The Effects of the Prenatal Plus Program on Infant Birth Weight and Medicaid Costs

December 2002

Colorado Department of Public Health and Environment

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Effectiveness of the Colorado Department of Health and Environment's Prenatal Plus Program

BACKGROUND

The Prenatal Plus Program is a Medicaid-funded program that provides case management, mental health, smoking cessation, and nutrition services to high-risk pregnant women in Colorado. These services complement the medical component of prenatal care. Multidisciplinary Prenatal Plus teams, consisting of a case manager, a registered dietitian, and a mental health professional, work with clients to make lifestyle changes related to non-medical factors that may affect pregnancies and birth outcomes.

The primary goal of the Prenatal Plus Program is to improve the health of high-risk Medicaid-eligible pregnant women in Colorado to increase the likelihood of healthy births. Additional program goals are:

- to reduce the incidence of low-weight births;
- to improve the nutritional and psychosocial health status of pregnant, high-risk Medicaid clients;
- to assist women in developing and maintaining healthy lifestyles during pregnancy and beyond, focusing on smoking cessation counseling and discouraging use of alcohol and other drugs;
- to increase appropriate use of medical and social services; and
- to increase women's self-sufficiency.

The Prenatal Plus Program is administered by the Colorado Department of Public Health and Environment, Women's Health Section. Medicaid directly reimburses providers for Prenatal Plus services.

The Department of Public Health and Environment and the legislature have expressed interest in the effects of this program on both low birth weight incidence and cost. This report responds to that interest and describes the effectiveness of the program in reducing the low birth weight rate among Medicaid's high-risk pregnant women, the costs of the program, and costs (savings) to Medicaid resulting from the program. For assessing the effects of the program on cost, the appropriate type of analysis is a net cost analysis. This involves describing the costs of the program itself, the costs or savings associated with the program, e.g., lower (or higher) medical expenditures for program participants, and determining whether the program saves money or adds to costs. Other types of cost analysis, such as cost-benefit analysis and cost-effectiveness analysis, are inappropriate for various reasons.[1]

The Effects of Low Birth Weight

Low birth weight, i.e., less than 2500 grams, or 5 pounds, 8 ounces or less, has been associated with numerous effects on the lives of children born with low birth weights, their parents, and society. These effects are not confined to the child's early years, but for many children with low birth weight, problems have been found to persist into the school years and adulthood. A review of the research literature documents numerous problems associated with low birth weight.

Infancy. When compared with infants of normal birth weight, a low birth weight (LBW) child consumes more medical care resources at birth and is more likely to be re-hospitalized during the first year of life and to require specialized child care (Lewit et al., 1995).

Childhood and Adolescence. During the elementary school years, very low birth weight children (<1500 grams) are three to four times as likely to be hospitalized, and heavier LBW children (1500-2500 grams) are two to three times as likely to be hospitalized as normal weight children (McCormick et al., 1993). Moreover, all LBW children are at significantly greater risk than are normal weight children of having health problems such as neurological deficits, sensory deficits, learning problems and central nervous system conditions. They are also at significantly greater risk of having limitations in one or more activities of daily living (McCormick et al., 1992). Low birth weight children are also several times more likely than are children born at normal weights to have psychiatric disorders and attention deficit hyperactivity disorder (ADHD), a risk factor for academic problems (Botting et al., 1997).

Studies of children that examined their performance at both elementary and middle-school age found that the intellectual and educational status of LBW children did not change over time, i.e., they did not outgrow their earlier problems (Hunt et al., 1988); indeed, there is evidence that the disparity between the abilities and performance of LBW children and those of normal birth weight children increases with age (Taylor et al., 2000, O'Callaghan et al., 1996).

While a number of researchers have found that socio-economic factors, such as low income or low educational attainment of the mother, affect the degree to which LBW children exhibit learning and behavior problems, several studies have found that LBW has effects independent of socio-economic factors. A study of twins with differing birth weights found that lower birth weight was a continuous risk factor for child behavior problems (van Os et al., 2001). Other research on 6-14 year-olds has found that, while social and economic factors exert a strong influence on the developmental outcomes of children, LBW (both very low birth weight and heavier low birth weight) exerts an influence independent of social and economic factors (Boardman et al., 2002). These findings suggest that interventions aimed at reducing low birth weight are worthwhile even in a socio-economically disadvantaged population.

The problems encountered by school-age LBW children have numerous effects. Most obvious are grade repetition and the need for special education for those with significant cognitive or other disabilities. The effects of LBW on both repeating grades and receiving special education are significant and continuous with birth weight. One study found that 23 percent of very low birth weight children repeated grades, while 17 percent of heavier LBW and 11 percent of normal birth weight children did so. Nearly 30 percent of very LBW children needed special education, while 5 percent of higher LBW children and 4 percent of normal birth weight children needed special education. Even after controlling for social and economic factors, differences in the need for special education persisted. This study also found that hyperactive behavior was strongly associated with school difficulty (McCormick et al., 1990). Other studies have found the same patterns. Depending on the study, the rate of grade repetition among LBW children ranged from 22 percent to 43 percent, compared with a range of 8 percent to 23 percent of normal weight children (Taylor et al., 2000; Klebanov et al.,1994; and Schraeder et al., 1997). These problems pose significant costs to society in the form of additional education expenditures. Children who repeat grades are in the public school system longer and impose costs in direct proportion to the number of years repeated. The cost of special education has been estimated to be about 2.3 times the cost of regular education (Chaikind et al. 1993).

Adulthood. The effects of low birth weight apparently extend well beyond childhood and adolescence. Low birth weight has been found to be a risk factor for low bone mineral content, a component of osteoporosis, in post-menopausal women (Yarbrough et al., 2000). It has also been found to increase the risk of early-onset chronic renal failure resulting from hypertension, diabetes and other causes (Lackland et al., 2000). A study of Pima Indians found LBW to be a risk factor for the later development of diabetes: the odds of developing diabetes were found to be 3.81 times greater for those with low birth weight, after controlling for age, sex, body mass index, maternal diabetes during pregnancy, and birth year (McCance et al., 1994). Men with LBW have been found to be at increased risk of stroke, even after adjusting for socio-economic status (Eriksson et al., 2000). In addition to these long-term health risks, low birth weight has been found in a longitudinal study to result in lower educational attainment, which is strongly correlated with lower income (Conley and Bennett, 2000). All of these effects, in addition to the burden borne by people born with low birth weight and their families, impose a cost on society in the form of increased medical care costs and smaller contributions to social and economic welfare.

The Effects of Being Born Small for Gestational Age (SGA)

Infants born small for gestational age are those with birth weights below the 10th percentile for their gestational age. This group overlaps with the LBW group of infants, but not all of them have low birth weights. They simply weigh much less than average for infants born at the same gestational age. For instance, babies born at full term may be small for their gestational age, but not have low birth weight. The research literature on the subject of small-for-gestational-age children is smaller than that for LBW children, but a review of it is instructive. These babies have outcomes similar to those of LBW children. For instance, one study found that the risk of rehospitalization in infancy was elevated for SGA infants compared with non-SGA infants (Vik et al., 1996). Another study found developmental delay and later language problems for SGA infants, although this group was not more likely to have these problems than were very LBW infants who were appropriate for gestational age (AGA) (Gutbrod et al., 2000). Other studies (Larroque et al., 2001; Pryor et al., 1995; Hollo et al., 2002; Kutschera et al., 2002) found that the academic achievement and intellectual functioning of SGA children were significantly below that of AGA children. A longitudinal study of 166 SGA (also very low birth weight) children found a range of problems, including cerebral palsy, other motor disturbances, severe developmental delays, and cognitive gaps that increased with age. Visual deficits also increased with age (63% in older children). Language delays and behavioral disturbances were common (Monset-Couchard et al., 2002). Another study found that children born small for gestational age were at twice the risk of having infantile autism than were children who were AGA (Hultman et al., 2002).

Cost of Low Birth Weight

An evaluation of Colorado’s Prenatal Plus program performed in 1999 found that, in 1996-97, hospital and provider charges to Medicaid averaged $26,333 for low birth weight babies and their mothers, while charges for normal weight babies and their mothers averaged $5,442—a nearly five-fold difference (Ricketts, 2000). Actual Medicaid reimbursement was much lower than were charges, however. Average reimbursement for low weight births for both mothers and babies was $12,350, and for normal-weight births, the average was $3,160, a four-fold difference. This study was confined to participants in the Prenatal Plus program, a high-risk population, and may not therefore reflect average charges and reimbursement for the entire Medicaid population of births occurring during the study period.

The findings of the Prenatal Plus evaluation described in the preceding paragraph are consistent with the research literature regarding the cost of low birth weight. Lewit et al. (1995) calculated the incremental costs of low birth weight throughout childhood, concentrating on health care, special child care, special education and grade repetition. The mean incremental cost per year (costs over and above the costs for normal birth weight children) per LBW child was $16,135 in 1988 dollars. Total nationwide costs were estimated to be $5.4 billion in 1988. Adjusting for inflation, the incremental cost per child would be $31,575 in 2001 dollars.

A study of the cost of postnatal care of children born to undocumented immigrants in California found that postnatal care for LBW infants born to the women in this population averaged 12 times that for infants of normal weight ($12,470 and $1003, respectively, in 1998 dollars--$14,054 and $1,130 in 2001 dollars) (Lu et al., 2000). While this population may differ in many respects from an average U.S. population, the magnitude of the difference in costs between the two groups of infants illustrates the cost consequences of low birth weight.

Although the research literature on this issue is sparse, studies of the cost of low birth weight consistently found that low birth weight imposes costs on society that are several times the cost of normal-weight births. Moreover, nearly all of these estimates, while they measure somewhat different outcomes, are remarkably similar with respect to the magnitude of the cost differences.

METHODS

Sources of Data

Prenatal Plus participants must be enrolled in Medicaid and voluntarily agree to participate in the program. We analyzed birth outcomes for two populations: Prenatal Plus participants and a group of Medicaid enrollees who were similar to Prenatal Plus participants, but who did not participate in the program. This latter group constituted a comparison group. We obtained Medicaid claims records for both Prenatal Plus participants and non-participants from the Colorado Department of Health Care Policy and Financing's Medicaid program.

Prenatal Plus Participants. The Medicaid program maintains files for five years only, largely because of its high volume of records. When a new month's data are entered, the first month's data are deleted. We were interested in all charges and payments accruing to each newborn for one year after birth and were able to obtain Medicaid data for children born in fiscal years 1998 to 2000, the only years for which complete data were available. In Medicaid's claims records, Prenatal Plus participants are identified by specific billing codes. Medicaid staff provided staff from the Colorado Department of Public Health and Environment (CDPHE) with files of inpatient claims with DRG codes for childbirth (370-375). This method of identifying Prenatal Plus participants resulted in finding 3,441 births to individual mothers enrolled in Prenatal Plus as identified by the Prenatal Plus billing code. This number was substantially smaller than the number of women participating in Prenatal Plus during the period for which Medicaid maintained files, so CDPHE staff performed a search of all Medicaid claims with Prenatal Plus billing codes. An additional 2,450 Prenatal Plus individual participants were identified, for a total of 5,891 Prenatal Plus births for analysis.

Once Medicaid records had been obtained, it was necessary to match them with birth certificates, since the birth certificate is the source of all risk factor and outcome data used in the study. The Medicaid births, including the Prenatal Plus participants that had been identified, were matched to birth certificate data by CDPHE staff. A second step in matching consisted of identifying other Medicaid births with characteristics similar to those of Prenatal Plus in order to constitute the comparison group, described below.

Comparison group. The comparison group of Medicaid recipients was selected based on criteria for participation in Prenatal Plus to the extent possible. The criteria we used were those that were available on birth certificates

(Medicaid does not keep records on risk factors). To qualify for Prenatal Plus, a woman must meet either one of a list of five criteria, or three of a list of 18 other criteria.

Three of the five former criteria are available from the birth certificate: 17 years or younger at time of delivery, recent or current alcohol use, and recent or current smoker. Note, however, that the report of alcohol or tobacco use were obtained at the time of delivery, when Prenatal Plus women may be more likely to have stopped the use of these substances. Missing from birth certificate data are two of these five criteria: nutrition risk and history of having a low birth weight infant.

Of the 18 criteria in the second group of risk factors (of which three must be met to qualify), six were available on the birth certificate: recent delivery (less than 12 months between date of last delivery and date of conception), pre-existing diabetes (Type I or Type II), less than age-appropriate education (has not graduated from high school, does not have a GED, or less than appropriate for age), not married, age 18 or 19, or over age 35 at time of delivery. We included in the comparison group all Medicaid women who met any of the first group of criteria and those who met at least three of the latter criteria and gave birth during the study period. Birth certificates do not include many risk factors, e.g., nutrition and psychosocial risks, that are determinants of enrollment in Prenatal Plus. Therefore we could not identify women with these risks for the comparison group. The size of the comparison group was 8,022. Women who received emergency services (labor and delivery) only were excluded from the analysis.

Analysis

We analyzed the effects of participation in the Prenatal Plus program on both low birth weight and Medicaid expenditures. We used bivariate analysis to compare two groups of Prenatal Plus participants, those receiving a full package of services (eight or more Prenatal Plus office visits plus two or more home visits) and those receiving a partial package (any combination of care not meeting the standard for a full package), with the comparison group. We examined risk factors and outcomes (low birth weight, being small for gestational age, and Medicaid charges and payments) for all three groups. All statistical analyses were carried out using SAS, Version 8e (Cary, NC.) We tested significance in bivariate analysis using t-tests for continuous variables or chi-squared tests for categorical variables. A p-value of 0.05 or less was considered significant.

We also analyzed the effects of Prenatal Plus participation by performing multiple logistic regressions. This allowed us to ensure that the effect of Prenatal Plus (the study variable of interest) was not influenced by other independent variables, e.g., characteristics of the different groups. Multivariate analyses allow us to determine with greater certainty that any effect of Prenatal Plus on the outcome variables, low birth weight and being small for gestational age, is due to the program and not to other factors. The other factors, or explanatory variables, were: fiscal year of birth (97/98, 98/99, or 99/00), maternal race (white/non-Hispanic, white/Hispanic, African American, or other), participation in Prenatal Plus (none, partial package, or full package), maternal age-appropriate education, maternal age in years, whether it was a first pregnancy, whether the mother was married at time of delivery, estimated gestational age of infant in weeks, and infant gender. We did not include self-reported smoking, self-reported alcohol use, or any measure of prenatal care (either number of visits or summary indices of appropriateness of prenatal care) because of accuracy (self-reported smoking and alcohol use) and validity (prenatal care—see Koroukian and Rimm, 2002) problems. Stepwise logistic regression was used for these analyses. To analyze birthweight as a continuous variable, we used multiple regression.

Table 1. Characteristics of Study Populations			
Risk Factors:	Prenatal Plus Group N=5891 N (%)	Comparison Group N=8022 N (%)	p value
Age:			
≤ 17 at delivery	1111 (18.9%)	1950 (24.3%)	<0.0001
18 or 19 at delivery	1388 (23.6%)	1941 (24.2%)	0.39
>35 at delivery	178 (3.0%)	402 (5.0%)	<0.0001
Mean (sd) Maternal Age	21.7 (5.3)	22.0 (6.0)	0.017
Maternal Education:			
Not Age-appropriate	1805 (31.2%)	3417 (43.2%)	<0.0001
Race of Mother:			
White/Non-Hispanic	3325 (56.6%)	3993 (49.8%)	
White/Hispanic	1975 (33.6%)	3251 (40.5%)	
Black	374 (6.4%)	516 (6.4%)	
Other	204 (3.5%)	259 (3.2%)	<0.0001
Unmarried at delivery	4141 (70.3%)	5791 (72.2%)	0.01
Behaviors:			
Self-reported alcohol use during pregnancy	127 (2.2%)	405 (5.1%)	<0.0001
Self-reported smoking during pregnancy	1622 (27.7%)	4321 (54.1%)	<0.0001
Other Characteristics:			
First pregnancy	2831 (48.1%)	3154 (39.3%)	<0.0001
Recent (<12 months) delivery	894 (15.2%)	2030 (25.3%)	<0.0001
Maternal weight gain in lbs. (sd)	33.0 (14.4)	31.3 (14.2)	<0.0001
Estimated gestation in weeks (sd)	38.9 (2.1)	38.6 (2.4)	<0.0001
Mean # PN visits (sd)	10.9 (4.0)	9.6 (4.3)	<0.0001
Prenatal care:			
4 or less	940 (11.8%)	291 (5.0%)	
5 or more	7001 (88.2%)	5562 (95.0%)	<0.0001

sd = standard deviation

Adjustment for Inflation

For the cost analysis, it was necessary to adjust for inflation since we used summary measures, such as average charges, for several categories of births over the entire time period of study, and since several years' data were analyzed. We used the Consumer Price Index for medical care for the Denver-Boulder-Greeley area (http://data.bls.govT) to adjust all charge and payment figures to fiscal year 2002 dollars.

RESULTS

Characteristics of Prenatal Plus Participants and Comparison Group

Prenatal Plus participants were different from the comparison group in a number of ways. Prenatal Plus participants were less likely to be younger than 17 or older than 35 at delivery; they were less likely to lack age-appropriate education (the number of years of education expected for each age). They were less likely to be Hispanic and more likely to be white/non-Hispanic; they were less likely to be unmarried at delivery; and they were less likely to report smoking or alcohol use during pregnancy. They were more likely to be having their first babies and less likely to have had a recent delivery. They gained more weight, had longer periods of gestation, and had more prenatal visits than did their counterparts in the comparison group. Table 1 shows the differences between the two groups. Virtually all of the differences, even small ones, are statistically significant, to a great extent because of the large numbers in the two groups.

Effect of Prenatal Plus Program on Incidence of Low Birth Weight

Descriptive Analyses. In bivariate analyses, that is, analyses in which we do not adjust for the different characteristics of the Prenatal Plus and comparison groups, we found that Prenatal Plus participants were significantly less likely than were comparison-group mothers to have LBW babies (Figure 1, page 7). Only 10.6 percent of

Prenatal Plus births were low-weight births, whereas 12.5 percent of the comparison group's births were low-weight (p = .0004). Among Prenatal Plus births (Figure 2), those mothers receiving a full package of services were significantly less likely to have a low-weight baby than those receiving only a partial package of services (9.5% and 11.6%, respectively; p = .01).

Figure 1. Incidence of Low Birth Weight, FY 98-FY 00, Prenatal Plus Participants and Comparison Group

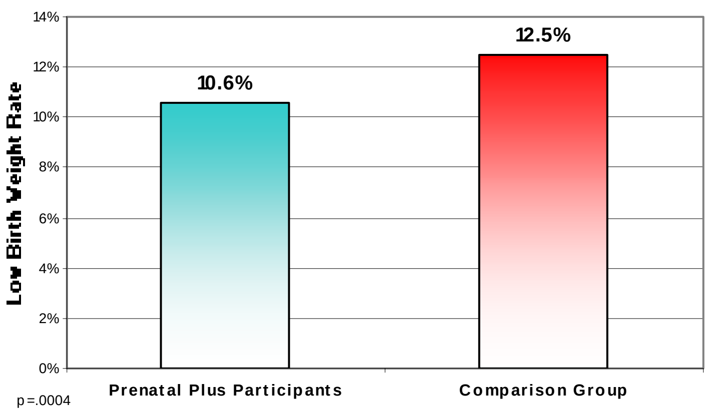
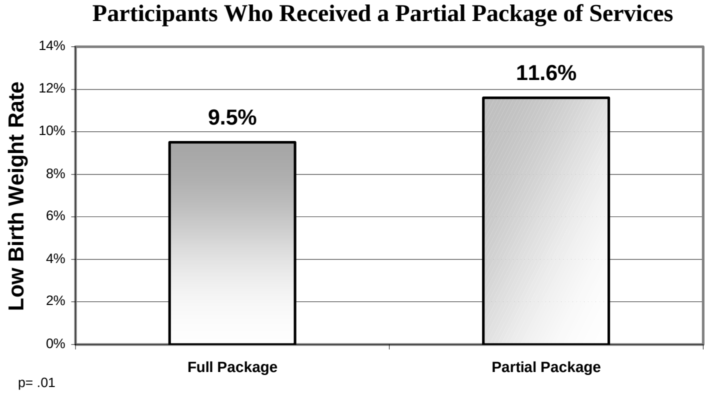


Figure 2. Incidence of Low Birth Weight, FY 98-FY 00, Prenatal Plus Participants Who Received a Full Package of Services and Participants Who Received a Partial Package of Services



A comparison of characteristics of Prenatal Plus participants and comparison-group women having LBW children reveals a few significant differences (Table 2, page 8). Prenatal Plus participants with LBW infants were more likely to have age-appropriate education, to be having their first child, to have more prenatal visits and to have gained more weight during pregnancy than were comparison group women with LBW infants.

Multivariate Analyses. To account for differences between Prenatal Plus participants and comparison group women, it was necessary to perform multivariate analysis. In multiple logistic regression, when we included factors that were different for the two groups (age-appropriate education, whether this was a first pregnancy, maternal age, race/ethnicity of mother, whether married at time of birth, and Prenatal Plus participation) as well as other factors known to affect birth weight (gender and estimated gestational age), many of the influences seen in bivariate analysis were not significantly related to low birth weight. Table 3 (page 8) expresses the effects of each factor as an odds ratio (OR). An odds ratio greater than 1 means that the factor results in an increased likelihood of, in this case, having a LBW baby. An odds ratio of less than 1 means that the likelihood is decreased. The factors significantly associated with having a low-birth weight baby were older maternal age (OR =1.026 for each additional year of age) and black race (OR = 1.30). The factors associated with being less likely to have a LBW baby were: white/Hispanic race/ethnicity (OR = 0.79); male gender of infant (OR = 0.71); and greater gestational age (OR = 0.43 for each additional week of gestation). Participation in Prenatal Plus did not reach significance, although the trend was in the direction of preventing LBW for the women receiving a full package of services (OR = 0.89, CI=0.75-1.07).

The preceding analyses examined the factors affecting LBW as a dichotomous variable, i.e., whether the infant weighed at least 2500 grams or not. When we conducted an analysis of birth weight as a continuous variable, we found that many of the variables that were significant in their effects on whether a birth was classified as LBW remained significant in their effects on birth weight. In this analysis, participation in the

Table 2. Comparison of Prenatal Plus Participants and Comparison Group Whose Infants Had Low Birth Weight

UVariableU	UPrenatal Plus Group N=624	UComparison Group N=1006	Up valueU
Fiscal Year of birth:			
1997/98	228 (36.5%)	320 (31.8%)	
1998/99	188 (30.1%)	408 (40.6%)	
1999/00	208 (33.3%)	278 (27.6%)	0.0001
Age of Mother:			
≤ 17	115 (18.4%)	210 (20.9%)	0.23
18-19	142 (22.8%)	232 (23.1%)	0.89
>35	34 (5.5%)	60 (6.0%)	0.66
Mean (sd) Maternal Age	22.4 (6.1)	22.7 (6.3)	0.39
Education of Mother:			
Not Age Appropriate	189 (30.9%)	437 (44.2%)	<0.0001
Race of Mother:			
White/Non-Hispanic	355 (57.0%)	521 (51.8%)	
White/Hispanic	188 (30.2%)	350 (34.8%)	
Black	55 (8.8%)	105 (10.4%)	
Other	25 (4.0%)	30 (3.0%)	0.08
Unmarried at delivery	442 (70.8%)	697 (69.3%)	0.51
First pregnancy	275 (44.1%)	330 (32.8%)	<0.0001
Of those with prior births most recent <12 months before birth	106 (35.7%)	248 (42.0%)	0.07
Maternal weight gain (lbs) (sd)	26.8 (13.2)	25.4 (13.2)	0.04
Mean (sd) number of prenatal visits	10.0 (4.4)	8.4 (4.6)	<0.0001

sd = standard deviation

Table 3. Results of Multiple Logistic Regression for Factors Associated with Low Birth Weight (Birth Weight as Dichotomous Variable—LBW or not LBW)

	ULBW BirthU	
UVariableU	UOdds RatioU	UConf. IntervalU
Maternal Age (continuous)	1.026	1.015-1.038**
Race/Ethnicity of mother (ref:		
White)	0.79	0.68-0.91**
White/Hispanic	1.30	1.01-1.67**
Black	0.87	0.60-1.26
Other		
Male infant	0.71	0.63-0.82**
Estimated Gestational Age	0.43	0.41-0.45**
Participation in Prenatal Plus (Ref: None)		
Partial	1.01	0.86-1.19
Full	0.89	0.75-1.07

** p≤0.05

Table 4: Results of Multiple Logistic Regression for Factors Associated with Low Birth Weight (Birth Weight in Grams as a Continuous Variable)

	UBirth WeightU	
UVariableU	UEstimate (g)U	UConf. IntervalU
FY 99/00	19	2 to 37**
First Pregnancy	-22	-38 to –5**
Race/Ethnicity of mother (ref: White)		
White/Hispanic	28	13 to 44**
Black	-92	-121 to –63**
Other	-7	-47 to 33
Male infant	115	101 to 129**
Estimated Gestational Age	168	165 to 171**
Participation in Prenatal Plus (Ref: None)		
Partial	36	19 to 54**
Full	26	7 to 44**

Prenatal Plus program was also significant in increasing birth weight. Table 4 shows that, after adjusting for group characteristics, participation in Prenatal Plus resulted in an average infant weight gain of between 26 and 36 grams.

Because being born small for gestational age (SGA) is also a risk factor for numerous problems, we examined the effects of the same variables using SGA as the outcome variable. This analysis resulted in findings that were somewhat different from the LBW incidence findings (Table 5, page 9). Older age of mother and Black race were predictors of higher incidence of SGA (OR =1.021 and OR = 1.57, respectively), as they were for LBW, and greater gestational age and white/Hispanic race were predictors of lower incidence of SGA. The odds ratio for gestational age was 0.96, i.e., each additional week of gestation results in a lower likelihood (less than 1.0) of being born SGA. Several other characteristics were different in

Table 5. Results of Multiple Logistic Regression for Factors Associated with Small-for-Gestational-Age Births		
	USGA BirthU	
UVariableU	UOdds RatioU	UConf. IntervalU
Age of mother (continuous)	1.021	1.014-1.028**
Race/Ethnicity of mother (ref: White)		
White/Hispanic	0.91	0.83-1.00**
Black	1.57	1.34-1.85**
Other	0.82	0.63-1.06
Male infant	1.09	1.01-1.19**
Estimated gestational age (continuous)	0.96	0.94-0.98**
Participation in Prenatal Plus (Ref: None)		
Partial	0.91	0.81-1.01
Full	0.89**	0.80-0.999**

their effects on SGA than in their effects on LBW. For instance, male gender was a risk factor for SGA (OR = 1.09), whereas it was associated with lower risk in the LBW analysis. Receiving a full package of Prenatal Plus services was significantly associated with lower risk of SGA (OR = 0.89). Receiving a partial package was not significantly associated with lower risk of SGA, although there was a trend in that direction.

Cost Analysis

Medicaid claims were used for the cost analyses we performed. Medicaid claims included information on average and median charges as well as average and median reimbursement. Medicaid typically reimburses at levels at or below actual cost of care. For the purposes of this report, we report both charges and payments: the former is a gross measure of the relative resources expended to provide care for the population served, while the latter is a measure of the cost to the state of care for this population.

All charges and payments for one year after birth for children whose Medicaid records were available were included in the cost analysis. For Prenatal Plus participants, payment and charge figures include the cost of Prenatal Plus services. All figures are expressed in FY 2001-02 dollars. We examined charges and payments for three groups of infants: those whose mothers received a full package of Prenatal Plus services, those receiving a partial package, and the comparison group.

Average charges for LBW infants were several times those for normal weight infants in all three groups; the ratio ranged from 5.1 for full package infants to 8.9 for comparison group infants (Figure 3). Moreover, average charges for all comparison group infants were 54 percent higher than the charges for full package infants and 14 percent higher than those for partial package infants. Average *payment* for full-package

Figure 3. Average Infant Charge for Low Birth Weight Infant, FY 98-FY 00: Prenatal Plus Participants and Comparison Group

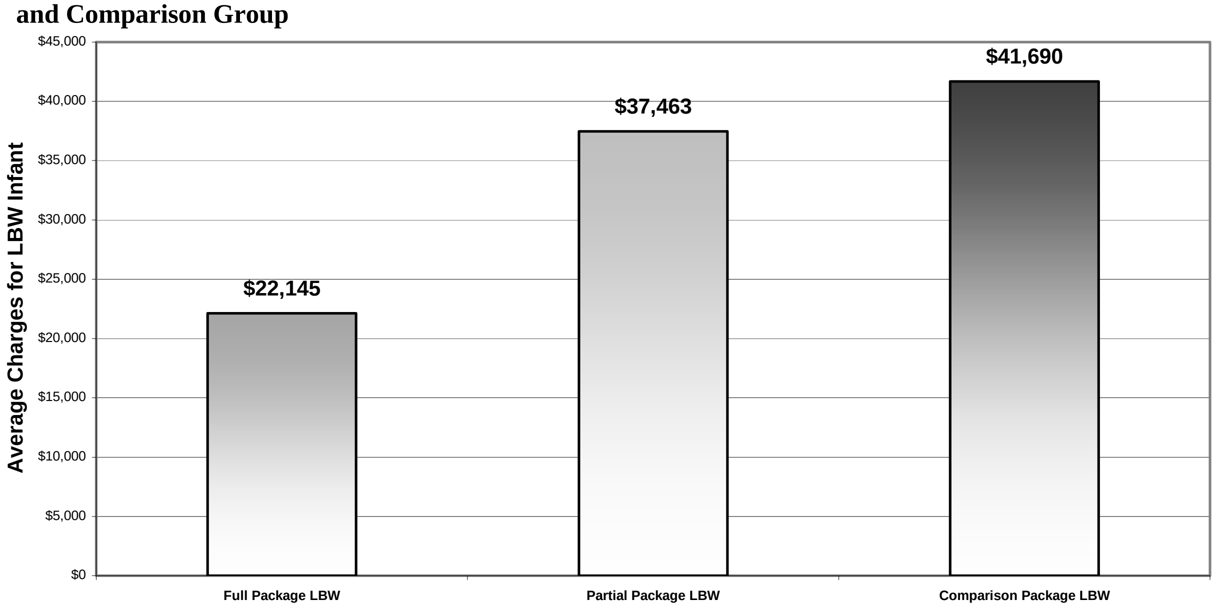


Table 6. Average Infant Charges and Reimbursement for Small-for-Gestational Age and Average-for Gestational Age Infants: Prenatal Plus Participants and Comparison Group, FY 2001-02 Dollars				
UGroupU	UMean Charges U	UMean Reimbur sementU	UMedia n Charges U	UMedian Reimbursement U
Prenatal Plus:				
Full Package:				
SGA (n=434)	$6,432	$4,509	$2,589	$2,048
Normal Size (n=2027)	$5,882	$3,557	$2,554	$2,017
Total Group (n=2461)	$5,977	$3,723	$2,563	$2,024
Partial Package:				
SGA (n=516)	$11,038	$6,245	$2,745	$2,281
Normal Size (n=2251)	$7,400	$3,990	$2,428	$1,972
Total Group (n=2767)	$8,078	$4,411	$2,468	$2,035
Comparison*:				
SGA (n=1486)	$10,662	$6,001	$2,736	$2,107
Normal Size (n=5805)	$8,842	$5,028	$2,567	$1,998
Total Group (n=7291)	$9,213	$5,226	$2,599	$2,015

*There is an infant in this group whose charges were $1,827,246 and

infants was $3,723 for all years; for partial-package infants, it was $4,411, and for comparison infants, the average was $5226, 40 percent higher than payments for full-package infants. These averages reflect both the lower incidence of LBW among Prenatal Plus participants as well as lower average charges and payments for the LBW infants in those groups.

When charges and payments for SGA infants are examined (Table 6), a different pattern emerges.

While SGA infant charges and payments are higher than those for average-for-gestational-age (AGA) infants, the differences are not as pronounced as for LBW infants. The ratios of SGA charges to AGA charges are: 1.1 for full-package infants, 1.5 for partial package infants, and 1.2 for comparison infants. The ratios for payments are similar to those for charges.

Figures 4 and 5 presents a net cost analysis for the Prenatal Plus program. This analysis shows the payments that could be expected if payments for Prenatal Plus participants were the same as those for the comparison group. The weighted average difference between payments at the comparison group level and actual payments for Prenatal Plus participants was $1,138 per birth (Medicaid payments for Prenatal Plus infants include those made for Prenatal Plus program services). The average Medicaid payment per client for Prenatal Plus client services and administration during the study period was $460. Therefore, for every dollar spent on Prenatal

Figure 4. Average Medicaid Payment, Prenatal Plus Full and Partial Package and Comparison Group, FY 98-FY 00

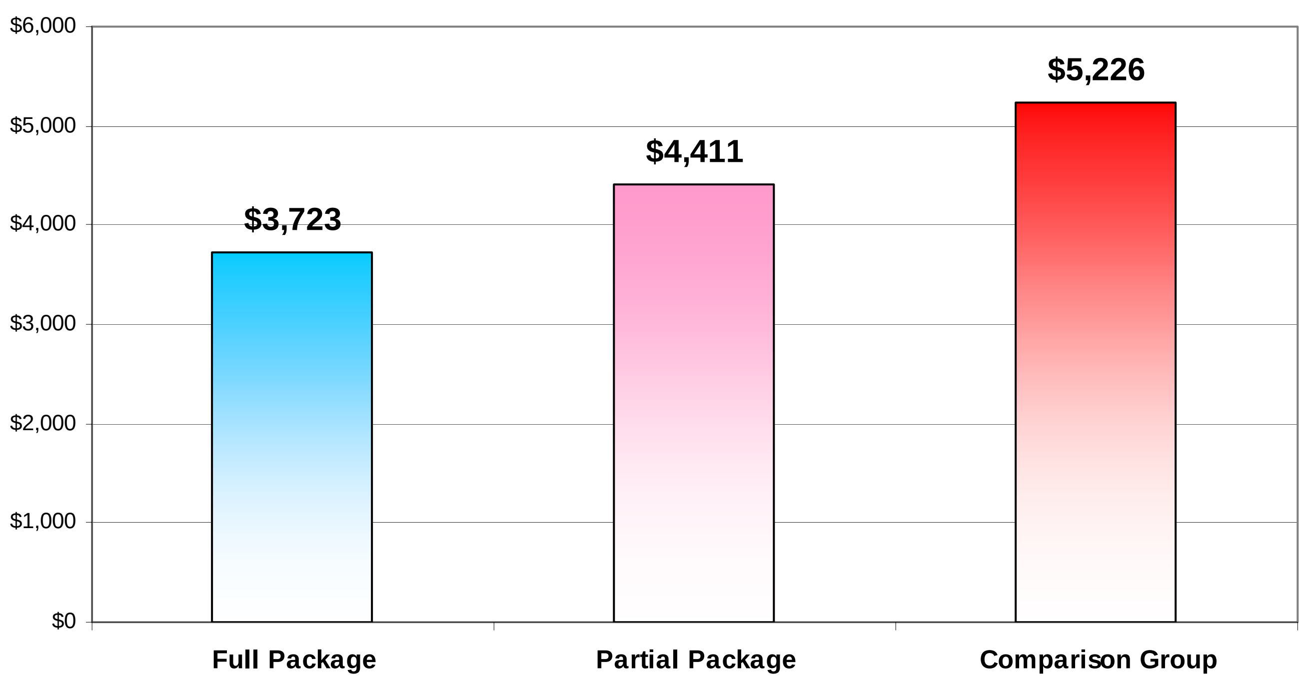
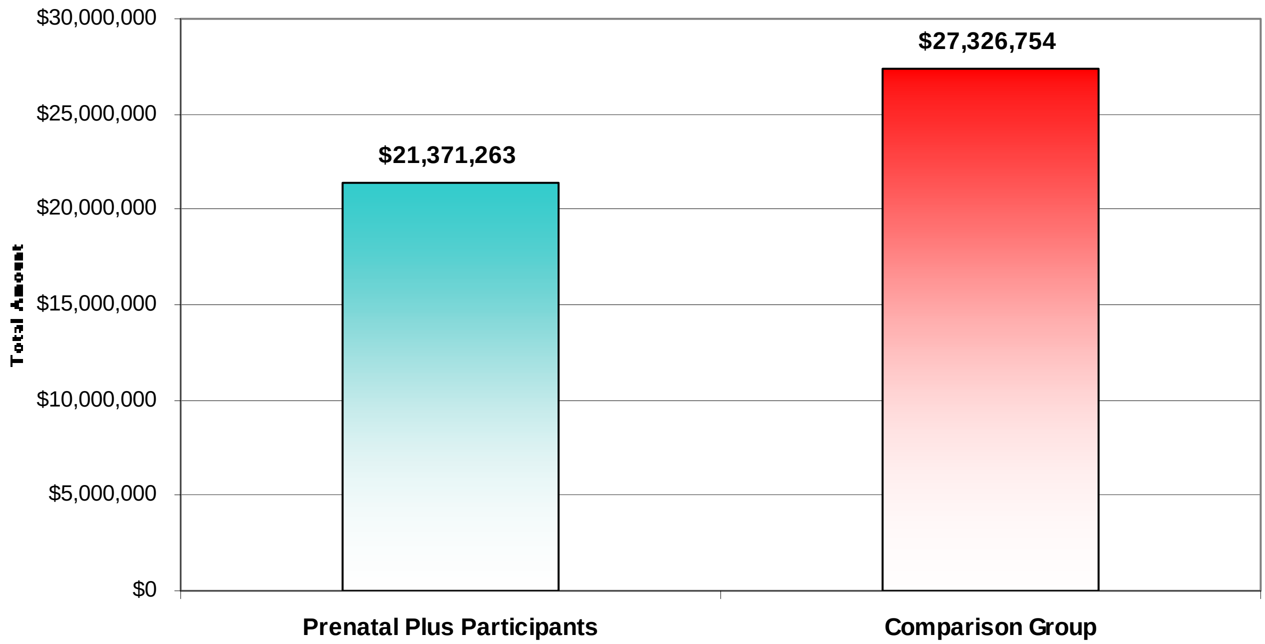


Figure 5. Total Expenditures for Prenatal Plus Participants and Comparison Group, FY 98-FY 00



Plus, a savings of $2.48 was realized, a substantial return on the Prenatal Plus investment. This net cost savings does not take into account any unreimbursed costs incurred by local providers who rendered Prenatal Plus services.

CONCLUSIONS

Effect of Prenatal Plus on Birth Outcomes

Prenatal Plus is significantly associated with lower risk of having a baby that is small for his or her gestational age. This appears to be a result of greater weight gain on the part of Prenatal Plus participants. Adequate weight gain is a primary goal of the program, a goal that is apparently being achieved. The Prenatal Plus program appears to be successfully addressing one of the important contributors to LBW in Colorado (Ricketts and Trierweiler, 2000).

In bivariate analysis, the Prenatal Plus program significantly reduced the incidence of low birth weight. When we adjusted for factors such as race and maternal education the program's effect on the incidence of LBW was not statistically significant although there was a trend in the direction of reducing LBW incidence. When we examined the effects of Prenatal Plus participation on birth weight as a continuous variable in multiple regression, however, we found that program participation was significant in increasing birth weight.

Effect of Prenatal Plus Participation on Charges and Payments

There was a consistent pattern for both charges and payments for LBW and SGA infants: charges and payments for children of Prenatal Plus participants who received a full package were lower than for those with a partial package and even lower than for children in the comparison group. This suggests that Prenatal Plus is effective in reducing health system and Medicaid costs.

The net cost analysis we performed demonstrates the magnitude of the savings to Medicaid realized by the state as a result of operating the Prenatal Plus program. Savings of $2.48 for every dollar spent is an important finding of this study. Few health-related interventions have been found to actually save money. Childhood immunization is one of the relatively rare cases of an intervention resulting in net savings. But, given the very high costs associated with low birth weight, it should not be very surprising that programs that are successful in reducing the risks of pregnancy would also save money.

RECOMMENDATIONS

Medicaid's High Risk Population

While Prenatal Plus participants are inarguably high-risk pregnant women, there are many women in Medicaid whose risks appear to be just as high, but who are not in the program. This may be an artifact of their getting into prenatal care late, thereby missing opportunities to fully participate in Prenatal Plus, but it may also be the case that the program's providers are not enrolling as many high-risk women as they could. Local providers may perceive that reimbursement is inadequate for the services they provide, which may contribute to a lack of capacity statewide for the program (Women's Health Section, Colorado Department of Public Health and Environment, November 26, 2002). It is worth exploring possible increases in Medicaid reimbursement in an effort to enroll more high-risk women.

Future of the Prenatal Plus Program

The results of the net cost analysis performed here suggest that, from a fiscal point of view, the Prenatal Plus program should be continued, since it results in lower Medicaid expenditures. The cost analysis also shows that participation in the full Prenatal Plus package lowers Medicaid expenditures more than does partial package participation. Providers should be encouraged to provide the full package, and Medicaid should be approached about increasing reimbursement for the full package, since the state stands to save money by doing so.

If possible, it would be useful to study subgroups of the Prenatal Plus population to determine whether the program is differentially successful with different groups. For instance, if the program were quite successful with women whose educational attainment is less than appropriate for their age (a plausible hypothesis, since educating women about their risks and behaviors is an important component of the program), it could target this group of women for intervention. Such analysis could lead to more specific program targeting and could possibly result in greater savings per dollar expended.

Limitations

A principal limitation in this analysis was that the only risk factor data available were those found on birth certificates. Therefore, to the extent that these do not represent the full range of risk factors for LBW, we have not fully represented the effects of all relevant variables. Indeed, we know that there are risk factors that we were not able to obtain, many of which were pre-pregnancy factors, such as being underweight and having a history of domestic violence or of psychosocial problems. Because we do not have this information about either Prenatal Plus participants or the comparison group, we do not know whether the two groups differ with respect to these other factors.

A second limitation has to do with the creation of the dataset for analysis. Approximately 88 percent of the Medicaid records were able to be matched with birth certificate records. Reasons for this include variation in spelling of names or of birth dates between the data sets. When there were discrepancies that could not be resolved, usually because of differences in more than one item, or large differences on even one item, on which matching depended, the records in question were removed from the data set.

Therefore, the resulting dataset may be somewhat incomplete. There may also have been Prenatal Plus births that were not captured by Medicaid claims records. To the extent this occurred, the dataset is incomplete.

The comparison group included women who might not have been included had information on their nutritional and psychosocial risk been available. Half of the Prenatal Plus participants were at nutritional risk. To the extent that this proportion was lower in the comparison group, the study will have underestimated the positive effects of the Prenatal Plus program on LBW.

Another limitation concerns the net cost analysis. This analysis necessarily used average cost figures in order to calculate the differences in cost to the state of the children of the three different groups. That is, average payments for the different groups were used to determine total state expenditures for Prenatal Plus participants, assuming they had incurred the average payments incurred by the comparison group. This does not take into account the differences in characteristics between the Prenatal Plus participants and the comparison group. The fact that the program’s effects on both SGA births and birth weight were significant, however, gives us confidence in using average payments. Moreover, it is unlikely that the large difference in average payments found in the net cost analysis would be accounted for entirely by the often small differences in characteristics between the two groups.

ACKNOWLEDGEMENTS

Mary Chase, of the Health Statistics section of the Colorado Department of Public Health and Environment, performed all of the acquisition, cleaning, and matching of Medicaid and birth certificate data used in this study. This was a very demanding and time-consuming task. Without Mary’s tireless efforts, this analysis could not have been performed.

The authors are also grateful to Candace Grosz, Erin Murray, Sue Ricketts, and Karen Trierweiler, of the Women’s Health Section of the Colorado Department of Public Health and environment, who provided important information about the Prenatal Plus program and insightful reviews of an earlier draft of this report.

Endnotes

P1P Cost-benefit analysis monetizes both costs and benefits to determine the ratio of costs to benefits. It therefore requires that all benefits be identified and quantified. The benefits of reducing the low birth weight rate are difficult to quantify. The research literature identifies numerous effects of low birth weight, many of which, e.g., attention deficit hyperactivity disorder, unsatisfactory school performance, and low bone mineral content in adulthood, are difficult to monetize. The data required for a full-blown cost-benefit analysis are either not available or very difficult to find. Cost-benefit analyses are not often conducted for this reason. Cost-effectiveness analysis does not require that benefits be assigned a monetary value. It does, however, require that more than one program be evaluated for effectiveness and cost in order to compare them and determine which is the most cost-effective at reaching a particular outcome. For more information on all types of cost analysis, see Drummond, et al., 1999.

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