The New England
Journal of Medicine

Volume 332 APRIL 27, 1995 Number 17

ASSOCIATION OF YOUNG MATERNAL AGE WITH ADVERSE REPRODUCTIVE OUTCOMES

ALISON M. FRASER, M.S.P.H., JOHN E. BROCKERT, M.P.H., AND R.H. WARD, PH.D.

Abstract *Background.* Pregnancy in adolescence is associated with an excess risk of poor outcomes, including low birth weight and prematurity. Whether this association simply reflects the deleterious sociodemographic environment of most pregnant teenagers or whether biologic immaturity is also causally implicated is not known.

Methods. To determine whether a young age confers an intrinsic risk of adverse outcomes of pregnancy, we performed stratified analyses of 134,088 white girls and women, 13 to 24 years old, in Utah who delivered singleton, first-born children between 1970 and 1990. Relative risk for subgroups of this study population was examined to eliminate the confounding influence of marital status, educational level, and the adequacy of prenatal care. The adjusted relative risk for the entire study group was calculated as the weighted average of the stratum-specific risks.

Results. Among white married mothers with educational levels appropriate for their ages who received adequate prenatal care, younger teenage mothers (13 to 17 years of age) had a significantly higher risk ($P<0.001$) than mothers who were 20 to 24 years of age of delivering an infant who had low birth weight (relative risk, 1.7; 95 percent confidence interval, 1.5 to 2.0), who was delivered prematurely (relative risk, 1.9; 95 percent confidence interval, 1.7 to 2.1), or who was small for gestational age (relative risk, 1.3; 95 percent confidence interval, 1.2 to 1.4). Older teenage mothers (18 or 19 years of age) also had a significant increase in these risks. Even though sociodemographic variables associated with teenage pregnancy increase the risk of adverse outcomes, the relative risk remained significantly elevated for both younger and older teenage mothers after adjustment for marital status, level of education, and adequacy of prenatal care.

Conclusions. In a study of mothers 13 to 24 years old who had the characteristics of most white, middle-class Americans, a younger age conferred an increased risk of adverse pregnancy outcomes that was independent of important confounding sociodemographic factors. (N Engl J Med 1995;332:1113-7.)

DURING the past decade in the United States, approximately 10 percent of teenage girls from 15 to 19 years old became pregnant.[1] Births to mothers in this age group now account for approximately 13 percent of all live births in the United States.[2] This pattern is a source of societal concern, since teenage mothers have an increased risk of having low-birth-weight babies, premature babies, and babies who die during the first year of life[3,4]; they thus have a disproportionate share of all adverse outcomes of pregnancy. Despite the magnitude of the problem, it is unknown whether the poor outcomes of teenage pregnancy are partly attributable to the biologic fact of a young maternal age or are solely the consequence of sociodemographic factors generally associated with pregnancy among teenagers. Teenage mothers are more likely than older mothers to be nonwhite, poor, less well educated, and unmarried, and they are less likely to have received early prenatal care[1,5] — all known risk factors for low birth weight in their babies.[6,7] Hence, the biologic risk associated with a young maternal age may have been exaggerated in previous studies because of inadequate control for sociodemographic risk factors.[8-11] Studies in animals and a small number of epidemiologic studies suggest, however, that a young age alone may be an independent risk factor for adverse outcomes of pregnancy.[4-6,12]

Vital-statistics data from Utah offer an excellent opportunity to evaluate the biologic risk associated with pregnancy in adolescents, since the mothers in this state are largely white and married, have generally received adequate prenatal care, and usually have a healthy lifestyle. The rate of smoking among women 18 years of age or older in Utah[13] is half the national average of 24 percent,[14] and the use of alcohol and drugs is also lower than in the country as a whole.[15,16] Among the states, Utah ranks 47th in the percentage of children living below the poverty level and 10th in the proportion of high-school graduates.[17] We undertook this study to assess whether, in a population that is largely white and middle-class, a young maternal age

From the Department of Human Genetics, University of Utah (A.M.F., R.H.W.), and the Bureau of Vital Records, Utah Department of Health (J.E.B.) — both in Salt Lake City. Address reprint requests to Dr. Ward at the Department of Human Genetics, 2100 Eccles Institute of Human Genetics, University of Utah, Salt Lake City, UT 84112.

Supported by a grant (1R01 HD23492) from the National Institutes of Health and by a grant from the Willard L. Eccles Foundation.

Presented in part at the annual meeting of the American Association of Physical Anthropologists, Las Vegas, April 3, 1992.

is associated with a high intrinsic risk of adverse outcomes of pregnancy.

METHODS

Study Subjects

Of a total of 762,893 babies born in Utah between 1970 and 1990, 150,508 were white, singleton, first-born infants whose mothers were 13 to 24 years of age. Of these infants, 134,088 were selected for the study because their records contained complete data on the following variables: birth weight, duration of gestation, mother's age, mother's marital status, mother's educational level, and prenatal care received. The study protocol was approved by the local institutional review board.

Definition of Variables

Outcome Variables

Low birth weight was defined as a weight below 2500 g at birth, and prematurity as delivery at a gestational age of less than 37 weeks.[18] Small-for-gestational-age infants were defined as those with birth weights below the 10th percentile for gestational age and sex; an iterative method was used to compensate for the misclassification of gestational age among babies born prematurely.[19]

Teenage mothers were divided into two age groups: those 13 to 17 years old and those 18 to 19 years old. Since mothers from 20 to 24 years old had the lowest risk of all three adverse outcomes, they served as the reference group in all comparisons.

Covariates

The mothers were categorized as unmarried or married. Prenatal care was categorized as adequate, intermediate, or inadequate according to the criteria of the National Institute of Medicine,[20] which are based on the trimester during which prenatal care is initiated and the total number of prenatal visits. A mother's educational level was defined as appropriate or inappropriate for her age, so that a consistent classification could be used for both younger and older mothers. Mothers older than 19 were considered to have an age-appropriate educational level if they had completed high school, whereas younger mothers had to have completed the minimal number of grades for their age.

Statistical Analysis

To eliminate the potentially confounding effects of sociodemographic covariates, deliveries were cross-classified according to the mother's marital status, the adequacy of prenatal care, and the mother's educational level, yielding direct estimates of relative risk in subgroups defined by these variables (stratum-specific relative risks) and 95 percent confidence intervals.[21] The effects of sociodemographic covariates were successively eliminated by restricting the comparisons to mothers who were characterized as having received adequate prenatal care; as married; as married and having received adequate prenatal care; and as married with an age-appropriate level of education and having received adequate prenatal care. Since in this final category the potential influence of a deleterious sociodemographic environment is minimized, the risk for the mothers in this category was assumed to reflect the underlying biologic risk. Adjusted relative risks for the entire study group (population-wide relative risks) and 95 percent confidence intervals were calculated by pooling the appropriately weighted logarithms of the individual stratum-specific risks.[21] Two-tailed tests were used to evaluate the significance of the difference between the logarithms of the individual risks,[21] and interactions in the multiway tables were tested with program 4f of the BMDP statistical package.[22]

RESULTS

In the entire cohort of infants born in Utah from 1970 to 1990, 170,699 were white, singleton, first-born infants with complete data. Of these, 53 percent were born to mothers who were 20 to 24 years old, 9 percent were born to younger teenage mothers (those ≤17 years of age), and 17 percent were born to older teenage mothers (those 18 or 19 years of age). The younger teenage mothers were the most likely of these three groups to be unmarried and the least likely to have received adequate prenatal care, whereas the older teenage mothers were the most likely to have an age-inappropriate educational level (Table 1). Since these summary statistics reflect data on the mothers of babies born over a 20-year period, we evaluated these distributions for each year (data not shown). There was no temporal trend in the distribution of categories of prenatal care for any age group. However, there was a small decline (<2 percent) in the proportion of mothers with age-appropriate education, and, in concert with national trends, the proportion of births to unmarried mothers increased approximately three-to-fourfold for all three age groups during this period.

The overall incidence of low birth weight was highest among the babies born to the younger teenage mothers (7 percent) and lowest among those whose mothers were 20 to 24 years old (4 percent) (Table 2). Similarly, the younger teenage mothers had the highest percentage of premature infants (10 percent) and small-for-gestational-age infants (14 percent). In all age groups, the babies born to mothers who were unmarried, who had not received adequate prenatal care, or who had an age-inappropriate educational level had an increased risk of all three adverse outcomes (Table 2). Inadequate prenatal care was most strongly associated with adverse outcomes: within an age group, mothers who did not receive adequate care were approximately twice as likely to have low-birth-weight babies as those who received adequate care and more than twice as likely to have premature babies.

Since adolescent mothers are more likely than older mothers to have sociodemographic characteristics associated with adverse outcomes of pregnancy, we eliminated the confounding effects of marital status, educational level, and adequacy of prenatal care by cross-classifying births according to these covariates. The distribution of births among mothers with age-

Table 1. Characteristics of the Mothers in the Study Population, According to Age.

CHARACTERISTIC	MOTHER'S AGE (YR)		
	≤17	18–19	20–24
No. of live births	15,106	28,667	90,315
Marital status — no. (%)			
Unmarried	5,793 (38)	5,911 (21)	5,611 (6)
Married	9,313 (62)	22,756 (79)	84,704 (94)
Prenatal care — no. (%)			
Inadequate	1,209 (8)	1,528 (5)	2,026 (2)
Intermediate	6,097 (40)	9,478 (33)	19,844 (22)
Adequate	7,800 (52)	17,661 (62)	68,445 (76)
Education — no. (%)			
Age-inappropriate	811 (5)	4,266 (15)	3,556 (4)
Age-appropriate	14,295 (95)	24,401 (85)	86,759 (96)

Table 2. Frequency of Adverse Outcomes of Pregnancy, According to the Mother's Age and Selected Characteristics.

Maternal Characteristic	Low Birth Weight			Prematurity			Small Size for Gestational Age		
	≤17 yr	18–19 yr	20–24 yr	≤17 yr	18–19 yr	20–24 yr	≤17 yr	18–19 yr	20–24 yr
	*percentage of live births**								
All subjects	7	5	4	10	8	5	14	12	10
Marital status									
Unmarried	7	7	6	11	9	8	15	15	16
Married	6	5	4	10	8	5	13	11	10
Prenatal care									
Inadequate	10	9	7	17	14	11	15	15	15
Intermediate	8	6	6	13	10	10	14	13	11
Adequate	5	4	3	8	6	4	13	12	10
Education									
Age-inappropriate	8	7	7	11	8	7	18	18	19
Age-appropriate	7	5	4	11	8	5	13	11	10

*The percentages are based on the numbers in Table 1.

appropriate educational levels indicates that, for all three age groups, most births occur among mothers in the more favorable sociodemographic categories (married and having received adequate prenatal care), and the fewest to mothers who did not receive adequate prenatal care (Table 3). The inverse relation between maternal age and the proportion of births in the least favorable categories emphasizes the importance of including sociodemographic covariates in the analysis.

The estimated relative risks for different subgroups defined according to sociodemographic covariates, plus the adjusted population-wide relative risks for both groups of teenage mothers as compared with mothers 20 to 24 years of age, are shown in Table 4. The relative risks in the subgroup with the most favorable sociodemographic characteristics (i.e., mothers who were married and had adequate prenatal care and age-appropriate educational level) represent estimates of the intrinsic biologic risk of adverse outcomes associated with a young age. Teenage mothers in this sociodemographic category had a significant elevation in the risk of all three adverse outcomes; the greatest elevation was in the risk of prematurity among the infants born to the younger teenage mothers (relative risk, 1.9; $P<0.001$). The babies of younger teenage mothers also had an increased risk of low birth weight (relative risk, 1.7; $P<0.001$). Older teenage mothers had lower, but still significant, risks of having premature infants or infants with low birth weights.

To determine whether temporal trends influenced these results, we repeated the analysis after dividing the mothers in the most favorable sociodemographic category into five-year age cohorts (data not shown). For younger teenage mothers, the risk of all three adverse outcomes remained significantly elevated in each cohort, and apart from a slight decline in the risk of low birth weight and prematurity, there was no significant temporal trend. Older teenage mothers in each age cohort also had significantly higher risks, though the decline in the risk of prematurity over time was more marked. We also evaluated the outcome among very young teenage mothers (those 13 to 15 years of age) to determine whether the intrinsic risk of adverse outcomes of pregnancy was inversely proportional to maternal age. Among the infants born to young girls who were married, had age-appropriate educational levels, and had received adequate prenatal care, the risks of all three adverse outcomes were significantly higher than the risks among the infants born to mothers 16 to 17 years old. The relative risk of low birth weight was 2.8 (95 percent confidence interval, 1.9 to 4.0) and that of prematurity was 2.6 (95 percent confidence interval, 1.9 to 3.6), whereas the relative risk of small size for gestational age was 1.4 (95 percent confidence interval, 1.1 to 1.8).

Although statistically significant, the adjusted relative risks for the entire study group shown in Table 4 were consistently lower than the relative risks for the most favorable stratum. However, the estimated adjusted relative risk for the entire group is potentially misleading because the existence of significant three-way interactions within the complete data set suggests that individual stratum-specific risks are likely to differ significantly. For example, analysis of all the subgroups in which the mothers had age-appropriate educational levels identified considerable variation in the risk of all three outcomes (Table 5). For both older and younger teenage mothers in this group, the relative risk of low birth weight and prematurity in their infants was significantly higher among those who were married but had not received adequate prenatal care than among those who were unmarried and had intermediate levels of care. Similarly, among teenage mothers who received intermediate prenatal care, the relative risk of having a small-for-gestational-age infant was significantly higher for those who were married than for those who were unmarried. The observation that teenage mothers with less-than-optimal sociodemographic characteristics tend

Table 3. Number of Infants Born to Mothers with Age-Appropriate Educational Levels in Each Age Group, According to Marital Status and the Adequacy of Prenatal Care.

Mother's Age (yr)	No. of Live Births	Married			Unmarried		
		Adequate Prenatal Care	Intermediate Prenatal Care	Inadequate Prenatal Care	Adequate Prenatal Care	Intermediate Prenatal Care	Inadequate Prenatal Care
		number of infants (percentage of total deliveries)					
≤17	14,295	4,970 (33)	3,398 (22)	431 (3)	2412 (16)	2383 (16)	701 (5)
18–19	24,401	12,968 (45)	6,106 (21)	717 (3)	2200 (8)	1870 (7)	540 (2)
20–24	86,759	63,657 (70)	17,038 (19)	1364 (2)	2534 (3)	1699 (2)	467 (1)

to have the same risk as mothers from 20 to 24 years of age (i.e., relative risk close to 1.0) suggests that the intrinsic risk due to young maternal age has its greatest effect when the sociodemographic environment is favorable.

Because information about smoking by mothers during pregnancy was available for births in Utah in 1989 and 1990, we stratified the analyses according to smoking history. The magnitude of the relative risks of all three adverse outcomes among the infants of teenage mothers who did not smoke during pregnancy (Table 6) was similar to that in the full analysis (Table 4), even though the small sample precluded statistical significance. Notably, nonsmoking younger teenage mothers had a significantly higher risk of delivering a low-birthweight infant than nonsmoking mothers from 20 to 24 years of age (relative risk, 2.0; 95 percent confidence interval, 1.2 to 3.1) and also a higher risk of delivering premature and small-for-gestational-age infants. Among the nonsmoking older teenage mothers, the relative risk of delivering a small-for-gestational-age infant was higher than in the previous analysis, but the relative risks of low birth weight and prematurity declined.

Table 5. Relative Risk of Adverse Outcomes of Pregnancy among Mothers with Age-Appropriate Educational Levels.*

Outcome and Mother's Age	Married		Unmarried		
	Intermediate prenatal care	Inadequate prenatal care	Adequate prenatal care	Intermediate prenatal care	Inadequate prenatal care
	relative risk (95% confidence interval)				
Low birth weight					
≤17 yr	1.4 (1.2–1.6)	1.8 (1.2–2.6)	1.1 (0.9–1.4)	1.2 (0.9–1.5)	1.2 (0.8–1.7)
18–19 yr	1.1 (0.9–1.2)	1.5 (1.0–2.0)	1.1 (0.8–1.4)	0.9 (0.7–1.2)	1.2 (0.8–1.7)
Prematurity					
≤17 yr	1.4 (1.2–1.5)	1.8 (1.4–2.4)	1.4 (1.3–1.8)	1.3 (1.1–1.6)	1.2 (0.9–1.5)
18–19 yr	1.1 (1.0–1.2)	1.5 (1.2–2.0)	1.1 (0.9–1.4)	1.1 (0.9–1.4)	1.0 (0.7–1.3)
Small size for gestational age					
≤17 yr	1.3 (1.2–1.4)	1.0 (0.7–1.3)	1.1 (0.9–1.2)	0.9 (0.8–1.1)	1.0 (0.8–1.3)
18–19 yr	1.1 (1.0–1.2)	1.0 (0.8–1.3)	1.0 (0.8–1.1)	0.9 (0.8–1.0)	0.9 (0.7–1.2)

*Relative risk is expressed as the risk in the subgroup in question as compared with that among mothers 20 to 24 years of age with the same characteristics.

Discussion

Our analysis confirms the influence of sociodemographic factors on reproductive outcome; inadequate prenatal care, in particular, was associated with a marked increase in prematurity. This finding is consistent with the results of many previous studies, indicating that sociodemographic factors and the adequacy of prenatal care have important effects on the outcomes of pregnancy among teenagers.[5-7,20,23,24] Our results also indicate, however, that although teenage mothers have a significantly elevated risk of delivering low-birthweight, premature, and small-for-gestational-age infants, these risks remain significant even when the analysis is limited to married mothers with age-appropriate educational levels who receive adequate prenatal care. This elevation in risk, consistent over the 20-year period we studied, suggests that a young age in the mother intrinsically increases the risk of adverse outcomes of pregnancy. That the relative risks were highest among the youngest mothers in the more favorable sociodemographic strata strengthens the case that young age is an inherent risk factor and challenges the contention that teenage mothers who receive adequate prenatal care will have reproductive outcomes as good as, or better than, those of older mothers.[10,23,25] Our data suggest that adequate prenatal care does not completely eliminate the risks inherent in teenage pregnancy, presumably because biologic immaturity increases the risk of a poor outcome.

Our estimates could have been influenced by the fact that we had no data on psychosocial attributes that are believed to increase the risk of adverse outcomes of pregnancy, such as emotional stress and lack of family support.[26] However, any bias is likely to have been minimal, since our main analysis was restricted to married teenage mothers, who are likely to receive both emotional and economic support. Similarly, we could not control for the use of illicit drugs such as cocaine, which are known to influence reproductive outcomes.[27] However, data from a random sample of pregnant women in Utah indicate a rate of cocaine use of only 1 percent, and a rate of 8 percent for all illicit drugs and alcohol combined.[28] Moreover, a population-based survey indicates that teenagers in Utah have lower rates of illicit-

Table 4. Relative Risk of Low Birth Weight, Prematurity, and Small Size for Gestational Age among Infants Born to Younger and Older Teenage Mothers, as Compared with Mothers 20 to 24 Years of Age.*

Outcome and Mother's Age	Adequate Prenatal Care	Married	Married, Adequate Prenatal Care	Married, Adequate Care, Age-Appropriate Education	Entire Group†
	relative risk (95% confidence interval)				
Low birth weight					
≤17 yr	1.7 (1.5–1.9)	1.8 (1.6–1.9)	1.7 (1.5–1.9)	1.7 (1.5–2.0)	1.4 (1.3–1.5)
18–19 yr	1.4 (1.3–1.5)	1.3 (1.2–1.4)	1.3 (1.2–1.4)	1.2 (1.1–1.4)	1.1 (1.1–1.2)
Prematurity					
≤17 yr	1.9 (1.8–2.1)	1.9 (1.8–2.1)	1.9 (1.7–2.1)	1.9 (1.7–2.1)	1.5 (1.4–1.6)
18–19 yr	1.5 (1.4–1.6)	1.5 (1.4–1.5)	1.5 (1.4–1.6)	1.5 (1.4–1.6)	1.3 (1.2–1.3)
Small size for gestational age					
≤17 yr	1.4 (1.3–1.5)	1.3 (1.2–1.4)	1.3 (1.2–1.4)	1.3 (1.2–1.4)	1.2 (1.1–1.2)
18–19 yr	1.2 (1.1–1.2)	1.1 (1.1–1.2)	1.1 (1.1–1.2)	1.1 (1.0–1.2)	1.0 (1.0–1.1)

*Relative risk is expressed as the risk in the subgroup in question as compared with that among mothers 20 to 24 years of age with the same characteristics. All relative risks were significant.

†The adjusted relative risk for the entire study group, calculated as the weighted sum of all stratum-specific relative risks.

Table 6. Relative Risk of Low Birth Weight, Prematurity, and Small Size for Gestational Age among Infants Born in 1989 or 1990 to Nonsmoking Teenage Mothers Who Were Married, Had Age-Appropriate Educational Levels, and Received Adequate Prenatal Care.*

Outcome	Mother's Age (yr)	
	≤17	18–19
No. of infants	277	934
	relative risk (95% CI)†	
Low birth weight	2.0 (1.2–3.1)	1.1 (0.8–1.6)
Prematurity	1.5 (1.0–2.2)	1.2 (0.9–1.6)
Small size for gestational age	1.4 (1.0–2.0)	1.2 (1.0–1.5)

*Relative risk is expressed as the risk in the subgroup in question as compared with the risk among the 5634 infants born to nonsmoking mothers 20 to 24 years of age with identical sociodemographic characteristics.

†CI denotes confidence interval.

drug use than teenagers in the nation as a whole.[16] Therefore, it is unlikely that illicit-drug use by pregnant teenagers influenced our results.

Two general features of biologic immaturity could have a role in increasing the risk of adverse outcomes: a young gynecologic age (defined as conception within two years after menarche)[29] and the effect of a girl's becoming pregnant before her own growth has ceased.[30-32] Immaturity of the uterine or cervical blood supply may predispose teenage mothers to subclinical infection, an increase in prostaglandin production, and a consequent increase in the incidence of preterm delivery. Teenage mothers who themselves continue to grow during pregnancy could compete with the developing fetus for nutrients, to the detriment of the fetus. This supposition is supported by evidence that weight gain during pregnancy may be more critical for teenage mothers than for older mothers.[31,32] Hence, the intrinsic increase in the risk of adverse outcomes of pregnancy among teenagers in Utah is likely to be partly attributable to young gynecologic age or inadequate weight gain.

Since white mothers have 67 percent of the infants born to teenagers in the United States,[33] we believe our results have important implications. Becoming pregnant as a young teenager can result in an intrinsic increase in the risk of adverse outcomes of pregnancy, quite apart from the increased risk due to the adverse social and behavioral factors that are frequently associated with teenage pregnancy. Consequently, efforts to improve the sociodemographic environment of pregnant teenagers may reduce their risk of poor reproductive outcomes but will not eliminate it. Our data support the notion that every effort should be made to persuade pregnant teenagers to obtain adequate prenatal care and to adopt a healthy lifestyle. However, our results also suggest that the burden of teenage pregnancy will remain unacceptably high unless efforts are made to identify the intrinsic biologic factors that contribute to the increased risk of adverse outcomes of pregnancy among younger mothers and then to find ways to minimize the effects of these intrinsic factors.

We thank Pat Corneli for statistical advice.

References

1. Trussell J. Teenage pregnancy in the United States. Fam Plann Perspect 1988;20:262-72.
2. Department of Commerce. Statistical abstract of the United States. 111th ed. Washington, D.C.: Government Printing Office, 1991:63.
3. Friede A, Baldwin W, Rhodes PH, et al. Young maternal age and infant mortality: the role of low birth weight. Public Health Rep 1987;102:192-9.
4. Brown HL, Fan YD, Gonsoulin WJ. Obstetric complications in young teenagers. South Med J 1991;84:46-8.
5. Ketterlinus RD, Henderson SH, Lamb ME. Maternal age, sociodemographics, prenatal health and behavior: influences on neonatal risk status. J Adolesc Health Care 1990;11:423-31.
6. Eisner V, Brazie JV, Pratt MW, Hexter AC. The risk of low birth weight. Am J Public Health 1979;69:887-93.
7. Ahmed F. Unmarried mothers as a high-risk group for adverse pregnancy outcomes. J Community Health 1990;15:35-44.
8. McAnarney ER. Young maternal age and adverse neonatal outcome. Am J Dis Child 1987;141:1053-9.
9. Horon IL, Strobino DM, MacDonald HM. Birth weights among infants born to adolescent and young adult women. Am J Obstet Gynecol 1983;146:444-9.
10. Makinson C. The health consequences of teenage fertility. Fam Plann Perspect 1985;17:132-9.
11. Lee KS, Ferguson RM, Corpuz M, Gartner LM. Maternal age and incidence of low birth weight at term: a population study. Am J Obstet Gynecol 1988; 158:84-9.
12. Committee to Study the Prevention of Low Birthweight, Division of Health Promotion and Disease Prevention, Institute of Medicine. Preventing low birthweight. Washington, D.C.: National Academy Press, 1985.
13. Utah Department of Health, Bureau of Vital Records and Health Statistics, Center for Health Statistics. Utah's 1991 health status survey: tobacco use. Technical report no. 162. Salt Lake City: Utah State University Dept. of Sociology, Population Research Laboratory, 1992.
14. Cigarette smoking among adults — United States, 1991. MMWR Morb Mortal Wkly Rep 1993;42:230-3. [Erratum, MMWR Morb Mortal Wkly Rep 1993;42:255.]
15. Utah Department of Health, Bureau of Vital Records and Health Statistics, Center for Health Statistics. Utah's 1991 health status survey: alcohol consumption. Technical report no. 167. Salt Lake City: Utah State University Dept. of Sociology, Population Research Laboratory, 1993.
16. Dan Jones & Associates. Executive summary: main findings: Utah household survey on substance abuse 1993. Salt Lake City: Utah Division of Substance Abuse, Utah Department of Human Services, 1993.
17. Annie E. Casey Foundation. Kids count data book: state profiles of child well-being. Washington, D.C.: Center for the Study of Social Policy, 1992: 110-1.
18. Dunn PM. The search for perinatal definitions and standards. Acta Paediatr Suppl 1985;319:7-16.
19. David RJ. Population-based intrauterine growth curves from computerized birth certificates. South Med J 1983;76:1401-6.
20. Showstack JA, Budetti PP, Minkler D. Factors associated with birthweight: an exploration of the roles of prenatal care and length of gestation. Am J Public Health 1984;74:1003-8.
21. Rothman KJ. Modern epidemiology. Boston: Little, Brown, 1986.
22. Dixon WJ, ed. BMDP statistical software manual. Vol. 1. Berkeley: University of California Press, 1990:231-310.
23. Elster AB. The effect of maternal age, parity, and prenatal care on perinatal outcome in adolescent mothers. Am J Obstet Gynecol 1984;149:845-7.
24. Scholl TO, Miller LK, Salmon RW, Cofsky MC, Shearer J. Prenatal care adequacy and the outcome of adolescent pregnancy: effects on weight gain, preterm delivery, and birth weight. Obstet Gynecol 1987;69:312-6.
25. Gale R, Seidman DS, Dollberg S, Armon Y, Stevenson DK. Is teenage pregnancy a neonatal risk factor? J Adolesc Health Care 1989;10:404-8.
26. Turner RJ, Grindstaff CF, Phillips N. Social support and outcome in teenage pregnancy. J Health Soc Behav 1990;31:43-57.
27. Zuckerman B, Frank DA, Hingson R, et al. Effects of maternal marijuana and cocaine use on fetal growth. N Engl J Med 1989;320:762-8.
28. Buchi KF, Varner MW, Chase RA. The prevalence of substance abuse among pregnant women in Utah. Obstet Gynecol 1993;81:239-42.
29. Scholl TO, Hediger ML, Salmon RW, Belsky DH, Ances IG. Association between low gynaecological age and preterm birth. Paediatr Perinat Epidemiol 1989;3:357-66.
30. Scholl TO, Hediger ML, Ances IG, Cronk CE. Growth during early teenage pregnancies. Lancet 1988;1:701-2.
31. Haiek L, Lederman SA. The relationship between maternal weight for height and term birth weight in teens and adult women. J Adolesc Health Care 1989;10:16-22.
32. Hediger ML, Scholl TO, Belsky DH, Ances IG, Salmon RW. Patterns of weight gain in adolescent pregnancy: effects on birth weight and preterm delivery. Obstet Gynecol 1989;74:6-12.
33. National Center for Health Statistics. Advance report of final natality statistics, 1991. Mon Vital Stat Rep 1993;42(3):Suppl.