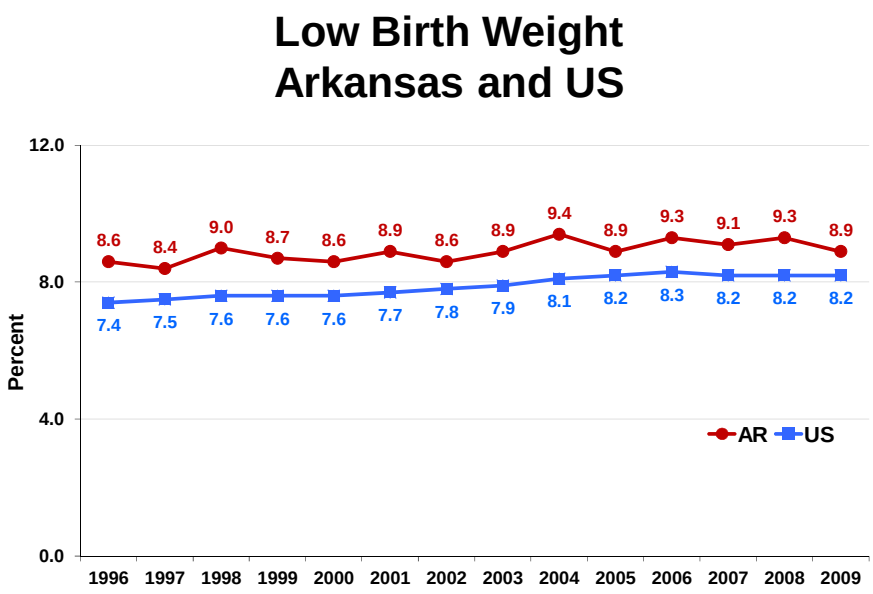
Figure 4

Post-neonatal Deaths
Top Five Causes, Arkansas 2009

- Sudden infant death syndrome 64
- Congenital malformations 14
- Unintentional injuries 6
- Diseases of the circulatory system 4
- Chronic respiratory disease 3
- Septicemia 3
- Assault (Homicide) 3

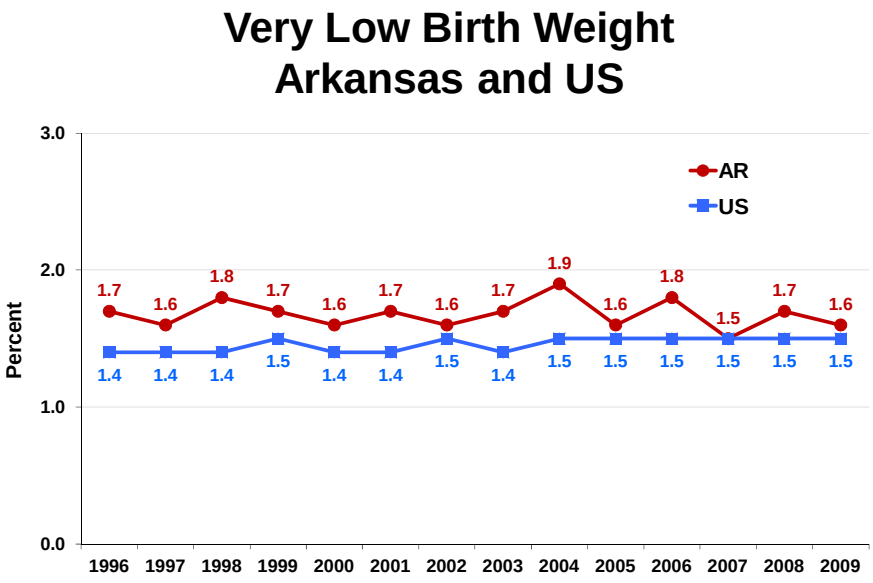
Source: 2007 Death Certificates, Health Statistics Branch, Center for Public Health Practice, Arkansas Department of Health

Figure 5



Sources: National Center for Health Statistics (NCHS) and Birth Certificate Data, Health Statistics Branch, Arkansas Department of Health.
Low birth weight is defined as less than 2,500 grams.

Figure 6



Sources: National Center for Health Statistics (NCHS) and Birth Certificate Data, Health Statistics Branch, Arkansas Department of Health.
Very low birth weight is defined as less than 1,500 grams.

Figure 7

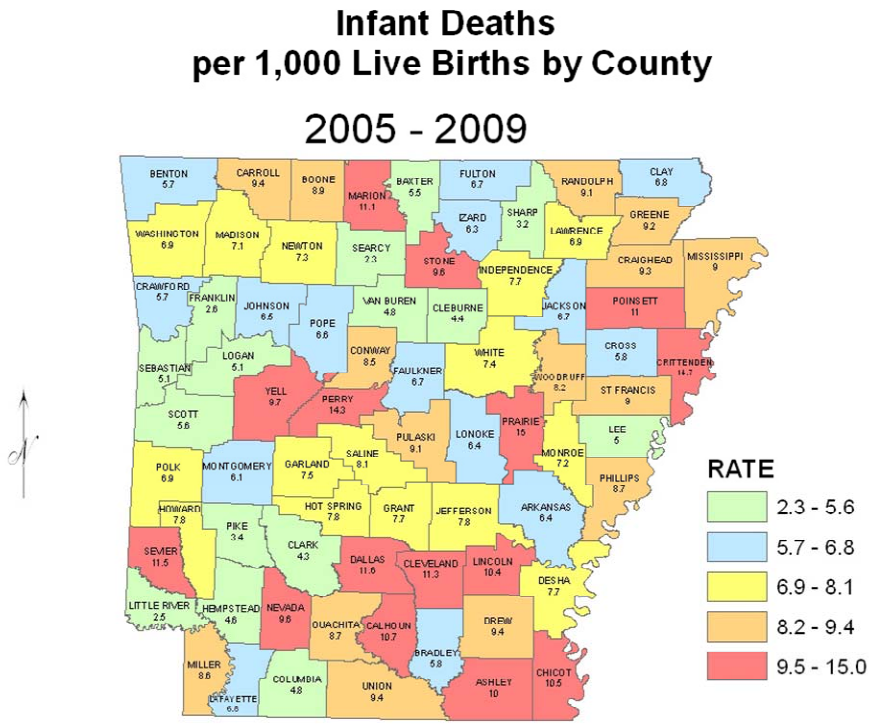
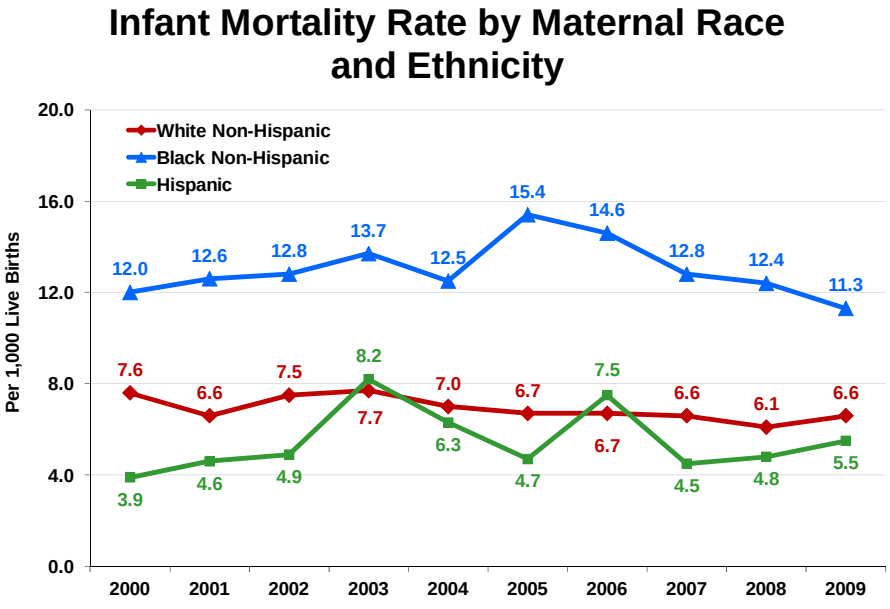
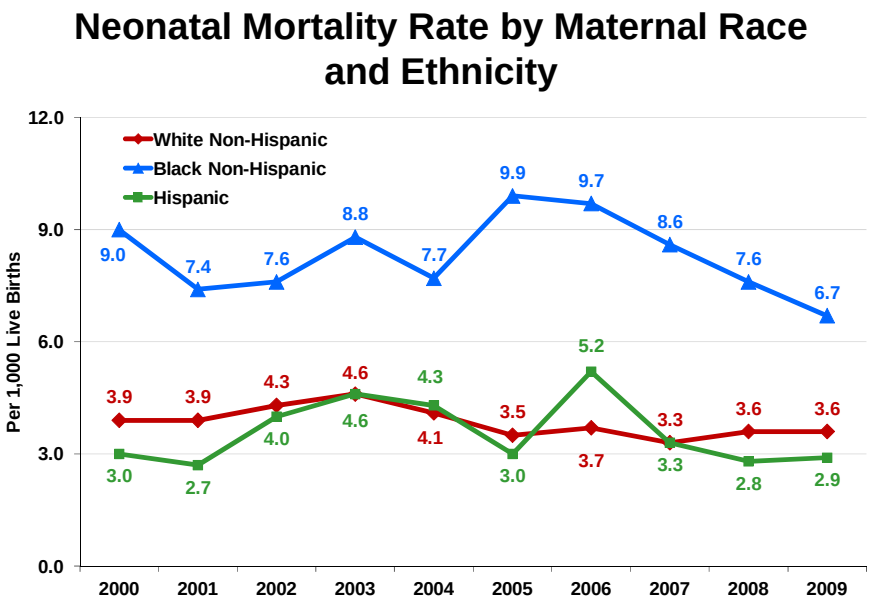


Figure 8



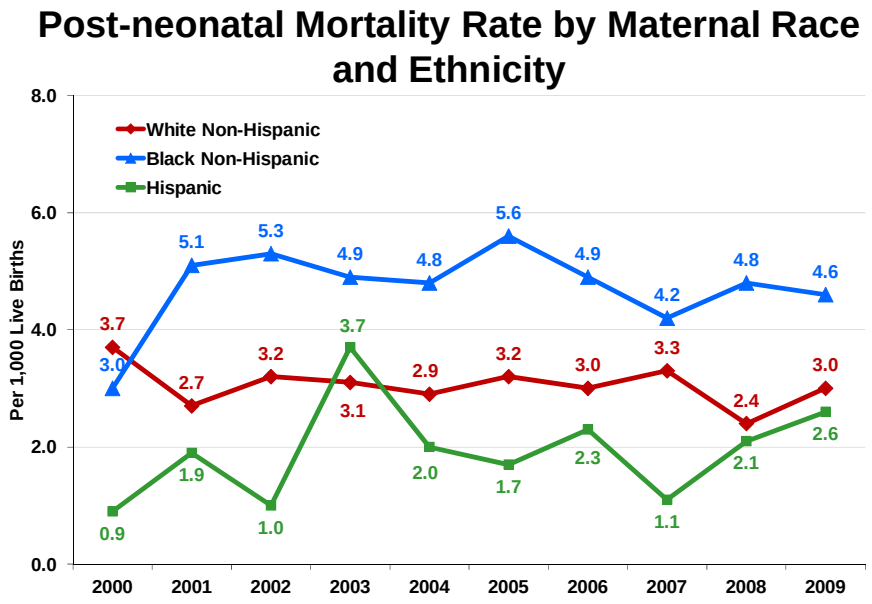
Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 9



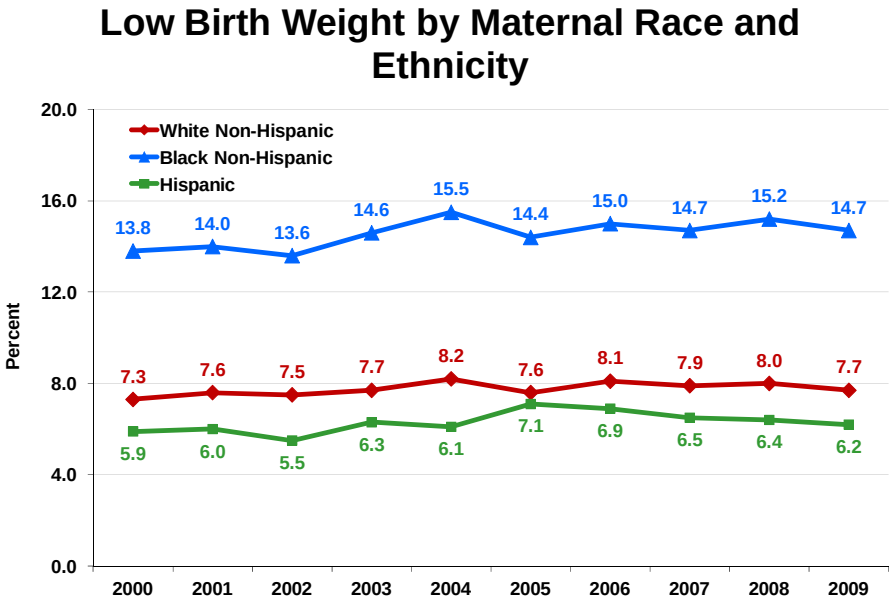
Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 10



Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 11



Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Legend for Figures 12 through 14 (next 3 pages)

Color	IMR Range*
Very High Risk	90.0 - 400+
High Risk	20.0 - 89.9
At Risk	8.9 - 19.9
Low Risk	<8.9

*** Infant mortality rate ranges chosen based on aggregated data, 2001-2009**

Figure 12

Arkansas Residents 2001-2009 Combined

	Indicator	Number of Births	Percent of Births	Infant Deaths	Percent of Deaths	Death Rate*	Adjusted Odds Ratio	95% Conf. Interval	Sig.
	Total	**352,647**	**100.0**	**2,789**	**100.00**	**7.9**			
1)	<28 weeks	2,865	0.8	1,051	37.68	**366.8**	56.78	46.51 - 69.31	**
	28-31 weeks	4,522	1.3	212	7.60	**46.9**	6.37	5.23 - 7.75	**
	32-36 weeks	39,480	11.2	438	15.70	**11.1**	2.16	1.89 - 2.46	**
	41+ weeks	54,552	15.5	188	6.74	**3.5**	0.98	0.84 - 1.15	
	37-40 weeks	250,474	71.0	880	31.55	**3.5**		Ref	
2)	<1000 grams	2,699	0.8	833	29.87	**308.6**	3.44	2.81 - 4.22	**
	1000-1499 grams	2,849	0.8	174	6.24	**61.1**	1.59	1.27 - 2.00	**
	1500-2499 grams	25,978	7.4	473	16.96	**18.2**	2.13	1.87 - 2.43	**
	2500 +	320,746	91.0	1,108	39.73	**3.5**		Ref	
3)	Defect present	4,019	1.1	374	13.41	**93.1**	14.79	12.9 - 16.9	**
	No defect present	348,358	98.8	2,401	86.09	**6.9**		Ref	
4)	Triplets +	343	0.1	31	1.11	**90.4**	1.36	0.85 - 2.17	***
	Twins	10,329	2.9	340	12.19	**32.9**	1.05	0.91 - 1.21	***
	Single Birth	341,954	97.0	2,418	86.70	**7.1**		Ref	
5)	No prenatal care	5,876	1.7	169	6.06	**28.8**	1.22	0.99 - 1.50	***
	Third trimester care	10,175	2.9	77	2.76	**7.6**	1.54	1.22 - 1.95	**
	Second trimester care	54,017	15.3	466	16.71	**8.6**	1.16	1.03 - 1.30	**
	First trimester care	270,793	76.8	1,884	67.55	**7.0**		Ref	
6)	<15 years	887	0.3	16	0.57	**18.0**	1.57	0.87 - 2.83	***
	15-19 years	52,080	14.8	564	20.22	**10.8**	1.12	0.99 - 1.26	***
	40+ years	4,527	1.3	42	1.51	**9.3**	1.11	0.80 - 1.56	***
	35-39 years	22,226	6.3	166	5.95	**7.5**	0.91	0.76 - 1.09	
	20-34 years	272,776	77.4	2,000	71.71	**7.3**		Ref	
7)	Complications of labor	101,438	28.8	1,399	50.16	**13.8**	1.20	1.10 - 1.32	**
	No complications of labor	250,909	71.2	1,379	49.44	**5.5**		Ref	
8)	Black, non-hispanic	68,080	19.3	894	32.09	**13.1**	1.13	1.01 - 1.25	**
	Other races/ethnicity	9,622	2.7	59	2.12	**6.1**	0.78	0.57 - 1.07	
	Hispanic	33,911	9.6	193	6.93	**5.7**	0.90	0.76 - 1.07	
	White, non-hispanic	240,783	68.3	1,640	58.87	**6.8**		Ref	
9)	Smoked > 1 pack/day	12,747	3.6	145	5.20	**11.4**	1.47	1.21 - 1.79	**
	Smoked ≤ 1pack/day	42,176	12.0	420	15.06	**10.0**	1.29	1.15 - 1.45	**
	Did not smoke	293,410	83.2	2,151	77.12	**7.3**		Ref	
10)	Medical risk factor	80,869	22.9	883	31.66	**10.9**	0.90	0.82 - 0.98	****
	No medical risk factor	271,419	77.0	1,895	67.95	**7.0**		Ref	
11)	Not Married	143,577	40.7	1,510	54.14	**10.5**	1.15	1.04 - 1.26	**
	Married	208,597	59.2	1,272	45.61	**6.1**		Ref	
12)	9th-11th grade	59,686	16.9	625	22.41	**10.5**	1.17	1.05 - 1.31	**
	< 9th grade	15,866	4.5	120	4.30	**7.6**	1.04	0.83 - 1.31	***
	12th grade +	273,744	77.6	1,977	70.89	**7.2**		Ref	

***** Infant mortality rate per thousand live births

****** P<.05

******* Non significance due to controls for birth weight and gestational age, or small numbers, or both

******** A protective factor

Figure 13

Arkansas Residents 2003

Indicator	Number of Births	Percent of Births	Infant Deaths	Percent of Deaths	Infant Death Rate *
Total	**37,795**	**100.00**	**332**	**100.00**	**8.8**
<28 weeks	353	0.93	148	44.58	**419.3**
28-31 weeks	464	1.23	18	5.42	**38.8**
32-36 weeks	4,093	10.83	42	12.65	**10.3**
41+ weeks	6,097	16.13	21	6.33	**3.4**
37-40 weeks	26,690	70.62	102	30.72	**3.8**
< 1000 grams	312	0.83	121	36.45	**387.8**
1000-1499 grams	273	0.72	12	3.61	**44.0**
1500-2499 grams	2,740	7.25	53	15.96	**19.3**
2500 +	34,426	91.09	114	34.34	**3.3**
Defect present	532	1.41	53	15.96	**99.6**
No defect present	37,253	98.57	276	83.13	**7.4**
Triplets +	44	0.12	9	2.71	**204.6**
Twins	1,082	2.86	39	11.75	**36.0**
Single Birth	36,667	97.02	284	85.54	**7.8**
No prenatal care	623	1.65	27	8.13	**43.3**
Third trimester care	985	2.61	10	3.01	**10.2**
Second trimester care	5,275	13.96	42	12.65	**8.0**
First trimester care	29,896	79.10	237	71.39	**7.9**
<15 years	109	0.29	1	0.30	**9.2**
15-19 years	5,577	14.76	66	19.88	**11.8**
40+ years	488	1.29	7	2.11	**14.3**
35-39 years	2,292	6.06	18	5.42	**7.9**
20-34 years	29,298	77.52	240	72.29	**8.2**
Complications of labor	11,421	30.22	194	58.43	**17.0**
No complications of labor	26,363	69.75	136	40.96	**5.2**
Black, non-hispanic	7,164	18.96	98	29.52	**13.7**
Other races/ethnicity	925	2.45	4	1.20	**4.3**
Hispanic	3,281	8.68	27	8.13	**8.2**
White, non-hispanic	26,415	69.91	203	61.14	**7.7**
Smoked > 1 pack/day	1,385	3.66	16	4.82	**11.6**
Smoked ≤ 1pack/day	4,608	12.19	58	17.47	**12.6**
Did not smoke	31,322	82.87	251	75.60	**8.0**
Medical risk factor	9,105	24.09	114	34.34	**12.5**
No medical risk factor	28,674	75.87	216	65.06	**7.5**
Not Married	14,353	37.98	172	51.81	**12.0**
Married	23,424	61.98	160	48.19	**6.8**
9th-11th grade	6,504	17.21	74	22.29	**11.4**
< 9th grade	1,768	4.68	22	6.63	**12.4**
12th grade +	29,281	77.47	230	69.28	**7.9**

*** Infant mortality rate per thousand live births**

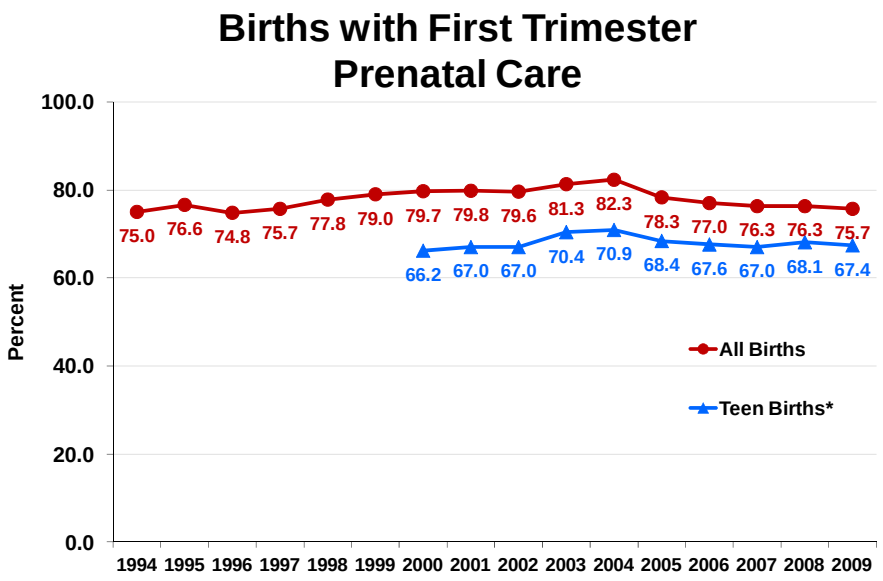
Figure 14

Arksansas Residents 2009

Indicator	Number of Births	Percent of Births	Infant Deaths	Percent of Deaths	Infant Death Rate *
Total	**39,678**	**100.00**	**290**	**100.00**	**7.3**
<28 weeks	309	0.78	99	34.14	**320.4**
28-31 weeks	493	1.24	18	6.21	**36.5**
32-36 weeks	4,374	11.02	53	18.28	**12.1**
41+ weeks	5,245	13.22	20	6.90	**3.8**
37-40 weeks	29,185	73.55	98	33.79	**3.4**
< 1000 grams	286	0.72	84	28.97	**293.7**
1000-1499 grams	331	0.83	22	7.59	**66.5**
1500-2499 grams	2,899	7.31	55	18.97	**19.0**
2500 +	36,129	91.06	111	38.28	**3.1**
Defect present	407	1.03	31	10.69	**76.2**
No defect present	39,243	98.90	258	88.97	**6.6**
Triplets +	30	0.08	2	0.69	**66.7**
Twins	1,179	2.97	31	10.69	**26.3**
Single Birth	38,466	96.95	257	88.62	**6.7**
No prenatal care	588	1.48	13	4.48	**22.1**
Third trimester care	1,191	3.00	7	2.41	**5.9**
Second trimester care	6,739	16.98	54	18.62	**8.0**
First trimester care	29,380	74.05	200	68.97	**6.8**
<15 years	78	0.20	1	0.34	**12.8**
15-19 years	5,736	14.46	52	17.93	**9.1**
40+ years	477	1.20	6	2.07	**12.6**
35-39 years	2,521	6.35	19	6.55	**7.5**
20-34 years	30,862	77.78	212	73.10	**6.9**
Complications of labor	11,052	27.85	148	51.03	**13.4**
No complications of labor	28,588	72.05	141	48.62	**4.9**
Black, non-hispanic	7,589	19.13	86	29.66	**11.3**
Other races/ethnicity	1,171	2.95	6	2.07	**5.1**
Hispanic	4,193	10.57	23	7.93	**5.5**
White, non-hispanic	26,712	67.34	175	60.34	**6.6**
Smoked > 1 pack/day	1,173	2.96	12	4.14	**10.2**
Smoked ≤ 1pack/day	4,447	11.21	45	15.52	**10.1**
Did not smoke	33,688	84.90	226	77.93	**6.7**
Medical risk factor	9,177	23.13	105	36.21	**11.4**
No medical risk factor	30,443	76.73	184	63.45	**6.0**
Not Married	18,015	45.40	154	53.10	**8.6**
Married	21,615	54.48	136	46.90	**6.3**
9th-11th grade	6,423	16.19	49	16.90	**7.6**
< 9th grade	1,474	3.71	7	2.41	**4.8**
12th grade +	31,287	78.85	230	79.31	**7.4**

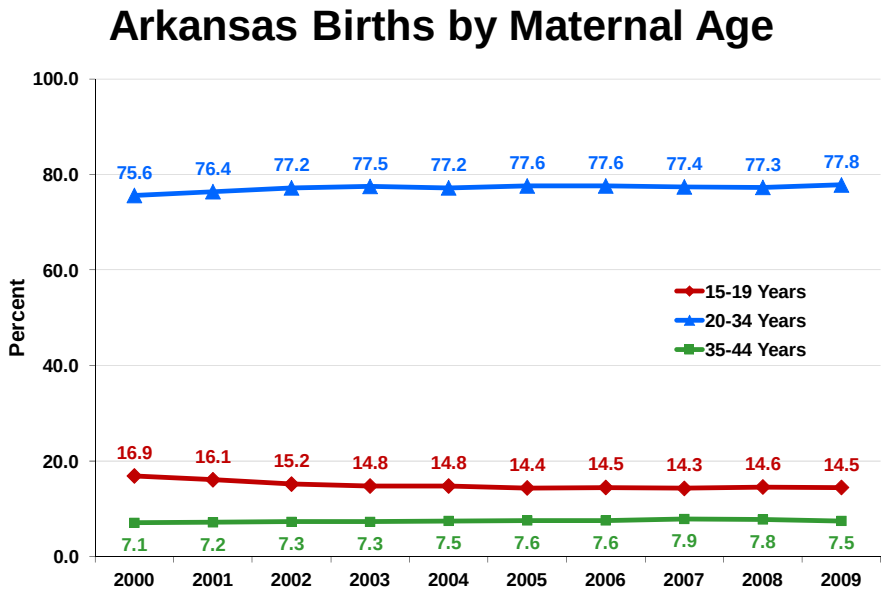
*** Infant mortality rate per thousand live births**

Figure 15



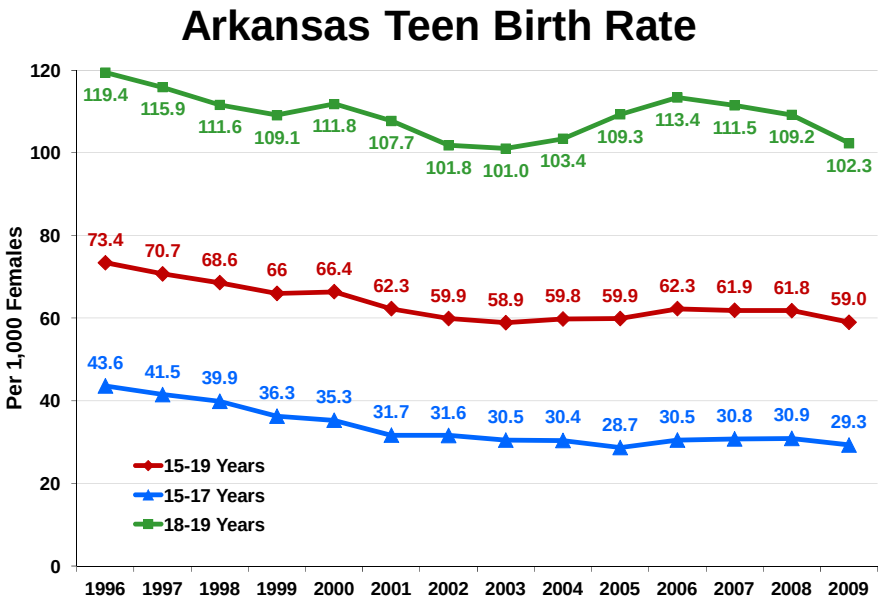
*AR Teens are adolescents less than 20 years.
Sources: National Center for Health Statistics (NCHS) and Health Statistics Branch, Arkansas Department of Health.

Figure 16



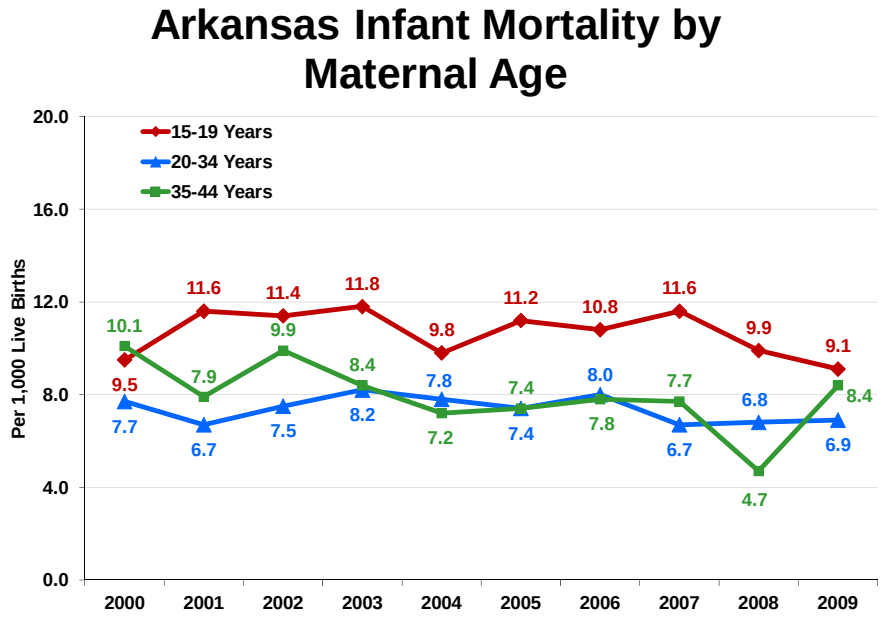
Source: Birth Files, Health Statistics Branch, Arkansas Department of Health

Figure 17



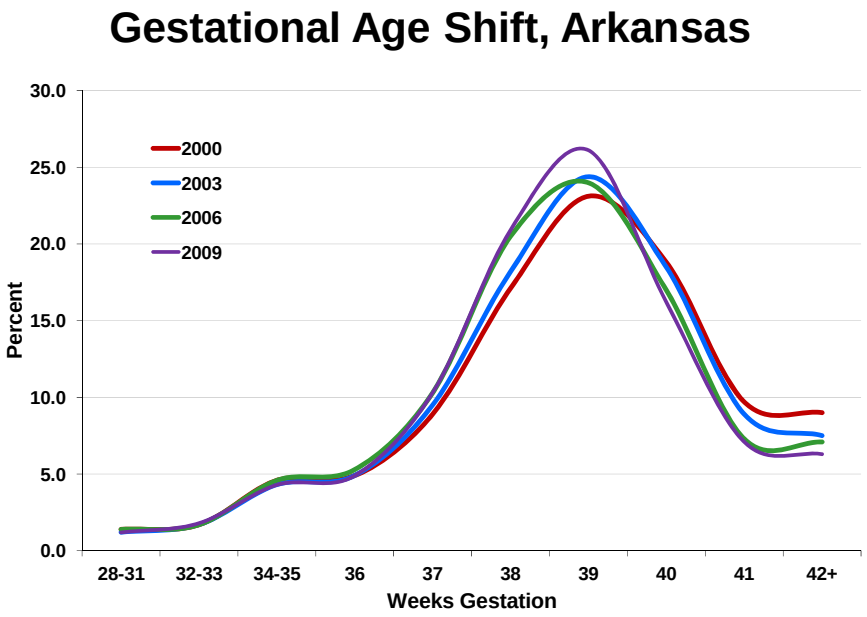
Source: Birth Files, Health Statistics Branch, Arkansas Department of Health and US Census Bureau

Figure 18



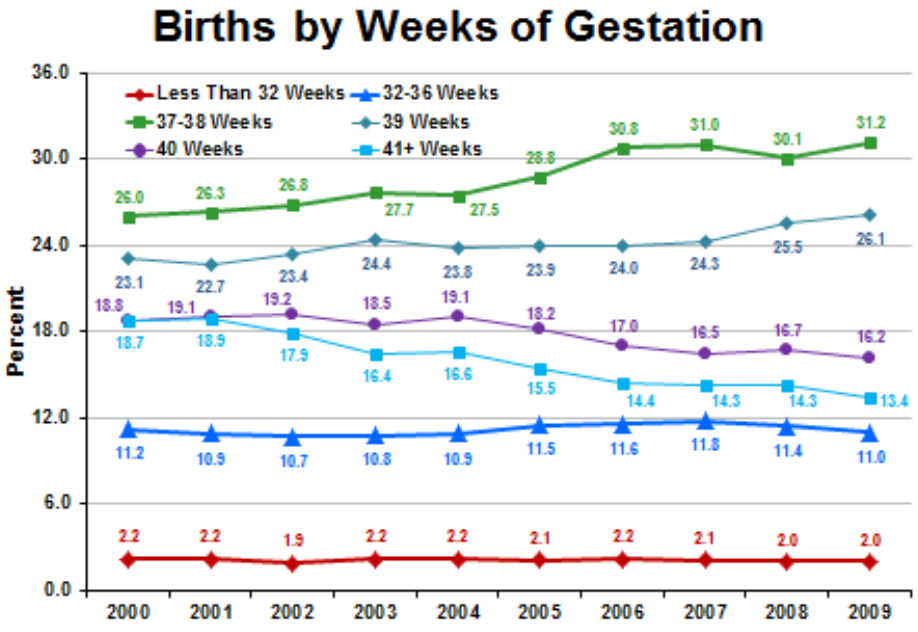
Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 19



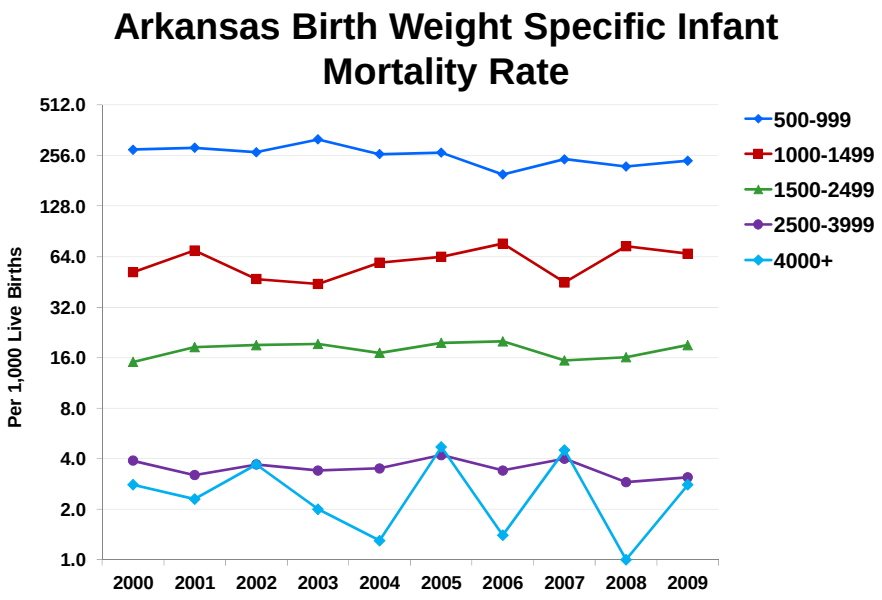
Source: Birth Files, Health Statistics Branch, Arkansas Department of Health

Figure 20



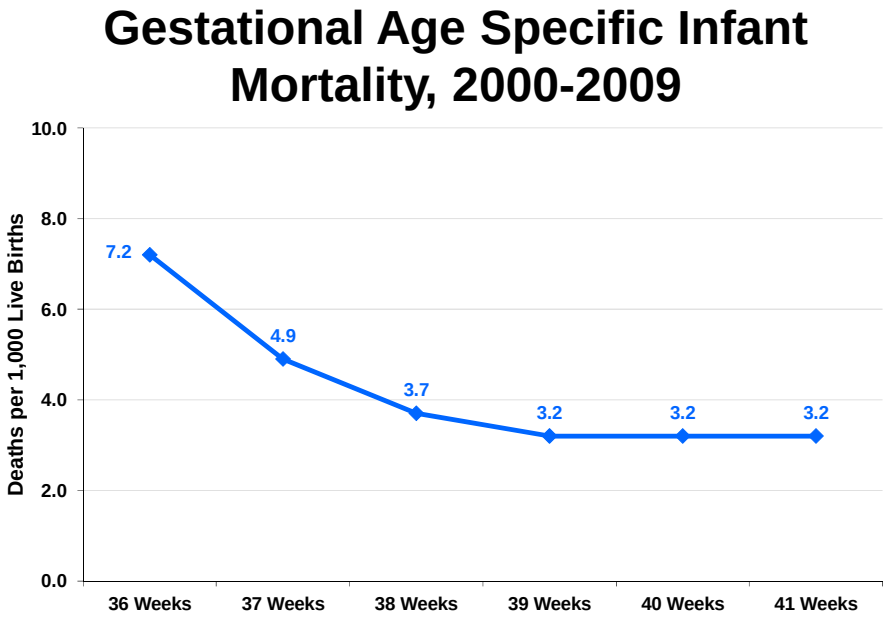
Source: Birth Files, Health Statistics Branch, Arkansas Department of Health

Figure 21



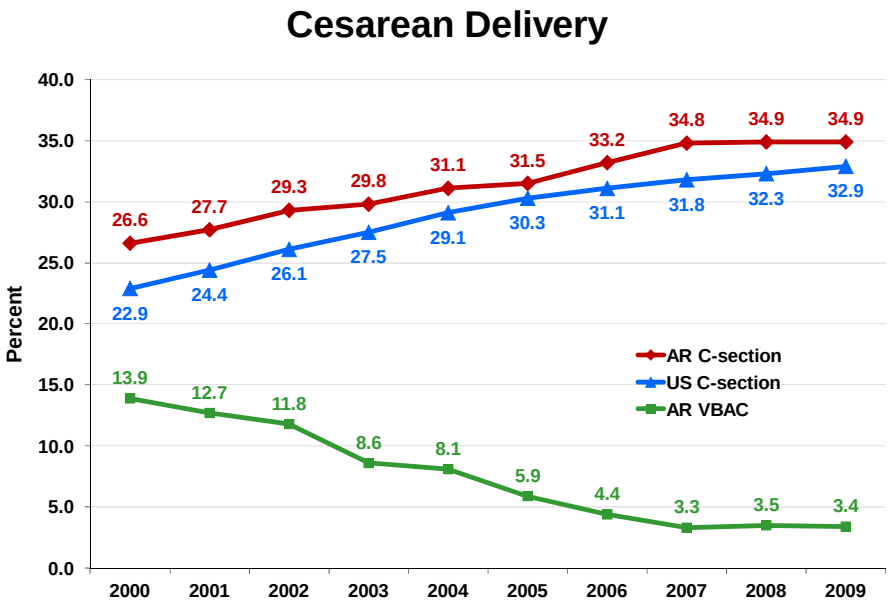
Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 22



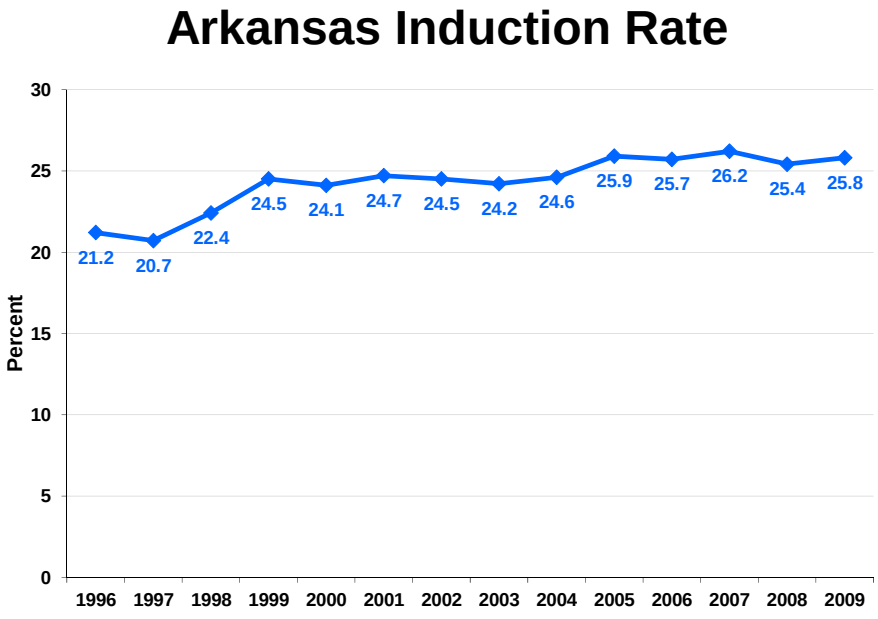
Source: Linked Birth/Infant Death Files, Health Statistics Branch, Arkansas Department of Health

Figure 23



Source: Birth Files, Health Statistics Branch, Arkansas Department of Health

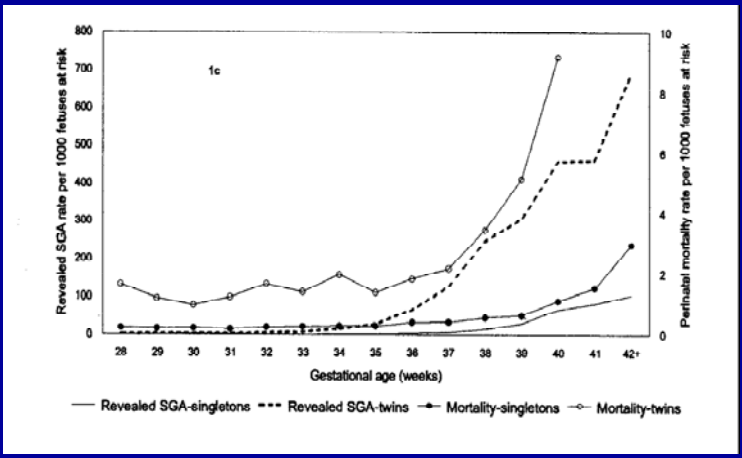
Figure 24



Source: Birth Files, Health Statistics Branch, Arkansas Department of Health

Figure 25

Fetus at Risk Model



Source: KS Joseph, Theory of Obstetrics; a framework to justify indicated early delivery, *BMC Pregnancy and Childbirth*, 2007, 7:4

Figure 26

MCH Pyramid of Health Services

The conceptual framework for the services of the Title V Maternal and Child Health Block Grant is envisioned as a pyramid with four tiers of services and levels of funding that provide comprehensive services for mothers and children. The pyramid also displays the uniqueness of the MCH Block Grant, which is the only Federal program that consistently provides services at all levels of the pyramid.