Prenatal Participation in WIC Related to Medicaid Costs for Missouri Newborns: 1982 Update

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Synopsis

This study replicates a 1980 evaluation of WIC prenatal participation in Missouri by using a file of 9,086 Missouri Medicaid records matched with the corresponding birth records. This file was divided into a WIC group containing 3,261 records and a non-WIC group of 5,825 records.

The 1982 results generally confirm the 1980 results, with the 1982 findings showing slightly improved pregnancy outcomes for WIC participants and slightly reduced benefit-to-cost ratios compared with the 1980 findings. In 1982, WIC participation was found to be associated with an increase in mean birth weight of 31 grams and reductions in low birth weight rates (statistically significant) and in neonatal death rates (not statistically significant). The reduction in each rate was 23 percent.

WIC participation was also associated with a reduction in Medicaid costs for newborns reported within 45 days of birth amounting to $76 per participant. For every dollar spent on WIC, about 49 cents in Medicaid costs were apparently saved. However, wide 95 percent confidence intervals ($.07, $.90) make it difficult to determine precisely what impact WIC has on Federal and State budget outlays.

THE SPECIAL SUPPLEMENTAL FOOD Program for Women, Infants, and Children (WIC) was established by Congress in 1972 to provide supplemental food to low-income pregnant or lactating women and young children who are nutritionally at risk. In addition to food, the WIC Program also provides these families with nutrition education and encourages the appropriate use of prenatal and other medical services.

The WIC Program in Missouri was statewide in 1982, operating primarily through county health departments in all but 3 of 115 counties. Pregnant or lactating women, infants, and children under age 5 are referred to local WIC Programs by health care providers (including Medicaid) under two eligibility criteria: income less than 175 percent of the poverty level and nutritional risk. Poor obstetrical history, anemia, and extremes of age, leanness, or obesity are among the criteria applied to determine nutritional risk.

The primary goals of the WIC Program for pregnant women are to enhance the mother's and infant's health and to reduce the incidence of negative outcomes such as prematurity and infant mortality. An important byproduct of these goals should be an increase in the infant's birth weight. Several studies (*1–6*) have shown that WIC apparently does increase birth weight and reduce prematurity.

Prematurely born infants often require intensive medical care at birth, including a possible transfer to a neonatal intensive care unit (NICU); hence length of hospital stay is longer and costs of hospital care are greater. Therefore, if WIC participation does indeed reduce the risk of having premature and low birth weight infants, WIC also should reduce the medical costs for these births at and immediately following birth. In a previous 1980 Missouri study, Schramm (*1*) found that WIC participation was associated with the reduction in Medicaid newborn costs of about $100 per participant. For every dollar spent on WIC, about 83 cents (95 percent confidence interval $.40, $1.30) in Medicaid costs within 30 days after birth were apparently saved.

This study serves as important followup to the 1980 Missouri study; I will attempt to verify the 1980 findings, using a 1982 WIC-Medicaid file.

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Between 1980 and 1982, the Missouri WIC Program expanded in number of counties served (93 to 112), number of participating mothers (6,700 to 9,300), and proportion of Medicaid mothers on WIC (25 percent to 36 percent). The Missouri Medicaid Program also changed the hospital reimbursement procedures between 1980 and 1982. In 1980 Medicaid reimbursed hospitals at 100 percent of charges for the newborn if the infant met eligibility requirements. In 1982 Medicaid used a per diem formula based on the entire population of patients in each hospital. Hospitals were reimbursed at this per diem rate for a predetermined length of stay based on the diagnosis. This change in reimbursement procedures dramatically changed the relationship between submitted charges and paid claims.

These changes may or may not affect the cost benefits of the WIC prenatal programs. With the 1982 data set, I sought answers to many of the same questions addressed in the original 1980 study:

- Does WIC improve pregnancy outcome among births to women on Medicaid as measured by mean birth weight, low birth weight (LBW), and neonatal mortality and morbidity?
- How do the relationships of birth weight, length of hospital stay, and NICU admissions affect the WIC–non-WIC Medicaid cost differentials?
- Does WIC participation reduce Medicaid costs for the newborn and the mother during the 45 days immediately following birth?
- Do reduced Medicaid costs for WIC participants outweigh WIC costs, thus demonstrating a cost-beneficial program?

Methods

Study design and population. The basic design of the study involved linking five separate data files: (*a*) Medicaid, (*b*) birth certificates, (*c*), WIC records, (*d*) NICU admissions, and (*e*) death certificates. The Medicaid file provided Medicaid cost data, hospital diagnosis, and length of stay for the newborn. The birth certificate provided data on maternal characteristics and birth weight. The WIC file established which Medicaid mothers received WIC benefits and provided the WIC costs for each birth. The NICU file offered a means of explaining differences between WIC and non-WIC Medicaid costs and included additional information about the diagnosis. The death certificate was used to determine neonatal (under 28 days) death rates by WIC Program participation.

Initially, a computer file of 10,196 newborn Medicaid records was created from the January 1982 to November 1983 Missouri Medicaid claim tapes. Only claims for newborns with a date of service within 45 days of birth and only babies born in calendar year 1982 were included on this file. The 45-day requirement represents a slight expansion from the 30-day criteria used in 1980, thus allowing for the inclusion of more costs for intensive care. Maternal records were excluded because matching between newborn and maternal records was incomplete, and the 1980 study demonstrated virtually no relationship between paid claims for maternity care and WIC participation.

These 10,196 Medicaid records for newborns were then matched with their corresponding birth records by using the name and date of birth as the principal matching criteria. A total of 10,017 Medicaid records were matched to birth records for a match rate of 98.2 percent.

Additional exclusions were made so that the final study file contained Medicaid cost data that were as complete as possible. A total of 68 records were excluded from the sample because a third-party liability was reported, thereby affecting the total Medicaid paid claims. An additional 863 records were excluded because no hospital claims had been reported.

These exclusions left 9,086 records in the study sample, or 89 percent of the original Medicaid file of newborns. This file was then matched against a file of 9,307 1982 Missouri WIC birth records. The WIC file had been created from a tape of WIC prenatal participants having an estimated date of childbirth (EDC) between November 1981 and April 1983. The WIC file was matched with the

1982 birth records. Approximately 93 percent of the WIC records with an EDC of 1982 were matched with a birth record. (Stockbauer (*4*) gives a more detailed explanation of this matching process.) The Medicaid and WIC files were merged using the birth certificate number. The final study sample contained 3,261 Medicaid-birth records that were on the WIC Program and 5,825 Medicaid-birth records that were not on WIC.

These files were then merged with the NICU file to see whether any infants had been transferred to one of these units. The NICU file was created by a voluntary reporting system in which all major NICU centers in the State report admissions and diagnoses to the Missouri Department of Health. These NICU records are then matched to the birth file; the resulting match rate between NICU records and their corresponding birth certificates was 99 percent.

Finally, the Medicaid newborn file was merged with a matched birth-infant death file by birth certificate number. About 60 neonatal deaths were found by this procedure, considerably fewer than expected for this high risk population. Many Medicaid mothers whose babies die within the first week of life do not certify their babies to the Medicaid program. Therefore, early (under 1 week) neonatal Missouri deaths were matched manually with a Medicaid eligibility file of women aged 10-49 years. An additional 50 Medicaid neonatal deaths were found through this process.

Selection of covariates. To determine what intervening variables need to be controlled in testing whether WIC reduces Medicaid costs for newborns, a stepwise regression was performed between a number of possible confounding variables and the primary dependent and independent variables, Medicaid costs, and WIC participation. Among the possible confounding variables tested were number born (multiple birth); per diem hospital reimbursement rate by Medicaid; birth spacing less than 18 months; and mother's height, prepregnancy weight, smoking habits, age, education level, marital status, metropolitan residence, and race. With the exception of the per diem reimbursement rate, information on all these variables came from the birth certificate.

Table 1 presents percent distributions of some of these confounding variables for the WIC and non-WIC study population in 1982. Generally, there were more differences found between these two populations in 1982 than in the 1980 study, but the differences were not very substantial. As in 1980, more WIC mothers were under age 18, married, and nonmetropolitan residents than were non-WIC mothers. But, in contrast to 1980, fewer WIC mothers smoked, had inadequate prenatal care, and had higher order births compared with non-WIC mothers in 1982. These variables may have differing effects on cost, but it is important to control for the most important of these variables in the analysis.

Table 1. Percent distributions of WIC and non-WIC Medicaid populations by selected variables available on Missouri birth certificates

Variables	WIC (N = 3,261)	Non-WIC (N = 5,825)
WIC risk criteria variables		
Mother under 18 years	20.2	[1]17.4
Mother 35 years or older	1.7	1.9
Birth spacing less than 18 months	17.0	16.9
Birth order 4 or more	7.3	[1]10.4
Mother at least 15 percent underweight[2]	16.3	16.4
Mother at least 20 percent overweight[2]	17.5	16.4
Previous fetal or infant death or 2 or more miscarriages	6.4	6.0
Multiple birth	2.7	2.7
WIC medical risk[3]	5.1	5.9
WIC risk identifiable from birth record	64.5	64.1
Other selected variables		
Black	54.0	53.0
Metropolitan	69.5	[1]73.7
Mother unmarried	74.9	[1]78.5
Mother smoking	46.3	[1]49.1
Inadequate prenatal care	35.4	[1]44.2

[1]WIC and non-WIC percentages significantly different at .05 level.
[2]According to 1959 Metropolitan Life Insurance tables.
[3]Diseases and conditions complicating pregnancy such as hypertension, diabetes, renal disease, sickle cell disease, tuberculosis, or heart disease.

Variables significantly correlated with either WIC participation or Medicaid costs for newborns, after adjustment for the other variables in the equations, were given a rank based on order of entrance into each stepwise regression. Ranks for each equation and variable were then averaged.

For example, per diem reimbursement was the first variable entered into the stepwise regression with paid claims as the dependent variable, and it was the fourth variable entered when WIC participation was the dependent variable. Therefore, per diem reimbursement is clearly an important covariate when testing if WIC participation is associated with Medicaid costs. Smoking, on the other hand, was not significantly associated with paid claims for newborns after adjustment for other variables, and it was only the eighth variable entered into the WIC participation stepwise regression. Therefore, smoking was not used as a covariate.

Table 2. WIC—non-WIC low birth weight rates by selected WIC risk criteria variables, race, and smoking level

Variables	Number of live births		Low birth weight rate			
	WIC	Non-WIC	WIC	Non-WIC	Difference	95 percent confidence interval of difference
Total	3,221	5,719	10.1	13.1	[1]3.0	±1.3
WIC risk criteria variables						
Mother under 18 years	654	993	9.6	12.4	2.8	±3.0
Mother 35 years or older	54	108	8.3	19.9	[1]11.6	±11.3
Birth spacing less than 18 months	542	970	13.2	17.4	[1]4.2	±3.6
Birth order 4 or more	238	591	14.0	18.7	4.7	±5.4
Mother at least 15 percent underweight	514	892	12.9	17.0	[1]4.1	±3.9
Mother at least 20 percent overweight	563	951	6.3	10.8	[1]4.5	±2.8
Previous fetal or infant death or 2 or more miscarriages	205	344	15.1	23.6	[1]8.5	±7.2
Multiple birth	84	152	50.8	66.0	[1]15.2	±13.0
WIC medical risk	163	334	13.3	19.6	6.3	±6.8
WIC risk criteria identifiable from birth record	2,067	3,640	10.9	14.7	[1]3.8	±1.8
No WIC risk	1,154	2,079	8.9	10.4	1.5	±2.1
Other selected variables						
White	1,474	2,674	9.1	10.3	1.2	±2.1
Black or other	1,747	3,045	11.0	15.4	[1]4.4	±2.0
Smoking during pregnancy	1,493	2,808	13.0	16.3	[1]3.3	±2.2
Nonsmoker	1,728	2,911	7.3	10.0	[1]2.7	±1.6

[1]Statistically significantly different at .05 level.

NOTE: Low birth weight rates were obtained from an analysis of covariance with adequate prenatal care, race, mother's smoking level, number born, and gravida used as covariates. Records with information missing for any of these variables were excluded from the analysis.

'Length of WIC participation, as measured by the dollar total of WIC food vouchers redeemed plus administrative overhead, showed that WIC mothers with the most participation had the heaviest babies, the lowest LBW rates, and the greatest newborn Medicaid savings.'

The five best covariates were selected in testing each hypothesis. Most of the tested variables are highly correlated with each other, and imputing more variables does not add much to the analysis and may create noise and misleading results. As other variables are added to the equation, reduction of sample size also is a problem because of missing values for those added variables.

Variables selected as covariates in testing the null hypothesis that there is no difference in newborn Medicaid costs between WIC and non-WIC populations were per diem hospital reimbursement, adequate prenatal care, race, education of mother, and number born. Analysis of covariance was used to control for these variables. Least square estimates of newborn costs were calculated and compared between WIC and non-WIC populations.

Besides costs, other dependent variables studied were mean birth weight, LBW rates, neonatal death rates, length of newborn's hospital stay, NICU admission rates, and newborn's diagnosis. In a method similar to that used in the cost hypothesis, the following covariates were selected in testing whether WIC participation is related to these outcomes.

- mean birth weight and LBW rates: adequate prenatal care, smoking level, gravida, number born, and race.
- length of stay: adequate prenatal care, smoking level, age of mother, number born, and race.

Medicaid paid claim amounts and LBW rates were also stratified by selected WIC risk criteria to attempt to determine if WIC is more beneficial for selected subgroups. Cost and LBW rates in these subgroups were adjusted for the same covariates as those used for the total study sample.

The *t*-test for differences in proportions was used in testing differences in unadjusted rates. These included neonatal death rates, NICU admis-

sion rates, and diagnosis rates. Small numbers prevented adequate control for confounding variables for these unadjusted rates. Two diagnoses each were obtained from the Medicaid file and the NICU files.

Cost benefit analysis. To determine whether WIC is cost beneficial, WIC costs for the mothers on Medicaid were compared with the Medicaid savings on newborns, if any. WIC costs were calculated by using the actual costs of the redeemed food vouchers for the 1982 WIC mothers in the study sample plus an administrative overhead cost of around 20 percent. For Medicaid, the administrative overhead is negligible (1 percent), so no adjustment is necessary for these costs.

As mentioned previously, the Missouri Medicaid Program made a major change in the hospital reimbursement procedures in 1982. As a result, charges submitted were less than Medicaid reimbursement totals in 1982, the reverse of the 1980 pattern. Because of this change, total charges submitted to Medicaid may be more comparable to 1980 paid claim amounts than the pattern of 1982 paid claim amounts. Therefore, total submitted Medicaid charges were also examined when analyzing costs and benefits.

To estimate a dose-response effect of the WIC Program, mean birth weight, low birth weight rates, and Medicaid cost savings will be calculated for three levels of WIC food costs. Approximately 8 percent of WIC records had incomplete cost data. For these records, length of WIC participation was used to estimate WIC costs.

Covariates selected to test for dose-response in an analysis of covariances were these:

- Medicaid claim amounts: length of pregnancy, adequate prenatal care, per diem reimbursement, number born, race, education of mother, and smoking level.
- mean birth weight and LBW rates: length of pregnancy, adequate prenatal care, smoking levels, number born, mother's prepregnancy weight, race, and mother's marital status.

Results

Birth weight and neonatal mortality. WIC babies in this study weighed 31 grams more than non-WIC babies (3,162 versus 3,131 grams), after adjustment for the appropriate confounding variables. The adjusted LBW rate for WIC babies was 10.1 percent compared with 13.1 percent among non-WIC infants, a 23 percent difference. Both of these differences were statistically significant.

Table 3. Percent of WIC and non-WIC newborns with selected diagnoses

Diagnosis (ICD numbers)	*WIC (N = 3,261)*	*Non-WIC (N = 5,825)*
Respiratory distress syndrome (769)	1.8	[1]2.4
Immaturity—low birth weight (764–765)	5.1	[1]6.3
Birth trauma (763, 767–768)	4.0	3.4
Congenital anomalies (740–759)	1.5	1.7
Infections (10–80, 100–139, 480–487, 770–771)	2.7	2.7
Maternal conditions (760–762, 775)	0.5	0.6
Systematic disorders (140–478, 490–629, 680–729)	1.6	1.6
No complications	80.3	79.4

[1]Statistically significantly different at .05 level.

Table 2 shows that WIC infants had lower LBW rates for all WIC risk subgroups, and these differences were statistically significant for six of the nine subgroups. The LBW WIC to non-WIC differential was greater for those infants with a WIC risk identifiable on the birth certificate (26 percent) than for those without a WIC risk identifiable from the birth record (14 percent).

The LBW WIC to non-WIC differential was also greater among blacks and other races than it was among whites. As table 2 shows, WIC was associated with reduced LBW rates regardless of mother's smoking habits.

Neonatal death rates were also 23 percent lower among WIC infants than for non-WIC infants. The WIC neonatal death rate was 10.1 per 1,000 live births compared with 13.1 for the non-WIC population. This difference, however, was not statistically significant, possibly because of small numbers.

Hospitalization data. WIC babies stayed in hospitals an average of 5.2 days compared with 5.5 days for non-WIC babies. The average Medicaid costs per day were the same for both WIC and non-WIC newborns ($242).

Fewer WIC babies were admitted to NICUs than non-WIC babies, but the difference was not statistically significant at the .05 level. The WIC NICU admission rate was 3.9 percent compared with 4.5 percent for non-WIC infants.

No complications were reported for about four-fifths of both WIC and non-WIC newborns from Medicaid and NICU diagnoses. However, WIC infants had a significantly lower incidence of

Table 4. WIC—non-WIC mean Medicaid paid claim amounts for newborns by selected WIC risk criteria variables, race, and smoking level

Variables	Number of live births		Mean Medicaid paid claim amounts (dollars)			
	WIC	Non-WIC	WIC	Non-WIC	Difference	95 percent confidence interval of difference
Total	3,245	5,816	$1,250	$1,326	$[1]76	±$64
WIC risk criteria variables						
Mother under 18 years	656	1,007	1,243	1,345	102	±153
Mother 35 years or older	54	111	1,124	1,775	651	±656
Birth spacing less than 18 months	549	985	1,397	1,394	-3	±176
Birth order 4 or more	239	803	1,323	1,420	97	±254
Mother at least 15 percent underweight	527	940	1,212	1,432	[1]220	±170
Mother at least 20 percent overweight	570	952	1,355	1,351	-4	±148
Previous fetal or infant death or 2 or more miscarriages	209	348	1,454	1,934	[1]480	±421
Multiple birth	87	155	3,524	2,710	-814	±899
WIC medical risk	166	540	1,876	1,623	-253	±333
WIC risk criteria identifiable from birth record	2,093	3,707	1,291	1,387	[1]96	±84
No WIC risk	1,152	2,077	1,186	1,224	38	±98
Other selected variables						
White	1,496	2,718	1,155	1,260	[1]105	±96
Black, other	1,749	3,066	1,336	1,383	47	±87
Smoking during pregnancy	1,492	2,800	1,262	1,360	101	±102
Nonsmoker	1,724	2,895	1,247	1,283	36	±80

[1]Statistically significantly different at .05 level.
NOTE: Mean Medicaid paid claim amounts were obtained from an analysis of covariance with per diem reimbursement, adequate prenatal care, race, education level of mother, and number born used as covariates.

Table 5. Estimated Medicaid savings, mean birth weight, and LBW rates by WIC cost levels

Category	Number	Estimated Medicaid savings (dollars)	Mean birth weight (grams)	Percent LBW
Non-WIC	5,825	...	3,139	12.8
WIC costs:				
Under $110	1,059	$62	3,125	11.9
$110–$219	1,420	-$9	3,154	[1]10.2
$220 or more	782	$107	3,177	[1]9.4

[1]Statistically significantly different from non-WIC at .05 level.
NOTES: Estimated Medicaid savings were adjusted for length of pregnancy in completed weeks, prenatal care, per diem reimbursement, number born, race, education of mother, and smoking level, using analysis of covariance. Mean and low birth weight rates were adjusted for length of pregnancy, adequate prenatal care, smoking levels, number born, mother's prepregnancy weight, race, and mother's marital status, also using analysis of covariance.

respiratory distress syndrome and immaturity reported than their non-WIC counterparts (table 3).

Newborn Medicaid costs. Adjusted Medicaid paid claim amounts for newborns averaged $76 less for WIC participants than for non-WIC clients, a statistically significant reduction. Mean Medicaid costs for WIC newborns were $1,250 compared with $1,326 for those newborns whose mothers were not on WIC. These figures were nearly identical to paid claims for Medicaid newborns before adjustment for confounding variables.

Table 4 shows a breakdown of WIC and non-WIC differences in adjusted Medicaid costs for newborns by selected WIC risk criteria. A statistically significant reduction in Medicaid costs of $96 was found for those babies with a WIC risk identifiable from the birth certificate. Other statistically significant reductions were found for only two of nine WIC risk subcategories; babies of mothers at least 15 percent underweight for height and those with a previous fetal or infant death or two or more miscarriages.

Despite the weaker birth weight association, there was a greater reduction in costs among white newborns than among black and other infants.

Length of WIC participation. Length of WIC participation, as measured by the dollar total of WIC food vouchers redeemed plus administrative overhead, showed that WIC mothers with the most participation had the heaviest babies, the lowest LBW rates, and the greatest newborn Medicaid savings (table 5). The lower adjusted LBW rate for those with WIC costs of more than $220 was statistically significantly lower than the rate for non-WIC participants, while the higher mean birth

Table 6. Cost-benefit analysis: WIC costs compared with estimated Medicaid savings and submitted charge savings

Item	Mean WIC costs (dollars)	Estimated mean savings (dollars)	95 percent confidence interval of savings (dollars)	Benefit to cost ratio	95 percent confidence interval of benefit to cost ratio
Medicaid paid claims	$156	$76	($12–$140)	0.49	($.07–$.90)
Medicaid submitted charges	$156	$200	($57–$343)	1.28	($.37–$2.20)

NOTE: Estimated mean savings were adjusted for per diem reimbursement, adequate prenatal care, race, education of mother, and number born.

weight and increased estimated Medicaid savings barely missed statistical significance ($P = .06$).

The pattern for the two categories with less WIC prenatal participation (less than $110 and $110–219) showed a more mixed pattern. The $110–$219 group had a LBW rate significantly lower than non-WIC, but there were no Medicaid cost savings for this group. The lowest WIC participation category demonstrated virtually no improvement in birth weight, but had a slight Medicaid cost reduction ($62).

Cost-benefit analysis. Estimated Medicaid savings related to WIC participation were slightly less than half of WIC costs. For the 3,261 WIC mothers in the study sample, total WIC costs were approximately $508,000. Estimated newborn Medicaid costs saved within 45 days after birth were about $248,000. Thus for every WIC dollar spent, 49 cents in Medicaid costs was apparently saved (95 percent confidence interval (7 cents, 90 cents)).

Charges submitted to Medicaid, as illustrated in table 6, showed a greater benefit to cost ratio ($1.28) than paid claim amounts. However, the 95 percent confidence interval was also much wider ($.37, $2.20).

The improved birth weight distribution of WIC babies provided the primary explanation for the reduced newborn costs of WIC babies compared with non-WIC babies. After controlling for birth weight in addition to the other covariates listed in the methods section, the $76 reduction in Medicaid paid claim amounts for newborns associated with WIC prenatal participation was reduced to $11. Therefore, it is estimated that 86 percent of the $76 WIC to non-WIC Medicaid cost differential is explained by the improved birth weight distribution of the WIC infants.

In a similar procedure for submitted charges, estimated cost savings were reduced from $200 before adjustment to $71 after adjustment for birth weight. Therefore, nearly two-thirds of the $200 WIC to non-WIC Medicaid cost differential for submitted charges was explained by the higher birth weight distribution of WIC participants.

After adjustment for birth weight, the slight differential in NICU admission rates between WIC and non-WIC infants had virtually no effect on the WIC to non-WIC Medicaid cost differentials. A nonsignificant increase in Medicaid costs of $660 for non-WIC NICU admissions probably provided much of the nonbirth weight-explained Medicaid cost differential between WIC and non-WIC newborns.

Discussion

In comparison with the 1980 Missouri WIC–Medicaid study, the findings of the 1982 study show WIC to be associated with improved pregnancy outcome as measured by higher mean birth weight, lower LBW rates and lower neonatal mortality, but decreased cost benefits. WIC participation was associated with an increased mean birth weight of 31 grams in 1982 compared with 6 grams in 1980 and 31 grams in 6 studies cited by GAO (*2*). WIC LBW rates were 23 percent lower than non-WIC rates in 1982 compared with a 15 percent reduction in 1980 and 17 percent in the GAO report. Neonatal death rates also were 23 percent lower in 1982 compared with virtually no difference in 1980. However, estimated Medicaid cost savings for newborns were reduced to $76 in 1982 from $98 in 1980. For every dollar spent on WIC in 1982, an estimated 49 cents was saved in reduced Medicaid paid claims. These sums contrast with an 83 cents to $1 benefit cost ratio 2 years earlier.

With the increased LBW rate advantage for WIC babies, but decreased Medicaid newborn savings in 1982, the improved birth weight distribution of WIC babies provided a greater explanation for the reduced Medicaid costs in 1982 than it did 2 years earlier. In 1982, approximately 86 percent of the reduced Medicaid costs among WIC newborns was explained by the improved birth

weight distribution of WIC infants in contrast to explaining 45 percent of the estimated savings in 1980. NICU admissions played less of a role in explaining WIC to non-WIC cost differentials in 1982. In 1980, an implausible, but statistically significant differential of $1,100 between WIC and non-WIC NICU admissions explained about 38 percent (*7*) of the total WIC–non-WIC Medicaid cost differential. In 1982 non-WIC Medicaid NICU costs averaged $660 more than comparable WIC costs, but this difference was not statistically significant. It was reduced to $350 after adjustment for the specific NICU. The larger 1980 NICU cost differential may have been a statistical anomaly. Nevertheless, the 1982 NICU cost differential probably explains most of the nonbirth weight-explained WIC to non-WIC Medicaid cost differential.

Reasons for the improved birth weight distribution of 1982 WIC infants may include expansion of the WIC Program from 1980 to 1982, fewer first-time WIC participants in 1982, or improved WIC nutritional education in 1982. On the other hand, the 95 percent confidence intervals of the 1980 and 1982 WIC and non-WIC differences in mean birth weight and LBW rates cross each other, and therefore the improved outcomes may be due to random fluctuation.

In 1980 there was a 2.4 percent difference in the proportions of WIC and non-WIC mothers who had adequate prenatal care, but in 1982 the difference in the two groups was much greater—8.8 percent. This increase may reflect either an improvement in referral patterns among WIC providers or a change in the type of mothers participating in WIC. As with other studies of this type, WIC mothers were self-selected in that they were motivated to apply for and receive WIC benefits. Other Medicaid mothers may not have been aware of WIC because Medicaid referrals to WIC were not as good in their counties. Still others probably had the same opportunity but were not motivated to apply for WIC. These mothers may have been less interested in health and nutrition and these factors may have affected their infants' birth weights and Medicaid costs. As Rush (*8*) points out, greater participation in general health programs by WIC mothers may have improved the health of their babies more than WIC alone. Adequate or inadequate prenatal care was one of the covariates in most of the tests made, but it had only minimal effect on the relationship between WIC participation and outcome. This dichotomy may not have been strong enough to take fully into account Rush's point.

Although the proportion of Medicaid mothers on WIC increased from 25 percent in 1980 to 36 percent in 1982, this proportion is still rather low, considering the high-risk nature of the Medicaid population. There was wide variation in participation rates by county, suggesting widely different referral patterns by family services' units. The adjustments by per diem hospital reimbursement, however, suggest that these different referral patterns had little effect on results.

The apparent dose-response effect of WIC was generally not as strong in this study as in other studies, including the 1980 Missouri Medicaid study. Those with the longest participation and most vouchers redeemed generally had the highest birth weights, lowest LBW rates, and greatest reduction in newborn costs, but the degree of improvement was smaller. For example, there was only a 38-gram increase in those with 7 months or more participation in 1982 compared with a 68-gram increase in 1980. LBW rates were reduced for this group by 3.4 percent in 1982 compared with a 4.4 percent reduction in 1980. In the current study, there was a more rigorous control for confounding variables and this step may have decreased the apparent effects.

The cost results present more methodological problems than the birth weight results. A primary source of potential error is incomplete Medicaid cost data. Deleting records with third-party liabilities and records without hospital claims improves the data, but does not completely eliminate the problem. All eligible costs may not have been paid or claimed. Costs for the hospital of birth may have been paid by Medicaid, but not the NICU costs or vice versa. Billing problems with many rural hospitals also may have reduced claims. Submitted charges as well as paid claims may have been affected by these same problems. It is possible, although not probable, that the WIC and non-WIC populations varied with respect to these complicating factors.

The change in Missouri Medicaid reimbursement procedures before 1982 probably had some effect on the cost-benefit results. In 1980, Medicaid reimbursed hospitals at 100 percent of charges submitted for newborns, with some minor exceptions while in 1982, a per diem formula based on the hospital's entire population of patients was used. As a result, submitted charges were frequently lower than paid claim amounts for normal pregnancies, since per diem costs for newborns are lower than for adults. For NICU births, as in

1980, the submitted charges were higher than the paid claims. One result of this change was that the WIC–non-WIC Medicaid cost differential was explained entirely by differences in length of stay, not by increases in average costs per day as in 1980.

Because of this change in procedure, the greater savings in charges submitted for newborns in 1982 may compare more closely with the 1980 results than the paid claims. Submitted charges also may reflect more closely true hospital costs. Submitted charges are, however, subject to more fluctuation than paid claims, and it is more difficult to determine what they are reflecting. Submitted charges may be different from paid claim amounts for any of the following reasons: procedures are not covered by Medicaid, or the stay is too long for Medicaid coverage, or the actual per diem costs for the hospital are different from the Medicaid reimbursable rate, or the patient may not have been Medicaid eligible for the entire submittable charge period.

Excluding 931 records, or 9 percent, for incomplete financial data may have affected the results, but a lower percentage of records had to be excluded in 1982 than the 15 percent in 1980. The proportion of excluded records on WIC (34 percent) was nearly the same as the study file (36 percent). A higher proportion of excluded records were of low birth weight infants, but the relationship between WIC and non-WIC LBW rates (11.1 percent versus 16.4 percent) was roughly the same as the study population. This observation suggests that the WIC–non-WIC cost differentials found would not have changed much if there had been no exclusions, and the 931 records had been included in the study.

The 93 percent match rate between WIC expectant mothers and birth records suggests that some mothers in the non-WIC study group were actually WIC mothers. (If the correct matching birth record for a particular WIC record could not be found because of a name change or whatever reason, that birth record would be counted as non-WIC when, in fact, it should have been a WIC birth or mother.) However, not all nonmatching would lead to this misclassification. As Kotelchuck (*3*) and Stockbauer (*4*) note, many nonmatches may be due to spontaneous or induced abortions, migration out of State, or changes of name. Unless the nonmatched records include many abnormally high risk and premature births, it is unlikely that they greatly affected the results.

Only short-term savings within 45 days after birth were used in the primary analysis in this study. Since WIC apparently reduces the risk of low birth weight, an examination of long-term costs may have produced greater savings. However, in a preliminary analysis of Medicaid claims for services occurring 45 days to 1 year after birth, no additional savings were found for WIC participants.

In summary, the findings for 1982 Medicaid newborns generally confirm the 1980 results as well as those found in other published reports. WIC apparently reduces significantly low birth weight, the incidence of respiratory distress syndrome and, possibly, even neonatal mortality. WIC also apparently reduces Medicaid costs immediately following the infant's birth. It does not appear that the reduction in Medicaid costs outweighs the food and adminstrative costs associated with the WIC Program. Because of the wide confidence intervals of the calculated benefit-cost ratios, however, it is difficult to determine precisely what impact WIC has on Federal and State budget outlays.

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