WIC Prenatal Participation and Its Relationship to Newborn Medicaid Costs in Missouri: A Cost/Benefit Analysis

WAYNE F. SCHRAMM, MA

Abstract: The primary purpose of this study was to determine if WIC prenatal participation is associated with a reduction in Medicaid costs within 30 days after birth, and, if so, whether the reduction in Medicaid costs is greater than the WIC costs for these women. This evaluation of WIC was performed using 7,628 Missouri Medicaid records matched with their corresponding 1980 birth records. This file was then divided into a WIC group containing 1,883 records and a non-WIC comparison group of 5,745 records.

WIC participation was found to be associated with the reduction in Medicaid newborn costs of about $100 per participant (95 per cent confidence interval $43,153); mother's Medicaid costs were not affected. For every dollar spent on WIC, about 83¢ in Medicaid costs within 30 days of birth were apparently saved according to the results of this study (95 per cent confidence interval $.40, $1.30). Reductions in low birthweight rates and NICU admission rates among WIC infants provided two possible reasons for the reduced Medicaid costs associated with WIC food supplementation. As WIC food costs increased, both mean birthweight and newborn Medicaid savings also increased. Because of possible inconsistencies in the data, similar studies are needed in other states. (*Am J Public Health* 1985; 75:851–857.)

Introduction

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 nutritional education to these families and encourages the appropriate use of prenatal and other medical services.

The WIC program in Missouri was nearly statewide in 1980, operating primarily through county health departments in 93 out of 115 counties. Pregnant or lactating women, infants and children under age five are referred to local WIC programs by health care providers (including Medicaid) under two eligibility criteria: income less than 195 per cent poverty level, and nutritional risk. Poor obstetrical history, anemia, and extremes of age, leanness, or obesity are among the criteria used to determine obstetrical 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 pregnancy outcomes such as prematurity and infant mortality. An important by-product of these goals should be an increase in the infant's birthweight. Several studies have shown that WIC apparently does indeed increase birthweight and reduce prematurity.[1–4]

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[5] and costs of hospital care are generally greater.[6] Therefore, if WIC participation does indeed reduce the risk of having low birthweight and premature infants, WIC should also reduce the medical costs for the infants at and immediately following birth. In the only other known study to examine cost/benefits of WIC, Kennedy, *et al,** estimated that for every $1 spent on WIC prenatal costs, more than $3 are saved in newborn medical costs after birth in Massachusetts.

The present paper will also focus on the cost/benefits of the WIC program, but it uses concrete medical cost data rather than theoretical synthetic estimates used by Kennedy, *et al*. This paper will seek answers to the following questions:

- Does WIC participation reduce Medicaid costs for the newborn and its mother for the 30 days immediately following birth?
- Does WIC increase birthweight and reduce low birthweight (LBW) among Medicaid births?
- How do the relationships of birthweight, length of hospital stay, and NICU admissions affect the WIC/non-WIC Medicaid cost differentials?
- Is increased participation on WIC, as measured by the value of redeemed food vouchers, associated with reduced Medicaid costs and/or increased birthweight?
- Do reduced Medicaid costs for WIC participants outweigh WIC costs, thus demonstrating a cost-beneficial program?

Methods

Study Design

The basic design of the study involves a linking of four separate data files: 1) Medicaid, 2) birth certificates, 3) WIC records, and 4) Neonatal Intensive Care Unit (NICU) admissions. The Medicaid file provided Medicaid cost data. The birth certificate file provided data on maternal characteristics. The WIC file established which Medicaid mothers received WIC benefits, and provided the WIC costs for each birth. The NICU file provided a means of explaining differences between WIC and non-WIC Medicaid costs.

Study Population

Initially, a computer file of 9,062 newborn Medicaid records was created from January 1980 to November 1981 Missouri Medicaid claims tapes. Only claims with a date of service within 30 days of birth and only babies born in calendar year 1980 were included on this file.

These newborn records were then matched with their mother's claim records using Medicaid identification numbers as the matching criteria. Once again, only Medicaid claim records with a date of service within 30 days of the child's birth were used. A matching mother's Medicaid record was found for 75 per cent of these newborn records.

Address reprint requests to Wayne F. Schramm, MA, Director, Bureau of Health Data Analysis, Missouri Center for Health Statistics, Division of Health, Department of Social Services, Broadway State Office Building, P.O. Box 570, Jefferson City, MO 65102. This paper, submitted to the Journal July 16, 1984, was revised and accepted for publication February 27, 1985.
Editor's Note: See also related editorial p 828 this issue.

*Kennedy ET, Austin JE, Timmer CP: Cost/Benefit and Cost/Effectiveness of WIC. Privately circulated, n.p. n.d.

These 9,062 newborn Medicaid records were then matched with their corresponding birth record using name and date of birth as the principal matching criteria. A total of 8,996 Medicaid records were matched to birth records for a match rate of 99.3 per cent.

Additional exclusions were made in order that the final study file contain Medicaid records as complete as possible. A total of 407 records were excluded from the sample because they indicated a third-party liability was reported, thereby affecting the total Medicaid paid claims.

An additional 961 records were excluded because total paid claims for either the mother or newborn were less than \$100. Only 26 per cent of these records involved hospital payments indicating that the total Medicaid claims were missing from these records. Over 99 per cent of the newborn records with over \$100 paid claims involved hospital costs.

This left 7,628 records in the study sample. This file was then matched against a file of 6,657 1980 Missouri WIC birth records. This WIC file had been created from a tape of WIC prenatal participants with an estimated date of childbirth (EDC) between October 1979 and June 1981. The WIC file was matched with 1980 birth records. Approximately 93 per cent of the WIC records with an EDC of 1980 were matched with a birth record. (Stockbauer[4] gives a more detailed explanation of this matching process.) The Medicaid file and WIC file were merged using birth certificate numbers.

The final study sample contained 1,883 Medicaid-birth records that were on the WIC program and 5,745 Medicaid-birth records which were not on WIC. A summary of the entire matching process is illustrated in Figure 1.

Characteristics of WIC, Non-WIC Populations

The two populations, WIC and non-WIC, were then examined by a number of demographic and behavioral variables taken from the birth record to determine what intervening variables should be controlled for in testing the hypothesis that WIC participation reduces Medicaid costs. Table 1 shows there basically was little difference in the WIC and non-WIC populations for most variables studied.

FIGURE 1—Medicaid-birth WIC Matching Process

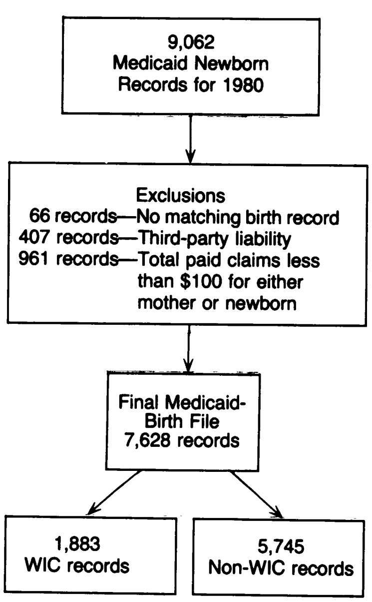

TABLE 1—Per Cent Distributions of WIC and Non-WIC Medicaid Populations by Selected Variables Available on Missouri Birth Certificates

Variables	% WIC	% Non-WIC
Black	56.5	56.7
Mother under 18	21.5	19.2
Mother 35+	1.7	1.7
Birth order 4+	7.9	9.1
Mother's education <12	60.7	57.3
Mother under 100 lbs	7.4	6.2
Mother 175+ lbs	9.4	10.0
Mother at least 15% underweight*†	16.6	14.1
Mother at least 20% overweight*†	17.4	17.9
Mother smoking during pregnancy†	47.0	48.9
Birth spacing <18 mos	12.6	12.7
Mother unmarried	76.9	80.0
Multiple birth	1.7	2.3
Inadequate prenatal care**	39.1	41.5
WIC risk identifiable from the birth record***	63.5	62.6
WIC medical risk‡	5.6	5.5
Metropolitan (SMSA) residence	66.6	77.3
N	1,883	5,745

*According to 1959 Metropolitan Life Insurance weight for height tables.

**Fewer than five prenatal visits for pregnancies less than 37 weeks, fewer than eight visits for pregnancies 37 weeks or longer or care beginning after four months of pregnancy.

***Age of mother less than 18 or over 34 or birth order 4+ or birth spacing less than 18 months or mother more than 15% underweight or mother more than 20% overweight or previous infant death or previous stillbirth or at least three miscarriages or a multiple birth or a WIC medical complication.

†Missouri is one of the few states in the US which include weight, height, and smoking on the birth certificate.

‡Diseases and conditions complicating present pregnancy such as hypertension, diabetes, renal disease, sickle cell disease, tuberculosis and heart disease.

The WIC group had a higher percentage of mothers under age 18, of mothers without a high school diploma, and of mothers at least 15 per cent underweight, and a lower percentage of illegitimate births and of metropolitan births than the non-WIC population. The only difference of any substantial, practical importance in testing the Medicaid cost hypothesis, however, is the metro-nonmetro variation. Medical costs tend to be higher in metropolitan areas, and therefore this is an important variable to control for when testing for differences in Medicaid costs between WIC and non-WIC populations.

Statistical Techniques

The direct method of standardization will be the primary method of adjustment and metro-nonmetro residence will be the primary variable adjusted for. The total study sample distribution will be used as the standard population. The normal deviate test[7] for standardized means will be used for testing the principal hypotheses. For unadjusted rates such as those in Table 3, the t-test for differences in proportions will be used.

As a validity check on the primary method of adjustment, an analysis of covariance will also be performed using the per diem hospital reimbursement rate as the covariate. Each hospital is assigned a reimbursement rate based on a comparison of each given hospital's total allowable inpatient routine and special care unit expenses, ancillary expenses and applicable professional fees divided by the total number of Medicaid recipient days of stay for a given fiscal year. This variable will be entered into the analysis of covariance as a continuous variable. Mean Medicaid claim amount differences between WIC and non-WIC participants will also be examined by individual hospitals for those hospitals with at least 25 WIC and 25 non-WIC births. This will also be done

TABLE 2—WIC/Non-WIC Differences in Mean Medicaid Paid Claims for Newborns by Selected Variables (adjusted for residence)

Variables	N	Mean Newborn Paid Claims (dollars) WIC	Non-WIC	Standard Error of Difference (dollars)
Total (crude)	7,628	$ 567	$ 672	$ 28
Total (adjusted for residence)	7,628	574	672	28
Residence				
Metro	5,695	597	677	32
Nonmetro	1,933	507	656	59
Race				
White	3,251	573	659	47
Nonwhite	4,377	584	691	48
Age of mother				
Under 20	3,268	564	649	41
20–29	3,856	585	686	42
30+	504	579	707	95
Birth order				
1st	3,063	559	639	39
2nd or 3rd	3,897	564	699	45
4th or more	668	646	678	81
Education of mother				
<12	4,434	561	668	36
12	2,606	553	678	47
13+	588	786	662	131
Mother's prepregnancy weight				
<110 lbs	1,409	627	857	83
110–129 lbs	2,679	578	624	47
130–149 lbs	1,908	516	619	33
150+ lbs	1,632	592	653	55
Mother's weight for height status				
>15% Underweight	1,207	692	816	98
Normal	5,084	525	636	31
>20% Overweight	1,337	640	679	65
Mother smoking during pregnancy				
Smoker	3,647	561	665	39
Non-smoker	3,884	578	661	41
Birth spacing				
<18 months	965	776	813	114
18 mos or more	3,141	533	670	44
N.A. or unknown	3,522	551	636	36
Mother's marital status				
Married	1,587	552	633	59
Unmarried	6,041	587	668	32
Number born				
Singleton	7,461	556	643	27
Multiple	167	1,602	1,895	472
Previous stillbirth, infant death or 2+ miscarriages				
Yes	508	814	768	132
No	7,120	558	665	31
Prenatal care				
Adequate	4,337	544	645	34
Inadequate	2,996	600	695	52
WIC Risk identifiable from birth record				
Yes	4,794	640	715	40
No	2,834	458	599	35
WIC Medical risk				
Yes	424	750	981	132
No	7,204	564	653	29

in order to check the validity of the primary method of adjustment.

Dependent and Independent Variables

Principal dependent variables examined will be the mean Medicaid costs for the newborn within 30 days of birth, and the mean Medicaid costs for the mother within 30 days of her child's birth; WIC program participation will be the primary independent variable. The low birthweight rate (under 2501 grams) will be the primary dependent variable used to help explain differences in Medicaid costs by WIC program participation.

To determine if WIC is cost beneficial, a comparison will be made between the WIC costs for the mothers on Medicaid and the Medicaid cost savings, if any. WIC costs are calculated by using the actual costs of the redeemed food vouchers for the 1980 WIC mothers in the study sample. A 20 per cent administrative overhead cost, as determined from the Missouri WIC budget, is then added to the food costs. For Medicaid, the administrative overhead is negligible (1 per cent) so no adjustment will be made for these costs.

To estimate a dose-response effect of the WIC program, mean birthweight, low birthweight rates, and Medicaid cost savings will be calculated for various categories of WIC food costs. These means will be adjusted by exact length of pregnancy in weeks and residence (metro, nonmetro). Using the analysis of covariance technique, the tests on low and mean birthweights will also be adjusted by race and education of mother because increased WIC participation is associated with higher education levels and fewer Black births and these variables are highly correlated with birthweight.

Additional dependent variables to be studied in explaining the Medicaid cost relationships include: mean birthweight, newborn and maternal hospital length of stays, and NICU admission rates.

The latter rates were calculated using a tape containing a 98 per cent match rate between NICU records and birth records. The NICU tape was created by a voluntary reporting system in which all major NICU centers in the state report admissions and diagnoses to the Missouri Division of Health.

Results

Medicaid Cost Results

Mean newborn Medicaid costs were nearly $100 less for WIC participants than non-WIC clients. The metro-nonmetro adjusted mean newborn Medicaid costs were $574 for WIC mothers compared with $672 for non-WIC mothers.

The lower newborn Medicaid costs for WIC participants was consistent for nearly all variables illustrated in Table 2. There was an apparent savings in Medicaid costs by WIC participation regardless of residence, race, age of mother, prepregnancy weight, smoking habits, legitimacy, or prenatal care.

The analysis of covariance technique using hospital per diem reimbursement rate as the covariate generally agreed with the standardization method adjusting for metropolitan residence. As Table 3 shows, WIC newborn costs were less than non-WIC by $89 using this method.

The examination by individual hospital revealed that, of the 17 hospitals with at least 25 WIC and 25 non-WIC births, 13 showed a decrease in newborn Medicaid costs for WIC babies. Four hospitals had higher newborn Medicaid paid claims for WIC babies, but differences were quite small.

In contrast to the substantial savings in newborn Medicaid costs associated with WIC participation, virtually no savings in the mother's Medicaid costs were found. The residence-adjusted mean Medicaid costs for WIC mothers was $1,063 or just $4 less than the comparable non-WIC costs.

Factors Related to Medicaid Costs

Birthweight—The original hypothesis proposed that WIC participation should reduce Medicaid newborn costs because it increases birthweight and decreases low birthweight rates. Table 4 shows that the WIC babies

TABLE 3—WIC/Non-WIC Differences in Newborn Mean Paid Claim Amounts (dollars) by Two Methods of Adjustment

	WIC	Non-WIC	Difference	95% Confidence Interval of Difference
Adjustment for metro-nonmetro residence (standardization)	574	672	98	(43–153)
Adjustment for per diem reimbursement (analysis of covariance)	577	665	89	(24–154)

NOTE: Differences may not add up due to rounding.

TABLE 4—Percentage Distributions of WIC and Non-WIC Birthweight Distributions

Birthweight (grams)	WIC	Non-WIC	Difference	95% Confidence Interval of Difference
Under 1501	1.1	1.4	0.3	± 0.6
1501–2500	9.6	11.2	1.6	± 1.7
2501–4500	88.7	86.4	−2.3	± 1.8
4501 or more	0.6	1.0	0.4	± 0.4
Low birthweight (under 2501 gm)	10.7	12.6	1.9	± 1.7
Mean (grams)	3,151	3,145	−6	±30
N	1,883	5,737		

weighed only six grams more than the non-WIC babies, but a LBW rate almost 2 per cent less than non-WIC babies. Table 5 shows that WIC infants' LBW rates were lower than those of non-WIC infants for nearly all variables tested. No pattern emerges as to which risk factors are most associated with a reduction in the risk of a low birthweight birth by WIC participation.

As WIC food costs increased, mean birthweight also increased and low birthweight rates decreased (Table 6). Mean birthweight was higher for non-WIC babies than for babies for which WIC food costs were under $75. Evidently mothers who drop out of WIC or enter WIC late in pregnancy experience little or no benefits from WIC food supplementation. This finding lends support to the importance of early and complete WIC participation.

Length of Stay—The average length of hospital stay after birth was slightly shorter for WIC babies than non-WIC babies (4.7 vs 4.9 days). WIC mothers also stayed in the hospital for a slightly shorter length of time than the non-WIC group (3.7 vs 3.8 days).

Although the newborn length of stay difference was only 0.2 days, given that the average Medicaid cost per day was $133, approximately $27 in newborn Medicaid costs were saved on this shorter length of stay of WIC newborns. The rest of the $98 difference between WIC and non-WIC newborn Medicaid costs were due to smaller costs per day of the WIC infants.

Neonatal Intensive Care Admissions—Approximately 3.7 per cent of WIC infants were admitted to NICUs compared to 4.8 per cent for non-WIC infants, a statistically significant difference. A smaller proportion of WIC infants was admitted to NICUs regardless of metropolitan residence. For metropolitan residents, the NICU utilization rate was 3.6 per cent for WIC infants and 4.2 per cent for non-WIC babies. The comparable nonmetropolitan rates were 3.8 and 6.9 per cent, respectively.

The greater utilization of NICUs by non-WIC newborns partly explains the higher cost per day noted above. NICU admission cost per day rates were two and one-half times the non-NICU rates.

In this study, the average newborn Medicaid costs were approximately four times greater for low birthweight babies than for normal weight babies and NICU admissions resulted in costs six times greater than non-NICU births.

When adjusted for birthweight distribution, the WIC/non-WIC differential in newborn Medicaid costs was reduced from $98 to $55 (see Table 7). This suggests that approximately 40 to 45 per cent of the newborn cost differential was explained by the WIC/non-WIC birthweight distribution.

NICU admissions, highly correlated with low birthweight, provided a further explanation of the apparent $100 newborn cost differential. When adjusted for both birthweight distribution and NICU admission status, there was a $47 differential between WIC and non-WIC newborn Medicaid costs. This difference, slightly less than half of the original difference, was all that was unexplained by birthweight or NICU admission distribution.

The remaining unexplained difference between WIC and non-WIC newborn costs primarily reflected a more than $1,000 difference between WIC and non-WIC NICU admission costs. The non-WIC NICU patients also had a significantly longer length of stay than the WIC patients (11.5 vs 9.0 days).

This WIC/non-WIC NICU newborn cost differential was rather surprising and several analyses were done to try to explain it. Using the analysis of covariance technique, this differential was adjusted separately and together, by birthweight, diagnosis, and death. The $1,000 difference continued after adjustment for all these variables. For each of the six major NICUs in Missouri, non-WIC newborn Medicaid costs were higher than the comparable WIC Medicaid costs.

In an additional analysis, outliers (>$10,000 or <$500) were excluded to see if a few records were causing the large WIC/non-WIC differential. After excluding these outliers, the WIC/non-WIC differential was reduced to about $800.

Cost/benefit Analysis

Estimated Medicaid savings related to WIC participation were nearly equal to WIC costs. For the 1,883 WIC mothers in the study sample, total WIC costs including a 20 per cent administrative overhead were approximately $229,000. Estimated Medicaid costs saved within 30 days of birth were approximately $191,000. Thus, for every WIC dollar spent, 83¢ in Medicaid costs were saved (95 per cent confidence interval $.40, $1.30).

Table 8 shows that, as WIC costs increased, estimated Medicaid cost savings also increased, although not proportionately. Greatest Medicaid savings were found for those mothers with WIC food costs over $150 while the least savings were found for mothers with WIC food costs under $75. This pattern of increased medical savings with increased WIC costs chiefly reflected savings in newborn costs.

While benefits increased with increased WIC costs, they did not rise in the same proportion as WIC costs. In fact, the cost/benefits in Table 8 were greatest for the under $75 WIC food cost category.

Discussion

The reduced Medicaid costs associated with WIC food supplementation were partly reflections of the reductions in

TABLE 5—WIC/Non-WIC Difference in Low Birthweight Percentages by Selected Variables

Variables	N	Percent Low Birthweight WIC	Percent Low Birthweight Non-WIC	Standard Error of Difference
Total	7,628	10.7	12.6	0.8
Residence				
Metro	5,695	10.5	12.7	1.0
Nonmetro	1,933	11.3	12.4	1.6
Race				
White	3,251	9.2	10.1	1.2
Nonwhite	4,377	11.9	14.7	1.2
Age of mother				
Under 20	3,268	11.4	12.9	1.3
20–29	3,856	10.6	12.6	1.2
30+	504	6.6	11.3	2.9
Birth Order				
1st	3,063	10.7	12.0	1.3
2nd or 3rd	3,897	9.7	13.1	1.3
4th or more	668	13.5	12.9	2.3
Education of mother				
<12	4,434	11.2	13.3	1.1
12	2,606	10.1	11.6	1.4
13+	588	9.6	12.9	3.2
Mother's prepregnancy weight				
<110 lbs.	1,409	16.1	19.7	2.3
110–129 lbs.	2,679	12.7	13.0	1.5
130–149 lbs.	1,908	7.8	10.9	1.5
150+ lbs.	1,632	5.9	8.6	1.4
Mother's weight for height status				
>15% underweight	1,207	16.1	18.1	2.4
Normal	5,084	10.3	12.5	1.0
>20% overweight	1,337	6.8	8.5	1.7
Mother smoking during pregnancy				
Smoker	3,647	12.8	15.9	1.3
Non-smoker	3,884	8.7	9.6	1.1
Birth spacing				
<18 months	965	18.1	19.3	2.9
18 mos or more	3,141	8.6	11.2	1.2
N.A. or unknown	3,522	10.5	12.1	1.2
Mother's marital status				
Married	1,587	9.0	10.6	1.6
Unmarried	6,041	11.3	13.3	1.0
Number born				
Singleton	7,461	9.8	11.8	0.8
Multiple	167	65.6	52.6	9.6
Previous stillbirth, infant death or 2+ miscarriages				
Yes	508	20.9	17.1	4.3
No	7,120	10.1	12.3	0.8
Prenatal care				
Adequate	4,337	9.2	11.1	1.1
Inadequate	2,996	12.0	14.0	1.4
WIC Risk identifiable from birth record				
Yes	4,794	12.4	14.2	1.1
No	2,834	7.8	10.0	1.2
WIC Medical risk				
Yes	424	16.0	22.1	4.3
No	7,204	10.4	12.1	0.8

low birthweight rates and NICU admission rates by WIC newborns. More than half of the $100 differential between WIC and non-WIC newborn Medicaid costs was explained by adjustments for birthweight and NICU admission status.

The low birthweight rate reduction is fairly straightforward, since it is logical and consistent with other studies for WIC food supplementation and nutrition education to reduce the risk of low birthweight. The reduced use of NICU services by WIC babies after control for birthweight may, however, reflect less sophisticated or less costly care for WIC babies. One might argue that this is due to the greater WIC participation in nonmetro areas where Level III hospitals are not located. This is a possibility, but the fact that there was reduced NICU usage by WIC infants in both metropolitan and nonmetropolitan areas tends to argue against this interpretation. The other possible, although not documented, interpretation is that WIC babies are less likely to be admitted to NICUs because they are less sick than their non-WIC counterparts.

TABLE 6—Mean Birthweight and Low Birthweight Rates by WIC Costs

	N	Mean Birthweight (grams)	Low Birthweight Rate
Non-WIC	5,605	3151	12.6
WIC Food costs			
<$75	682	3084	12.9
$75–$149	803	3182	10.3
$150 or more	346	3219	8.2
Total WIC	1,831	3153	10.8

NOTE: Adjusted for length of pregnancy, residence, race and maternal education level.

The third major factor influencing the reduction in Medicaid costs for WIC infants is the large $1,000 decrease in costs and shorter length of stay for WIC babies admitted to NICUs. An exhaustive analysis was done to try to determine the reasons for this differential. This analysis helped to eliminate various hypotheses, but did not result in a definitive answer. Medicaid costs were reduced for WIC infants at each of the six major NICUs in the state. Therefore, if WIC infants were getting less sophisticated and less expensive care than non-WIC infants with the same risk condition, that would have to be happening at the same hospital, a highly unlikely development. Other possibilities for the cost differential include small numbers, billing problems, eligibility changes, transportation costs, or that WIC infants of the same birthweight and same general diagnosis were less sick than non-WIC infants. It was not possible to determine the precise reason from the available data.

The apparent savings in Medicaid costs occurred for nearly all the demographic, lifestyle, and pregnancy history items tested. Of course, not all possible confounding variables could be tested. It is possible other factors may have influenced the results. In this study, as in other WIC studies of this type, the 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 or were unable to apply in their counties. But 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 Medicaid costs. In addition, 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.

Only about 25 per cent of the Medicaid newborn file was on WIC although most Medicaid mothers would qualify. There was a wide variation in participation rates by county, which suggests widely different referral patterns among Family Service units. However, the various adjustments for metropolitan residence, per diem hospital reimbursement rate, and specific hospital suggest that these different referral patterns had little effect on the overall conclusions of the study.

TABLE 7—WIC/Non-WIC Differences in Mean Medicaid Paid Claims for Newborns by Birthweight and NICU Admission Status

	N		Mean Paid Claims (dollars)		Non-WIC/WIC Difference (dollars)	95% Confidence Interval of Difference (dollars)
	WIC	Non-WIC	WIC	Non-WIC		
Low Birthweight*	200	718	$1,877	$1,904	$ 27	$± 365
NICU Admission*	40	150	2,865	3,984	1,119	±1,106
Non-NICU*	160	568	1,572	1,357	−215	± 337
Normal Birthweight*	1,683	5,016	429	488	59	± 34
NICU Admission*	29	124	1,650	2,878	1,228	± 802
Non-NICU*	1,654	4,892	408	426	18	± 24
Total (adjusted for residence only)	1,883	5,742	574	672	98	± 55
Total (adjusted for birthweight and residence)	1,883	5,742	604	659	55	± 52
Total (adjusted for birthweight, NICU admission status and residence)	1,883	5,742	606	653	47	± 50

*Adjusted for birthweight (500 gram increments) and residence.

TABLE 8—Cost/benefit Analysis: WIC Costs vs Estimated Medicaid Savings per Client (all figures are in dollars)

	Mean WIC Costs	Estimated Mean Medicaid Savings			Benefit/cost Ratio
		Newborn	Mother	Total	
WIC Food costs					
$ <75*	50	33	14	47	0.94
75–149*	137	126	−3	123	0.90
150+*	233	113	28	141	0.61
Total WIC*	122	92	9	101	0.83
Total WIC**	122	98	4	101	0.83

*Adjusted for length of pregnancy and residence.
**Adjusted for residence only.
NOTE: Numbers may not add up due to rounding.

It must be acknowledged that there were some confusing inconsistencies in this study's results, particularly in Table 2. For example, the lack of a relationship between smoking and newborn costs was surprising considering the widely documented relationship between smoking and reduced birthweight.[9] However, Table 5 shows the expected smoking-low birthweight relationship did occur in this study. While smoking reduces birthweight, it does not have as strong a relationship with prematurity and perinatal mortality which may affect costs more than birthweight.

Another surprising result was the fact that newborn Medicaid savings were apparently greater for subjects without a WIC risk identifiable from the birth record than for those with a risk ($141 vs $75). This result may have been due to the fact that nutritional risks cannot easily be identified on birth records; risks identified on birth records are primarily obstetrical risks for which food supplementation can be expected to have little effect.

The decreased rate of oversize WIC babies is also somewhat surprising. It may be that the supplemental food supplied by WIC reduces the need for overweight pregnant women to have high carbohydrate food that would excessively increase their weight. In addition, WIC nutritionists probably also advise against excessive weight gain.

A primary source of potential error was incomplete Medicaid cost data. Deleting records with third-party liabilities and records with total costs under $100 improves the data, but does not completely eliminate the problem. All eligible costs may not have been claimed. For example, claims for 1980 newborns were still being paid as late as November 1981. Billing problems with many rural hospitals also may have reduced claims. It is possible, although not probable, that the WIC and non-WIC populations varied with respect to these complicating factors.

Excluding 1,369 records for incomplete financial data may have affected the results of this study. The proportion of excluded records on WIC (25 per cent) was nearly the same as the study file. Similar to the study file, a higher proportion of non-WIC excluded records were admitted to NICUs than WIC excluded records (4.1 vs 3.1 per cent). However, the birthweight distribution of WIC and non-WIC participants was somewhat different for the excluded records. A somewhat higher percentage of excluded WIC babies were low birthweight (11.0 vs 8.7 per cent). This difference was concentrated in the 2001–2500 gram weight group as the non-WIC exclusions had a higher percentage under 2000 grams (3.7 vs 3.1 per cent). There was virtually no mean birthweight differential between WIC and non-WIC babies for the excluded records were approximately the same, as in the study file. Overall, the reversal of the low birthweight pattern among exclusions implies that the cost benefits of WIC may have been slightly diminished if the excluded records had had complete medical cost information and thus were included in the study.

While many of the birth data items may be subject to some error, they are fairly well reported in Missouri. An extensive editing and querying program has reduced the number of missing records to less than 2 per cent for any variable. In addition, studies comparing pregnancy outcome with smoking[9] and weight for height[10] categories using Missouri birth data have revealed patterns similar to more rigorously controlled clinical data studies, thus providing evidence of reasonably accurate birth data.

Another possible source of error includes the fact that only 75 per cent of the newborn Medicaid records were matched with a mother's record. The non-match rate for WIC mothers was 29 per cent compared to 24 per cent for non-WIC mothers. This high rate of non-matching makes the mother's Medicaid costs less reliable than the newborn's costs. However, since there were virtually no savings from WIC for mother's Medicaid costs, this should not have affected the major conclusion of this paper that WIC reduced Medicaid newborn costs.

The 93 per cent match rate between WIC expectant mothers and birth records means that some mothers in the non-WIC group were actually WIC mothers. However, not all non-matching would lead to this misclassification. As Kotelchuck[3] and Stockbauer[4] note, many non-matches may be due to spontaneous or induced abortions, migration out of state, or changes of name. Unless the non-matched records are abnormally high risk and premature, it is unlikely that they greatly affected the results of this study.

The WIC benefit/cost ratio for this study of 0.83:1 is much smaller than the 3.1:1 found by Kennedy, *et al*, in Massachusetts (see earlier footnote *). Since the Missouri Medicaid study is based on hard data, this leads one to question some of the assumptions made by Kennedy. Kennedy's assumption on the WIC/non-WIC low birthweight rate differential (3.4 per cent for WIC and 14.6 per cent for non-WIC) causes the greatest discrepancy between the two studies. This differential is much larger than any of the other major WIC evaluation studies.

Our study findings with respect to birthweight confirm those found by Edozien,[1] Kennedy,[2] Kotelchuck,[3] and Stockbauer.[4] The Missouri Medicaid study also confirms that WIC participation is associated with a dose-response effect; babies of mothers who received the most WIC food supplementation experienced the greatest increase in mean birthweight.

We examined only short-term savings within 30 days after birth. Since WIC apparently reduces the risk of low birthweight, an examination of long-term costs may produce greater savings. Prematurity is known to be related to mental retardation and neurological abnormalities.

In the current analysis on 1980 Missouri Medicaid live births, for every dollar spent on WIC, approximately 83¢ was saved in Medicaid newborn costs. One should not apply a great deal of weight to this precise number since the 95 per cent confidence interval ranges from about $0.40 to $1.30. Moreover, if this study were done for a later time period or in a different state, Medicaid savings might have been different; Medicaid coverage frequently changes and varies from state to state.

While this study has obvious methodological problems as any retrospective study of this type would, it has provided a unique data set in which to study the cost benefits of WIC as well as possible birthweight improvements. It is also the only known WIC study that has been able to control for income as all Medicaid clients have low incomes.

The findings suggest that WIC expenditures do not excessively increase the federal and state budget outlay in Missouri in the short term because of an apparent reduction in Medicaid costs of nearly the same amount. Similar additional studies are needed in other states to determine if the Missouri findings have broader national implications for the federal WIC budget.

ACKNOWLEDGMENTS

The author thanks Richard Blount, Director of the Missouri WIC Program, for his support of this study; the Missouri Divisions of Family Services and Data Processing for providing and creating the Medicaid tapes for the study; Joseph Stockbauer and Vera Gerling of the Missouri Center for Health Statistics for their assistance in preparing the data and manuscript; and Garland Land, Deputy Director of the Division of Health, and Milton Kotelchuck of Harvard University for providing critical review and comments on the paper. An earlier version of this paper was presented at the Annual Missouri Public Health Association Meeting, April 26, 1983.

REFERENCES

1. Edozien JC, Switzer BR, Bryan RB: Medical evaluation of the Special Supplemental Food Program for Women, Infant, and Children. Am J Clin Nutr 1979; 32:677–692.
2. Kennedy ET, Gershoff S, Reed R, Austin JE: Evaluation of the effect of WIC supplemental feeding on birth weight. J Am Dietet Assoc 1982; 80:220–227.
3. Kotelchuck M, Schwartz J, Anderka M, Finison K: WIC participation and pregnancy outcomes: Massachusetts Statewide Evaluation Project. Am J Public Health 1984; 74:1086–1092.
4. Stockbauer JW: Evaluation of the Missouri WIC Program: Prenatal Component. Jefferson City: Missouri Division of Health (in press 1985).
5. Pomerance JJ, Ukrainski CT, Ukra T, Henderson HH, Nash AH, Meredith JL: Cost of living for infants weighing 1,000 grams or less at birth. Pediatrics 1978; 61:908–910.
6. Jonsen AR, Garland MJ, (eds): Ethics of Newborn Intensive Care. A joint publication of Health Policy Program, University of California at San Francisco and the Institute of Governmental Studies, University of California at Santa Barbara, 1976; p 82.
7. Armitage P: Statistical Methods in Medical Research. New York: Wiley, 1971; 385–389.
8. Rush D: Is WIC worthwhile? (editorial). Am J Public Health 1982; 72:1101–1103.
9. Schramm W: Smoking and pregnancy outcome. Missouri Med 1980; 77:619–626.
10. Schramm WF: Obesity, Leanness and Pregnancy Outcome. Missouri Center for Health Statistics Pub. No. 10.5, 1981. (Also presented at the Annual Association for Vital Records and Health Statistics Meeting in July 1982.)