

Prenatal Care: Associations with Birth Outcomes and Medicaid at Varying Population Levels

Iqbal MT¹ and Iqbal MM^{2*}

¹CNYMPH-SUNYUpstate Medical University/Syracuse University, USA

²Central New York Psychiatric Center, USA

***Corresponding author:** Mohammad Masud Iqbal, MD, MPH, MSPH, Central New York Psychiatric Center, New York, USA, Email: mmiqbal569@gmail.com

Review Article

Volume 2 Issue 2

Received Date: June 15, 2018

Published Date: July 12, 2018

DOI: 10.23880/mhrij-16000121

Abstract

Purpose: To identify associations between timing of prenatal care, various pregnancy outcomes, and Medicaid within and across various aggregate population levels.

Data: The data for prenatal utilization, birth outcomes, and insurance were obtained from Central for Disease Control (CDC) Vital Statistics, Kaiser Family Foundation, National Health Expenditure, the New York State Minority Health Surveillance Report, and the New York State Community Health Data Set.

Methods: Descriptive statistics were run on all variables at all population levels to gauge the variability and characteristics of the study population. Bivariate (simple regression) analysis was then used to identify associations among variables and timing of prenatal care at all aggregate population levels of analysis.

Results: Early prenatal care was only found to be associated with reduced adverse birth outcomes at the national and regional aggregate population levels. The percent of births financed by Medicaid was also found to be associated with adverse birth outcomes and reduced per capita Medicaid spending at the national level.

Conclusions: Initiation of early prenatal care may result in reduction of adverse birth outcomes but these benefits may be difficult to measure due to current limitations in measuring the quality and content of prenatal care. Furthermore, prenatal care needs to be adjusted to reflect the specific needs of high risk pregnant women, with an emphasis on quality of visits over quantity of visits.

Keywords: Birth; Population; Prenatal Care; Pregnancy

Introduction

Research Questions and Study Objectives

This study attempts to identify associations between timing of prenatal care, multiple pregnancy outcomes, and Medicaid within and across various aggregate population levels (New York State County, New York State Region, and national). Questions of interest to this study are the following:

- What associations exist between early initiation of prenatal care and various pregnancy outcomes at the national, New York State Regional, and New York State county levels?
- Are there trends in low birth weight, preterm birth, and infant mortality associations across the various aggregate population levels (national, regional, county)?
- At the New York State county level, do certain minorities experience greater benefits from early initiation of prenatal care?
- What are the associations between percent of births financed by Medicaid, early prenatal care, and birth outcomes at the various aggregate levels? Are there trends in these associations across the various aggregate levels?

There exist no previous studies that aim to identify at what population level prenatal care services and Medicaid financed births begin to show associations with pregnancy outcomes. The majority of studies are also prospective in design or use linked data files. This study is concerned with the associations of current prenatal care utilization on various outcomes at a purely population level. Furthermore, no studies on prenatal care have included the indicators of maternal mortality and early childhood mortality, this study includes these outcome measures. A plethora of services, interventions, procedures, medications, and knowledge exist for pregnant women and the influence of prenatal care on pregnancy outcomes may be overshadowed. Comparing associations with prenatal care at increasingly larger population levels may shed light on the variance of prenatal care utilization, content, and quality across New York State and the nation. Since numerous other social and economic factors influence access or utility of prenatal services, it is often difficult to establish causality from associations. However, this study hopes to encourage further research into the functionality of prenatal care within the social and economic context of pregnant women. Specifically, of interest are what

prenatal services are found to be most effective, and to what demographics.

Background and Review of the Literature

The United States, to date, still ranks far below many other industrialized nations for infant mortality rates. By 1980, the infant mortality rate had plateaued and rates of adverse pregnancy outcomes between African American's and the rest of the nation were widening [1]. In the landmark report, *Preventing Low Birth Weight* (1985), the IOM recommended that timely and adequate prenatal care would reduce the incidence of low birth weight, the most common cause of infant morbidity and mortality [2]. As a result, numerous legislative actions and policy changes led to increased funding and expansion of prenatal care services. Along with this, Medicaid coverage for maternal care was extended to cover over 14 million previously uninsured women by changing eligibility requirements for pregnant women [3]. In 1985 only 17% of all births in the United States were financed through Medicaid, and in 2005 that number had soared to 41%, with the majority of these women being low income, a population at increased risk for adverse birth outcome [4]. It is clear that the IOM recommendations clearly influenced health policy, essentially portraying prenatal care as the solution to reduce low birth weight, and subsequently infant mortality.

Prenatal care (PNC) is a comprehensive set of services which includes risk assessment (screenings and diagnostics), health promotion, medical and psychosocial interventions, and continuous follow ups (11-14 visits). Although there is no standard of prenatal care, the American College of Obstetricians and Gynecologists publish recommendations and best practices for physicians, midwives, and nurses. Early Prenatal care is defined as care initiated within the first trimester, while late prenatal care is care sought any time after the first trimester. From 1985 to 2007, prenatal care utilization increased from 76% to 82%, with the greatest participation seen in lower socioeconomic and high risk women. Despite the increases in PNC utilization, rates of low birth weight in 2007 were 8.2%, an increase of 1.5% from 1983. Along with low birth weight, other indicators such as preterm and infant mortality saw no significant improvements due to increased utilization of timely prenatal care [5]. It would be expected that minority women would gain more from increased access and availability of prenatal care services; however the gap between pregnancy outcomes for African Americans and the rest of the nation has only slightly improved. In 1980,

the infant mortality rate for blacks was 22.2 compared to 10.9 for whites; by 2007, this gap still remained, with infant mortality rates of 13.2 and 5.6 respectively [6].

Although prenatal care is widely used to prevent or reduce adverse pregnancy outcomes, the evidence for its effectiveness remains ambiguous, and the primary purpose and effects are a topic of debate [7]. The IOM noted that the evidence used to support their recommendations was based on vital statistics data, and evaluation of prenatal programs at the time [8]. The drawback with using large data sets, such as vital statistics, is that no information with regard to the content or quality of visits is reported; only timing of initiation of prenatal care, and sometimes the number of visits is found. There also exist limitations in the findings from prenatal program evaluations since they are often specific for high risk women with special needs, and subject to self-selection.

The existing literature on prenatal care uses both primary and secondary data; those using primary data are either prospective or retrospective in nature but are often limited to small isolated samples. Secondary data is obtained from Vital Statistics databases, insurance company records, and national health surveys. Many studies note the difficulty in distinguishing between high and low risk mothers, and its effects on artificially reducing the benefit of prenatal care since missing a fraction of high risk women can dramatically augment statistical results [9]. There is no consensus on the benefits of prenatal care in reducing the rate of adverse pregnancy outcomes, and there is considerable variation in magnitude and scope of findings. This is due to the inherent limitation of evaluating prenatal care. It would be unethical to administer a randomized trial, and existing studies used data that was heavily influenced by self-selection of pregnant women into prenatal services [10]. Furthermore, as many risk factors for adverse pregnant outcomes are established before pregnancy, the social and economic environments are often the biggest threats to pregnancy outcomes. Complicating this is the difficulty in controlling for confounders from substance use, cultural practices, and the general health habits of pregnant women [11].

Data & Variables

Data from various sources were used in this study. The New York State Minority Health Surveillance Report and New York State Community Health Data Set were used to obtain data for all counties and regions in the State of

New York. County and regional level data was averaged for 2007-2009, but the data used to compare across race was averaged for 2006-2008. At that national level, data from the CDC Vital Statistics and Medicaid data from the Kaiser Family Foundation and Centers for Medicare & Medicaid Services National Health Expenditure Data were used for the year 2009.

The timing of prenatal care, measured as either early, or late or none, is the variable that is thought to influence various pregnancy outcomes of interest. A complete listing of variables for each aggregate population level is found below. Datasets are not mixed for the various population level analyses, with the exception of including Kaiser Family Foundation Medicaid births data and CMS NHE data with CDC Vital Statistics data for national level comparisons. Also, it is important to note that percent births financed by Medicaid at the county level with race are the county totals and are not adjusted for race. The following is a summary of the datasets and variables used at the different population levels of analyses.

- County level (n=58, New York City is considered as one county): New York State Community Health Data Set 2007-2009
- % early prenatal care, % late or no prenatal care, birth rate per 1,000 females aged 15-44, % preterm, % low birth weight, spontaneous fetal death rate per 1,000 live births, neonatal & infant mortality rate per 1,000 live births, maternal mortality & early childhood mortality rate per 100,000 live births, % Medicaid births, %private insurance births, and % poverty.
- County level analysis with adjusted values for race (n=16, New York City is considered as one county and sample only includes counties with populations over 100,000 with data for all race groups): New York Minority Health Surveillance Report 2006-2008
- Multiple neighboring counties are grouped as administrative regions in New York State
- % early prenatal care, % adequate prenatal care (Kotelchuk index), % preterm, % low birth weight, infant mortality rate per 1,000 live births, % Medicaid births, %private insurance births, and % poverty.
- Adequate prenatal care (Kotelchuk index) includes the initiation of prenatal care and the number of visits; prenatal care is considered adequate if at least 80% of the recommended visits are made.
- Regional level (n=8, New York City is its own region): New York State Community Health Data Set 2007-2009
- % early prenatal care, % late or no prenatal care, per 1,000 females aged 15-44%, preterm, % low birth

weight, spontaneous fetal death rate per 1,000 live births, neonatal & infant mortality rate per 1,000 live births, maternal mortality & early childhood mortality rate per 100,000 live births.

- State level (n=28, sample only includes States with published data for the year 2009): CDC Vital Statistics Births Data 2009, Kaiser Family Foundation State Health Data 2009, CMS NHE Fact Sheet 2009
- % early prenatal care, % late or no prenatal care, % preterm, % low birth weight, % Medicaid births, infant mortality rate per 1,000 live births, and per capita Medicaid spending

Methods

Descriptive statistics were run on each variable for each population level of analysis. This allows the distribution of values for a single variable to be compared across all counties, regions, and states. The results of this analysis will provide information on the variability of the timing of prenatal care utilization and the associated variables of interest. It will also give an indication if the data that will be used for further bivariate analysis has a normal distribution or not.

Bivariate analysis will then be used to calculate linear regression coefficients (Pearson's r) to test for significant associations between early initiation of prenatal care and the outcome variables of interest for each data set. These findings are then compared across the county, regional, and national levels to identify trends at increasingly larger aggregate levels of population. Medicaid data is

also used to run bivariate analysis with utilization of early prenatal care, pregnancy outcomes, and Medicaid spending by state.

Results

Low birth weight and preterm are considered to be more precise measures of prenatal care benefits than infant mortality since many factors postpartum and up to the first year of life can contribute to fatal outcomes [12]. Thus, this study will focus on the associations with low birth weight, preterm birth, and infant mortality as most relevant to prenatal care. Table summaries of the most relevant findings are found at the end of the results section.

Descriptive Stats

Descriptive stats on the county level (n=58, Table 1) variables show that the distributions do not follow a normal distribution. This is expected as the counties across the state are varied in terms of their economies, social structures, demographics, and health care. In the 58 county samples, the mean utilization of early prenatal care was 75.3%, while the mean value for late or no prenatal care was 4.2%. The mean low birth weight, preterm, and infant mortality for all 58 counties was found to be 7.3%, 11%, and 5.6 per 1,000 live births respectively. Descriptive statistics also show that on average for the 58 counties, 37.4% of all births are financed by Medicaid, and 55.9% are financed by private insurance.

Variable	Minimum	Maximum	Mean	Standard Deviation
Birthrate per 1,000 females aged 15-44	32.9	87.9	56.1862	8.60963
% Early PNC	55.5	88.4	75.1259	6.49541
% Late or NO PNC	1.4	9.1	4.2034	1.38056
% Preterm	7.9	13.4	10.9966	1.28048
Infant mortality per 1,000 live births	0	11	5.6172	1.91239
Sudden Fetal Death Rate per 1,000 live births	0.9	12.1	5.4759	2.39395
Neonatal Death Rate per 1,000 live births	0	8.2	3.8552	1.47911
Early Childhood Death Rate per 100,000 live births	0	102.4	27.7983	18.663
Maternal Mortality Rate per 100,000 live births	0	66.6	11.6362	17.50094
% Poverty	6.2	19.6	13.431	3.17132
% Low Birth Weight	4.3	10.8	7.3207	1.2116
% Medicaid births	14.5	59.2	37.4379	11.16278
% Private insurance births	21.49	79.07	55.8744	12.23618

Table 1: New York State County level descriptive (n=58).

Using the county level data set with race (n=16, Table 2), descriptive statistics show that nearly 81% of all white pregnant women received early prenatal care, compared to 61% and 64% of African American and Hispanic

mothers respectively. In a similar trend, 71% of white women, 52% of African American women, and 56% of Hispanic women received adequate prenatal care.

Variable	Minimum	Maximum	Mean	Std. Deviation
% Early PNC- Black	55.2	71.6	61.2938	4.60601
% Early PNC- Hispanic	53	74.7	64.3	5.2009
% Early PNC- White	70.1	91.2	80.7813	5.88061
% Total Early PNC	65.4	82.6	74.8875	4.74551
% Adequate PNC - Black	45.1	64	52.3125	5.54243
% Adequate- Hispanic	45.9	67.1	56.1375	5.1726
% Adequate- White	49.7	82.8	71.2125	8.71764
% Adequate- Total	57.2	77.3	67.325	6.59914
% Low birth weight- Black	10.4	14.6	12.925	1.24553
% Low birth weight- Hispanic	6.2	11	7.95	1.21161
% Low birth weight- White	5.8	7.6	6.8688	0.52118
% Low birth weight- Total	6.6	8.8	7.8688	0.63005
% Preterm- Black	13.3	18	16.0813	1.42324
% Preterm- Hispanic	10.5	14	12.4813	1.18784
% Preterm- White	9.3	12.2	10.4	0.86564
% Preterm- Total	10	13.2	11.4438	0.95706
Infant death rate per 1,000 live births- Black	9.5	32.6	16.85	6.23912
Infant death rate per 1,000 live births- Hispanic	1.7	16.9	7.9063	4.71416
Infant death rate per 1,000 live births- White	2.9	7.9	4.3	1.22474
Infant death rate per 1,000 live births- Total	3.8	9.5	6.1313	1.67759
% births by Medicaid	16.8	55.7	32.4813	10.50912
% Private insurance births	36.43	79.07	60.7216	11.79105

Table 2: New York State County level descriptive stats with values by race (n=16).

The Black infant death rate (16.9 per 1,000 live births) is slightly four times greater than the White infant death rate, and twice the Hispanic infant death rate. Although not as dramatic, the data also indicate that black infants have higher incidence of low birth weight and preterm births, while whites have the lowest. When moving to the smaller county sample of 16, the mean percent Medicaid birth value decreases by 5% to 32%, and percent private insurance births increases by 5% to 60%.

Surprisingly the total mean infant mortality rate in the smaller sample of counties increases slightly from 5.6% to 6.1%, influenced by proportional increases in the low

birth weight and preterm data. It is interesting to note that although Hispanic women utilize early prenatal care at similar rates to that of black women, their birth outcomes are more similar to white women who utilize early prenatal care mucmore.

At the regional level (n=8, Table 3), the distribution of the variables still cannot be considered normal. The mean utilization of early prenatal care was found to be 74.7%, while the utilization for low or none was 4.6%. Low birth weight, preterm birth, and infant mortality rates for the 8 regions was 7.8, 11.5, and 6.3 per 1,000 live births respectively.

Variable	Minimum	Maximum	Mean	Std. Deviation
Birthrate per 1,000 females aged 15-44	52.6	64.8	58.2625	4.67789
% Early PNC	71.2	77.4	74.7	2.40238
% Late or NO PNC	3.7	7	4.6	1.02539
% Preterm	10.6	13	11.5	0.84007
Infant mortality per 1,000 live births	4.3	9.2	6.2875	1.58964
Sudden Fetal Death Rate per 1,000 live births	4	8.8	5.5375	1.54914
Neonatal Death Rate per 1,000 live births	3.1	7.1	4.3875	1.32604
Early Childhood Death Rate per 100,000 live births	18.2	35.9	24	6.33584
Maternal Mortality Rate per 100,000 live births	12.2	40.9	19.925	9.81773
% Low Birth Weight	7.3	8.7	7.8125	0.40156

Table 3: New York State Regional level descriptive stats (n=8).

Using the national level data (n=28, Table 4) the results show that the incidence of low birth weight (11.7) is greater than the New York county and regional samples, while the incidence of preterm (7.8) is lower. The infant mortality rate at the national level is slightly greater, at 6.8 per 1,000 live births, compared to New

York county and regional sample values. Nationally, it was found that 36.5% of all births were financed by Medicaid, with the mean per capita spending being \$7,237.18. The distribution of all variable is found to be not normal, except for low body weigh which was found to be approximately normal.

Variable	Minimum	Maximum	Mean	Std. Deviation
% Early PNC	53.9	94.7	85.125	7.64764
% Late or NO PNC	3.2	17.7	9.1321	3.4735
% preterm	5.8	10	7.7571	1.11933
% Low Birth Weight	9.3	14.5	11.6571	1.30737
Infant death rate per 1,000 live births	4.5	9.4	6.7807	1.27533
% Medicaid births	19.7	51.7	36.5179	8.31603
Per capita Medicaid spending (dollars)	4569	10708	7237.18	1586.56055

Table 4: National state level descriptive stats (n=28).

Bivariate Correlations

Bivariate correlation analysis was run on pregnancy outcomes to determine if an association exists between them and timing of prenatal care. At the county level (n=58, Tables 5 & 6) no trends are significant, but surprisingly maternal mortality is slightly associated with

early prenatal care compared to late or none. Although insignificant, a weak association begins to be seen between infant mortality and timing of prenatal care that was expected: Early PNC is negatively associated and late or no PNC is positively associated. No associations are seen at the county level between timing of prenatal care and low birth weight or preterm births.

Timing of PNC & mortality value	Pearson correlation	P value
Early & Infant Death Rate	-0.097	0.469
Early & Neonatal Death Rate	0.068	0.614
Early & Sudden Fetal Death Rate	-0.093	0.490
Early & Early Childhood Death Rate	-0.069	0.609
Early & Maternal Mortality	0.174	0.192
Late or None & IDR	0.111	0.408
Late or None & Neonatal DR	-0.06	0.653
Late or None & SFDR	0.064	0.633
Late or None & Early Childhood DR	-0.067	0.616
Late or None & Maternal Mortality	-0.016	0.908

Table 5: New York State County level (n=58) bivariate correlations: associations between timing of prenatal care and mortality variables.

Timing of PNC & birth outcome	Pearson correlation	P value
Early & low birth weight	0.093	0.488
Early & preterm	-0.025	0.850
None or Late & low birth weight	0.001	0.993
None or Late & preterm	0.107	0.423

Table 6: New York State County level (n=58) bivariate correlations: associations between timing of prenatal care with low birth weight and preterm births.

At the county level (n=58, Table 7), weak negative associations are seen between early prenatal care and poverty rate, as well as late or no prenatal care and percent private insurance births. Similarly, positive weak

associations were found between late or no prenatal care and poverty rate. Birthrate is significantly positively associated with late or no prenatal care, and significantly negatively associated with early prenatal care.

Timing of PNC & SES factor	Pearson correlation	P value
Early & Medicaid births	-0.021	0.875
Early & poverty rate	-0.126	0.346
Late or None & Medicaid births	0.033	0.804
Late or None & poverty rate	0.251	0.057
Early & Priv Insurance	0.214	0.107
Late or None & Priv Insurance	-0.233	0.078
Timing of PNC & birthrate	Pearson Correlation	P value
Early PNC	-0.465	0.00**
Late or None	0.354	.006**

Table 7: New York State County Level (n=58) bivariate correlations: associations between timing of prenatal care with percent Medicaid births, percent private insurance births, percent poverty, and county birth rate.

Correlations with insurance type and birth outcomes at the county level (n=58, Table 8) yield scattered results for low birth weight, preterm birth, and infant mortality. As expected, significant positive associations were found

between percent births financed by Medicaid and poverty, as well as a significant negative association between percent births financed by private insurance and poverty.

	Pearson correlation	P value
Medicaid & low birth weight	-0.04	0.765
Medicaid & preterm	0.179	0.179
Medicaid & infant mortality	0.04	0.767
Medicaid & poverty rate	.484	0.0
Private & low birth weight	0.183	0.169
Private & preterm	-0.038	0.778
Private & infant mortality	-0.054	0.688
Private & poverty rate	-0.481	0.0
Private & Medicaid	-0.889	0.0

Table 8: New York State County Level (n=58) bivariate correlations: associations between insurance type, low birth weight, preterm, infant mortality, and poverty.

At the county level with race (n=19, Table 9a-9c) early prenatal care (EPNC) is found to have a weak negative association with low birth weight among black infants only, and moderately positive association with low birth weight among Hispanics and White infants. Early Prenatal Care is found to have weak positive associations with

preterm birth incidence for all races. Infant death rate is found to have a moderately negative association with early prenatal care among black infant and white infants, while having a weak positive association among Hispanic infants.

Early PNC & low birth weight by race	Pearson correlation	P value
Early PNC-Black	-0.250	.351
Early PNC-Hispanic	0.321	.225
Early PNC- White	0.461	.072
Early PNC- Total	0.242	.059

Table 9a: % Early Prenatal Care and % low birth weight by race.

Early PNC & preterm births by race	Pearson correlation	P value
Early PNC-Black	0.148	0.583
Early PNC-Hispanic	0.104	0.701
Early PNC- White	0.244	0.363
Early PNC- Total	-0.105	0.7

Table 9b: % Early Prenatal Care and % preterm by race.

Early PNC & Infant Death Rate by race	Pearson correlation	P value
Early PNC-Black	-0.4	0.884
Early PNC-Hispanic	0.130	0.632
Early PNC- White	-0.447	0.083
Early PNC- Total	0.221	0.412

Table 9c: % Early Prenatal Care and Infant Death Rate per 1,000 live births by race.

Table 9a-9c: New York State County level bivariate correlations with race (n=16): associations between timing of prenatal care and pregnancy outcomes by race and county totals.

Looking at women who received adequate primary care in the county sample with race (n=16, Table 10), it appears that adequate prenatal care has a weak negative association with low birth weight in black infants. On the contrary, adequate prenatal care is found to be positively associated with low birth weight among white infants. Adequate prenatal care is also found to have a weak

positive association with preterm births among black infants, and a moderately positive association with preterm births among white infants. No associations are seen between adequate prenatal care and infant mortality, except a weak, negative correlation among white infants.

% Adequate PNC & Low birth weight by race	Pearson correlation	P value
Adequate PNC-Black	-0.260	0.331
Adequate PNC- Hispanic	0.013	0.963
Adequate PNC- White	0.285	0.284
Adequate PNC- Total	0.001	0.996
% Adequate PNC & preterm births by race		
Adequate PNC-Black	0.218	0.417
Adequate PNC- Hispanic	-0.003	0.992
Adequate PNC- White	0.545	0.029
Adequate PNC- Total	-0.155	0.566
% Adequate PNC & Infant Mortality		
Adequate PNC-Black	-0.016	0.954
Adequate PNC- Hispanic	-0.053	0.844
Adequate PNC- White	-0.178	0.510
Adequate PNC- Total	0.068	0.804

Table 10: New York State County level bivariate correlations with race (n=16): associations between adequacy of prenatal care and pregnancy outcomes by race and county totals.

Comparing the results for adequate prenatal care and early prenatal care it appears that pregnancy outcome associations do not markedly differ within any racial category. However, the greatest benefits are seen in reducing low birth weight among Hispanic infants when compared to associations with early prenatal care.

County level data with race (n=16, Table 11) show that there are positive strong correlations between early prenatal care and adequate prenatal care for all races,

with the greatest correlation of 0.845 for Black mothers. Early prenatal care is found to have a moderately negative association with Medicaid births when looking within racial categories and a strong negative association exists for the total of all races. Adequate prenatal care is less negatively associated with Medicaid births for all races compared to early prenatal care. Early prenatal care and adequate prenatal care are both found to have weak positive associations with births financed by private insurance.

% Early PNC & % adequate PNC by race	Pearson correlation	P value
Early PNC-Black	0.845	0.00
Early PNC-Hispanic	0.795	0.00
Early PNC-White	0.513	0.043
Early PNC-Total	0.765	0.001
% Early PNC & Medicaid births		
Early PNC-Black	-0.410	0.114
Early PNC-Hispanic	-0.304	0.253
Early PNC-White	-0.417	0.108
Early PNC-Total	-0.725	.001
% adequate PNC & Medicaid births by race		
Adequate PNC-Black	-0.333	0.207
Adequate PNC-Hispanic	-0.126	0.641
Adequate PNC-White	-0.294	0.269
Adequate PNC-Total	-0.566	0.022
% Early PNC & Private Insurance births		
Early PNC-Black	0.233	0.384
Early PNC-Hispanic	0.199	0.460
Early PNC-White	0.370	0.158
Early PNC-Total	0.721	0.002
% adequate PNC & Private Insurance births		
Early PNC-Black	0.254	0.343
Early PNC-Hispanic	0.093	0.732
Early PNC-White	0.316	0.233
Early PNC-Total	0.592	0.016

Table 11: New York State County level bivariate correlations with race: associations between timing of prenatal care, adequacy of prenatal care, percent Medicaid births, and percent private insurance births.

Observing the associations at the New York State regional level (n=8, Table 12a), it appears that early prenatal care has a moderately strong association with infant death rate and neonatal death rate, and a weak

negative association with early child hood mortality. Early prenatal care is also observed to have a moderately negative association with sudden fetal death rate, and a weak negative association with maternal mortality.

Timing of PNC & mortality value	Pearson correlation	P value
Early & Infant Death Rate	0.459	0.253
Early & Neonatal Death Rate	0.578	0.133
Early & Sudden Fetal Death Rate	-0.507	0.199
Early & Early Childhood Death Rate	0.108	0.799
Early & Maternal Mortality	-0.107	0.801
Late or None & IDR	-0.456	0.256
Late or None & Neonatal DR	-0.521	0.185
Late or None & SFDR	0.811	0.015
Late or None & Early Childhood DR	-0.408	0.315
Late or None & Maternal Mortality	0.227	0.589

Table 12a: New York State Regional level (n=8) associations between timing of PNC and mortality.

Late or No prenatal care has a strong positive association, although not significant, with sudden fetal death rate, and a weaker positive association with maternal mortality. Late or No prenatal care is also found to have moderately negative associations with infant death rate, neonatal death rate, and early childhood death rate.

Regionally (n=8, Table 12b), early prenatal care has significant positive associations with low birth weight and preterm births, while late or no prenatal care has significant negative associations with low birth weight and preterm births.

Timing of PNC & birth outcome	Pearson correlation	P value
Early & low birth weight	-0.521	0.185
Early & preterm	-0.731	0.034***
None or Late & low birth weight	0.895	0.003**
None or Late & preterm	0.834	0.01***

Table 12b: associations between timing of PNC with low birth weight and preterm births.

At the national level (n=28, Table 13) of analysis, early prenatal care has significant negative associations with low birth weight, preterm births, and infant death rate. Similarly, late or no prenatal care was significantly positively associated with low birth weight, preterm birth,

and infant death rate. Also, a negative association was found between early prenatal care and Medicaid births, and a weak positive association found between late or no prenatal care and Medicaid births.

Timing of PNC & Infant Death Rate	Pearson correlation	P value
Early & Infant Death Rate	-0.496	0.007**
Late or None & Infant Death Rate	0.642	0.000**
Early & low birth weight	-0.592	0.001**
Early & preterm	-0.54	0.001**
None or Late & low birth weight	0.605	0.001**
None or Late & preterm	0.574	0.001**
Early & % Medicaid births	-0.307	0.112
Late or None & % Medicaid births	0.195	0.320

Table 13: National state level (n=28) associations between timing of PNC with low birth weight, preterm births, infant death rate, and % Medicaid births.

At the national level (n=28, Table 14), Medicaid is found to have moderately positive associations with low birth

weight, preterm births, and infant death rate.

% Medicaid births & pregnancy outcome	Pearson correlation	P value
% Medicaid births & low birth weight	0.425	0.024
% Medicaid births & % preterm births	0.404	0.033
% Medicaid births & Infant death rate	0.331	0.085

Table 14: National state level (n=28) associations between % Medicaid births and low birth weight, preterm births, and infant death rate.

At the national level (n=28, Table 15), increased per capita spending is found to have a weak positive association with early prenatal care. Increased per capita spending also has moderately negative associations with

late or no prenatal care, low birth weight, preterm births, infant death rate, and percent births financed by Medicaid births.

	Pearson correlation	P value
Per capita Medicaid spending & Early PNC	0.284	0.143
Per capita Medicaid spending & Late or No PNC	-0.270	0.164
Per capita Medicaid spending & low birth weight	-0.372	0.051
Per capita Medicaid spending & preterm births	-0.319	0.098
Per capita Medicaid spending & Infant Death rate	-0.324	.093
Per capita Medicaid spending & % Medicaid births	-0.517	0.005

Table 15: associations between per capita Medicaid spending, timing of prenatal care, low birth weight, preterm births, infant death rate, and % Medicaid births.

Table 16 summaries of the most relevant findings & associations:

- Early prenatal care was found to be associated with reduced low birth weight and preterm birth at the national (n=28) and regional levels (n=8); the association diminished at the county level (n=58).
- Early prenatal care was found to be associated with reduced infant mortality only at the national level (n=28), the opposite trend is found at the regional level (n=8), and no trends are observed at the county level (n=58).
- Findings from the county level with race (n=16 Table 17) shows that early prenatal care is associated with reduced low birth weight only for blacks, and reduced infant mortality for white and blacks.
- All other associations indicate an adverse relationship with early prenatal care
- Black infants are found to have the most adverse pregnancy outcomes, and lowest utilization of early prenatal and adequate care.
- Although Hispanics women have almost identical utilization of early prenatal as blacks, their pregnancy outcomes are more similar to white women.

- Adequate prenatal care was not found to be associated with more beneficial pregnancy outcome compared to the respective associations with early prenatal care.
- Adequate prenatal care was found to have the greatest benefits in reducing low birth weight among Hispanic infants.
- Adequate prenatal care was found to reverse the beneficial association seen between early prenatal care and black infant mortality.
- Associations with low birth weight, preterm birth, and infant mortality are found to be rather scattered and independent of birth insurance status at the county level (n=58).
- Early prenatal care was found to be positively associated with % Medicaid births
- % Medicaid births is found to be positively (adversely) associated with low birth weight, preterm birth, and infant mortality (Tables 18-21).
- Per capita Medicaid spending is found to have a positive association with early prenatal care.
- Per capita Medicaid spending is found to have a negative (beneficial) association with low birth weight, preterm birth, and infant mortality.
- Per capita Medicaid spending is found to have an inverse association with % Medicaid births.

Dataset	Low birth weight		Preterm birth		Infant mortality	
	r	p	r	p	r	p
National	-0.592	0.001	-.054	.001	-0.496	0.007
NYS Regional	-0.521	0.185	-0.731	0.034	0.459	0.253
NYS County	0.093	0.488	-0.025	0.850	-0.097	0.469
NYS County-Black	-0.250	0.351	0.148	0.583	-0.4	0.632
NYS County-Hispanic	0.321	0.225	0.104	0.701	0.130	0.083
NYS County-White	0.461	0.072	0.244	0.363	-0.447	0.412

Table 16: Associations with early prenatal care and low birth weight, preterm birth, and infant death rate; trends across the national, regional, and county levels with and without race (n=28, 8, 58, and 16).

Race	Low birth weight	Preterm birth	Infant mortality	% EPNC	% Adequate PNC
Black	10.4	13.3	9.5	61.3	52.3
Hispanic	6.2	10.5	1.7	64.3	56.1
White	5.8	9.3	2.9	80.8	71.2

Table 17: Descriptive comparisons of NYS County level data with race (n=16).

Correlation with % adequate care	r	p
NYS County Hispanic, low birth weight	0.013	0.963
NYS County White, low birth weight	0.285	0.284
NYS County Black, Preterm births	0.218	0.417
NYS County Hispanic, Preterm births	-0.003	0.992
NYS County White, Preterm births	0.545	0.029
NYS County Black, Infant mortality	-0.016	0.954
NYS County Hispanic, Infant mortality	-0.053	0.844
NYS County White, Infant mortality	-0.178	0.510

Table 18: Associations between adequate prenatal care and low birth weight, preterm birth, infant mortality by race (NYS County level data with race, n=16).

Correlations:	r	p
% Medicaid births & low birth weight	-0.04	0.765
% Medicaid births & preterm	0.179	0.179
% Medicaid births & infant mortality	0.04	0.767
% Private insurance births & low birth weight	0.183	0.169
% Private insurance births & preterm	-0.038	0.778
% Private insurance births & infant mortality	-0.054	0.688

Table 19: Associations between Medicaid and Private insurance with low birth weight, preterm birth, and infant mortality at the NYS county level (n=58).

Correlation with % Medicaid births	r	p
EPNC	-0.307	0.112
Low birth weight	0.425	0.024
Preterm birth	0.404	0.033
Infant mortality	0.331	0.085

Table 20: Associations between % Medicaid births, early prenatal care, low birth weight, preterm birth, and infant mortality at the national level (n=28).

Correlation with per capita Medicaid spending	r	p
EPNC	0.284	0.143
Low birth weight	-0.372	0.051
Preterm birth	-0.319	0.098
Infant mortality	-0.324	.093
% Medicaid births	-0.517	0.005

Table 21: Associations between per capita Medicaid spending and EPNC, low birth weight, preterm birth, infant mortality, and % Medicaid births at the national level (n=28).

Discussion

Prenatal care has been held as an essential component to reducing pregnancy complications, specifically low birth weight. The net effect of which is to ultimately reduce infant mortality rates in the United States. This study found increased utilization of early prenatal care was associated with low birth weight, preterm birth, and infant mortality at the national level. However, observing these same associations at the regional level show that early prenatal care is associated with infant mortality, although it is negatively associated with low birth weight and preterm births. These associations were nearly nonexistent at the county level of analysis.

It appears that the benefit of prenatal care is seen only at larger aggregate levels of population. This may be due to the inclusion of a threshold proportion of high risk women who have the most to gain from early prenatal care services. Our data indicate that these trends become weaker as the aggregate level of population becomes smaller. Since the national level of analysis included data from various states with various demographics, it represents meta-level associations with early prenatal care which includes a much richer sampling than the New York State Regional and County levels. Within New York State, a single county, or region, may be underrepresented in high risk women, or over represented in low risk women, which may artificially reduce the true benefits of prenatal care. For example, the New York State county data with race show that 61.3% of black women utilize early prenatal care, assuming that the remaining 38.7% of black women are also the majority of black women at risk for adverse pregnancy outcomes (greatest potential to benefit from EPNC), then it is unlikely that the benefits of prenatal care will be seen in this sampling.

Likewise, an overrepresentation of high risk women may also hide the true benefit of prenatal care because early or adequate prenatal care may not prevent or reduce adverse pregnancy outcomes in these women. Even the inclusion or exclusion of a small fraction of

complicated pregnancies can reduce the measurable benefits of prenatal care [9]. These phenomenon may have contributed to the almost nonexistent trends with early prenatal care at the county level (n=58), and the adverse associations seen with early and adequate prenatal care at the county level with race (n=16).

It was expected that adequate prenatal care [12] would have more beneficial associations with reduced low birth weight, preterm birth, and infant mortality. However, the results indicated that adequate prenatal care was not associated with reduced adverse birth outcomes any more than early prenatal care was. Again, this may be in part due to high risk mothers requiring enhanced prenatal services, which most often are defined as at least adequate. This is seen when comparing black infant mortality associations with early and adequate prenatal care. The association with early prenatal care was beneficial, while no association was found with adequate prenatal care possibly due to extremely high risk black women requiring adequate PNC more so than lower risk black women. Given the discrepancy between infant mortality between blacks and other races, the beneficial association between early prenatal care and black infant mortality supports the nature of prenatal care as a targeted program for women who are most at risk for adverse pregnancy outcomes [13].

Although early or adequate prenatal care was not seen to benefit birth outcomes for Hispanic infants, the descriptive data indicate better birth outcomes for Hispanics compared to blacks. This indicates that factors outside of the initiation of early prenatal care (excluding health care quality and access) play a role in pregnancy outcomes within minority groups that face similar structural, social, and financial hardships [14].

At the county level (n=58) early prenatal care was found to have an inverse association with percent Medicaid births indicating an issue with the knowledge or availability of prenatal services, or the choice of seeking timely prenatal care. As expected, poverty was found to

be positively associated with percent Medicaid births, which supports the findings that poverty is inversely associated with early prenatal care. At the county level (n=58), birth insurance, Medicaid or private, did not influence birth outcomes in any particular direction. However, at the national level (n=28) percent Medicaid births was found to have an inverse relationship with early prenatal care, and adverse associations with low birth weight, preterm births, and low birth weight. Although it may be possible that Medicaid financed births have a lower quality of prenatal services, this is not necessarily true. It is well known that a woman's decision to initiate timely prenatal care are made in a social, cultural, and historical context that. Many behavioral characteristics of Medicaid women may indirectly prevent, or delay their initiation of timely prenatal care [15].

At the national level (n=28), increased per capita Medicaid spending was found to be associated with increased early prenatal care utilization, and decreased low birth weight, preterm birth, and infant mortality. More significant, is the finding that as per capita Medicaid spending increases the percent of births financed by Medicaid decreases. It appears that as more women are covered for their pregnancy by Medicaid, that the dollar amount of benefits becomes diluted among all Medicaid beneficiaries. This may have major implications on the quality or availability of prenatal care due to reduced Medicaid reimbursement rates for health care providers.

Limitations

This study lacked data about the quality and content of prenatal care due to the use of large datasets. Even the inclusion of adequate prenatal care [12] only provided information about the number of visits attended, but failed to provide insights into the types of services provided, the manner in which they were provided, continuity of care, and various qualitative measures that influence a women's prenatal visit experience. The lack of any qualitative measures may have made it difficult to interpret or put in context the results found at the county level analysis with race since many cultural aspects could very well dictate how and when women utilize prenatal care services. This study was also limited to outcome measures that are influenced by adverse habits that begin before conception, and numerous psychosocial and structural confounding factors that are very difficult to control in a population study such as this.

Directions for Further Research and Policy Considerations

One of the major limitations in this study was the lack of quality and content measures. The creation of standardized measures of prenatal care content and quality and the inclusion of these measures in prenatal surveillance and statistics will allow for greater understanding and more accurate evaluation of prenatal care. Quality and content measures can also provide information on women's experiences and perceptions of prenatal care. Recognition of the salient, qualitative aspects, in women of different racial and socioeconomic groups can help include cultural competency in prenatal care delivery, possibly enhancing benefits for high risk women who are often intimidated or alienated by the health system.

More research is needed in the processes of prenatal care to determine what programs, services, and interventions are most beneficial, for specific demographics. The findings of this study show that prenatal care is associated with benefits in larger aggregate population levels. Augmenting prenatal care to a woman's specific needs may result in beneficial associations at smaller aggregate population levels since more women are receiving the prenatal care they need, instead of the generic set of services received by both low and high risk women from a wide range of cultural, social, and financial backgrounds. A more individualized approach to prenatal care may yield even greater benefits for women who are of high risk since these are also the women who are most contributing to low birth weight and infant mortality at all aggregate population levels. Of equal importance is the need to identify and remove structural barriers for low income, high risk women, by improving their financial stability, mobility (transportation), and access to established providers of care within the immediate community.

Insurance coverage, whether Medicaid or private, does not guarantee access to needed prenatal services, and access does not guarantee quality or utilization. Promotion, advocacy and political support for direct subsidies to offset the burden of cost sharing to local providers and health centers in low income neighborhoods may benefit a high proportion of Medicaid-eligible pregnant women and their newborns. By enhancing the access, quality, and cultural competency of prenatal care centers in these neighborhoods pregnant women will be more inclined to utilize prenatal care in a scheduled manner.

It was found that as more women have their births financed by Medicaid, that the per capita Medicaid spending decreases and rates of adverse birth outcomes increases. In addition, the findings that increased per capita Medicaid spending is associated with increased early prenatal care utilization and reduced adverse birth outcomes have serious implications on the notion that increasing access to prenatal services through Medicaid expansion will lead to better birth outcomes. This is especially relevant now as Medicaid coverage for women and children has been increasing during the current economic recession. The dilemma is a difficult one, since the majority of women who are at most risk of adverse birth outcomes are dependent on Medicaid, and as more women are covered by Medicaid, the per capita spending decreases, and the likelihood of adverse birth outcomes increases.

To make better use of finite resources, the number of visits and content of visits, should be adjusted accordingly for low and high risk women, especially those on Medicaid. Much evidence shows that a reduced frequency of prenatal visits, four at minimum, is effective, safe, and appropriate for low risk pregnant women [16]. Research to date has clearly shown that the content of prenatal care and not the quantity of visits is the key to healthy maternal and infant outcomes [17]. In actual practice, it is well known that many other industrialized countries which have much lower per capita health spending and reduced prenatal visits for low risk women have continued to have lower rates of adverse birth outcomes, including low birth weight and infant mortality compared to the United States [18]. Updated recommendations for reduced frequency prenatal visits that emphasize the quality and content of prenatal care for low risk women may result in cost savings that can be allocated for the higher risk pool of pregnant women.

Much has been learned about prenatal care since the Institute of Medicine's recommendations in 1985. Prenatal care may very well be an effective means to deliver necessary obstetric services, but much fine tuning and research is required to observe the beneficial effects of prenatal care for not only pregnant women and their infants, but all women of reproductive age. Data show that half of pregnancies in the United States are mistimed or unplanned and policy makers should recognize the value of preconception education, counseling, and care for women of reproductive age that are at risk for adverse birth outcomes. Prenatal care programs must also be transformed into specific risk appropriate interventions to reduce the differences in adverse birth outcomes that continue to widen among racial groups. Previous policy

and clinical aims have been to increase access and frequency of visits. Health care reform provides an opportunity to update prenatal care for the future by revisiting the content and frequency with which prenatal care services are provided, and the development of improved measures to assess whether pregnant women are receiving adequate, timely, beneficial, and culturally appropriate maternal care.

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