Effects of Care Coordination Services on Maternal and Child Health Outcomes
(MCHB R40MC21519)
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I. Introduction

A. Nature of the Research Problem

Eliminating health disparities in the US is widely regarded as a preeminent public health priority (US Department of Health and Human Services 2000; 2010). In the area of maternal and child health, inequality persists by socioeconomic status, race/ethnicity, and residential location in critical health outcomes including preterm birth (Hillemeier et al. 2007; Institute of Medicine 2006; Kramer and Hogue 2009), low birthweight (Collins and David 2009; Martin et al. 2010), fetal death (MacDorman and Kirmeyer 2009), and maternal well-being during pregnancy (Hedderson, Darbinian and Ferrara ; Institute of Medicine 2009), as well as in access to high quality health care (Agency for Healthcare Research and Quality 2010b; Institute of Medicine 2003) and other health-promoting services. ***Care coordination services have been identified as a key strategy to reduce disparities in maternal and child health and health care utilization*** (Agency for Healthcare Research and Quality 2010a; Berry et al. 2010; Johnson and Rosenthal 2009). Yet in an era of economic shortfalls and competing priorities, resources for care coordination services are increasingly in jeopardy (Burger 2009; Hines 2009; Metropolitan King County Council 2008). A strong evidence base is essential for understanding whether and to what extent care coordination can improve outcomes and reduce disparities, however ***existing evidence about the effects of care coordination services is contradictory and incomplete.***

B. Purpose, Scope, and Methods of the Investigation

The purpose of this project was to systematically examine how receipt of care coordination services affects perinatal and early childhood health and health service utilization, using advanced statistical methodology to reduce the influence of selection bias in evaluating program participation. The specific aims of the project were:

1. To examine relationships between receipt of care coordination services and health outcomes for women and children, and among women and children receiving care coordination services whether greater quantities of those services are associated with comparatively more favorable health outcomes

2. To analyze among women and children receiving care coordination services whether characteristics of their provider organizations including infrastructure, caseload size, and caseworker credentials differ by race/ethnicity and rural/urban residence

3. To examine whether characteristics of the provider organizations including infrastructure, caseload size, and caseworker credentials are associated with health outcomes for women and children receiving care coordination, and whether these associations differ by race/ethnicity and rural/urban residence

This project drew on a rich array of data sources and incorporated recent methodological advances in causal modeling to reduce the influence of selection bias in program participation. The research team used propensity score methods and instrumental variable estimation in addition to standard logistic and ordinary least squares regression and generalized estimating equations modeling to analyze relationships between care coordination service receipt and health and health care utilization in pregnant women and newborns in North Carolina, and to analyze variation in the effectiveness of care coordination among population subgroups.

C. Nature of the Findings

Results of our analyses indicate that coordination of care services significantly reduces the risk of experiencing poor birth outcomes, especially preterm delivery, as well as increases the chances that women avoid excessive weight gain during pregnancy. Moreover, compared with other pregnant women, those who received care coordination services in pregnancy were found to have more prenatal care visits and more visits for primary care, a higher likelihood of being enrolled in WIC, and a higher likelihood of receiving family planning services after delivery.

II. Review of the Literature

Care coordination services, which encompass activities that help to link mothers and children to an array of health-promoting resources, avoid duplication of effort, and improve communication between families and providers (Johnson and Rosenthal 2009), have been found to improve a number of important maternal and child health outcomes among low-income, race/ethnic minority, and geographically isolated populations. Reductions in the incidence of preterm birth and low birthweight, for example, have been observed among women receiving case management services in diverse settings (Buescher et al. 1991; Keeton, Saunders and Koltun 2004; Newman et al. 2008; Scheideberg 1997; Silva et al. 2006). Because the risk of preterm birth and low birthweight is related to maternal health status before and during pregnancy (Institute of Medicine 2006; Johnson et al. 2006; Moos 2004), it is highly relevant that care coordination services are linked to increased use of prenatal care (Piper, Mitchel and Ray 1996), reduced incidence of pregnancy-induced hypertension (Kitzman et al. 1997), greater use of prenatal vitamins (Piper, Mitchel and Ray 1996), and decreased prevalence of adverse health behaviors such as tobacco use and alcohol use (Margolis et al. 2001; May et al. 2008; Olds et al. 2002). Reduced incidence of preterm birth and low birthweight is also consistent with findings of Newman et al. (2008) that a prenatal care coordination initiative in South Carolina was associated with fewer neonatal intensive care (NICU) admissions and a reduction in the average length of NICU stay of more than 4 days. Other positive child health outcomes that have been associated with care coordination include higher rates of breastfeeding (Rosenbach et al. 2010), improved home environments for children (Margolis et al. 2001; Olds et al. 2002), greater compliance with the recommended number of well-child health care visits (Margolis et al. 2001) and immunizations (Wood et al. 1998), and a reduction in the need for emergency services related to injuries and toxic substance ingestions associated with child abuse and neglect (Margolis et al. 2001; Olds 2002). There is also evidence for a dose-response relationship between care coordination and health outcomes. Buescher et al. (1991) found that women who received care coordination services for a greater proportion of their pregnancies had better outcomes compared to those receiving fewer services.

Taken together, these studies suggest that care coordination services can play a significant role in improving multiple dimensions of maternal and child health, particularly among populations most at risk for adverse outcomes. It is important to note, however, that other research has failed to document similar beneficial effects of care coordination services for one or more of these health outcomes. For example, prenatal case management did not reduce the incidence of preterm birth or low birthweight in studies by Schulman et al. (1997), Kitzman et al. (1997), Piper et al. (1996), and Rosenbach et al. (2010). Studies focused on early childhood outcomes have also failed to find effects of care coordination on the likelihood of receiving recommended well child care (Rosenbach et al. 2010) and immunizations (Kitzman et al. 1997). The lack of consistent findings may be related to conceptual and methodological limitations that characterize existing research in this area. For example, previous research on care coordination has generally focused on overall effects, with little attention paid to whether the effectiveness of case coordination services varies among different sociodemographic groups. Moreover, little is known about the degree to which the effectiveness of care coordination is associated with specific aspects of service delivery itself such as characteristics and qualifications of the provider team and the quantity of services received. In addition, studies of service effectiveness are subject to selection bias in that those receiving services may differ from those who do not in ways that can affect health outcomes of interest. Lack of adequate data to control for population characteristics has been an important limitation in much of the previous research in this area.

III. Study Design and Methods

A. Study Design

The study design for this project was secondary data analysis of information about women living in North Carolina who gave birth to a live singleton infant during the period from October 1, 2008 through September 30, 2010. Multiple sources of data were integrated for analysis, beginning with the North Carolina "Babylove" file, which is a composite of electronic birth certificate data matched by the North Carolina State Center for Health Statistics to Medicaid newborn records, mothers' Medicaid delivery records, infant death certificate data, mothers' Medicaid Maternity Care Coordination (MCC) records, Child Service Coordination (CSC) records, health department maternal health records, and records of enrollment in the Special Supplemental Food Program for Women, Infants and Children (WIC). The research team also linked additional information to this file including local health department characteristics obtained from a survey of department administrators conducted in 2010, as well as county-level characteristics from the 2008 Area Resource File compiled by the Health Resources and Services Administration (http://arf.hrsa.gov/).

B. Population Studied

The population studied consisted of women living in the state of North Carolina who gave birth to a live singleton infant during the period from October 1, 2008 through September 30, 2010, whose deliveries were funded by Medicaid.

C. Sample Selection

A random sample of 8,000 live singleton deliveries funded by Medicaid was drawn from births occurring in North Carolina during the study period specified above. Of these infants, 7,987 could be matched to maternal Medicaid claims and eligibility files. Births covered by emergency Medicaid were excluded, thus requiring mothers in the sample to be covered by either full Medicaid or the Medicaid pregnancy waiver program for at least some of their pregnancy. This resulted in an analytic sample of 7,124 singleton infants and their mothers. In this sample, 2,255 mothers received at least one care coordination (MCC) service during their pregnancy; 4,869 women who were Medicaid or waiver enrollees and had Medicaid-funded deliveries, but did not receive MCC services during their pregnancy, were potential controls for propensity score analyses.

D. Statistical Techniques Employed

Drawing on the rich array of data sources discussed above, this research incorporated recent methodological advances in causal modeling, including propensity score methods and instrumental variable estimation in addition to standard logistic and ordinary least squares regression, generalized estimating equations modeling, and descriptive trend analyses.

IV. Detailed Findings

Descriptive analyses were initially conducted to compare women and infants who did and did not receive care coordination services. The first 2 columns of Table 1 on the next page, for instance, contain unadjusted means for selected sociodemographic characteristics (age, education, and race/ethnicity), health and reproductive history, participation in Medicaid and other government programs, and availability and characteristics of services from local health departments for Medicaid-covered women who received MCC services during their pregnancies and those who did not.

A number of differences between the two groups were noted. For example, women who received MCC services during pregnancy were more likely than those not receiving these services to be younger, to have less than a high school education, to be black, and to have a history of health problems including hypertension, mental health problems, and substance abuse. These women were also more likely to receive full Medicaid during pregnancy, indicating lower income, and to be enrolled in the state's Healthy Start initiative (Baby Love Plus). This suggests that women in this group were more likely to be identified as having high-risk status. They were less likely, however, to have had a prior live birth or infant death. Women receiving MCC services were also less likely to be living in an area where the local health department offered a high-risk maternity clinic or WIC services, and more likely to be in an area where the local health department had comparatively more staff for MCC service provision and generated higher revenue per capita.

Table 1. Study Variable Means for the Full Study Sample and the Propensity-Matched Analysis Subsample

Study Variable	Unadjusted Means for MCC recipients (full sample) (n=2255)	Unadjusted Means for potential controls (full sample) (n=4869)	Propensity weighted means for MCC recipients (n=2255)	Propensity weighted means for controls (n=4455)	Standardized difference in propensity weighted means
Younger than 18 at delivery	9.1%	5.1%	6.6%	6.6%	<0.001
Age 35 or older at delivery	4.4%	7.4%	6.5%	6.4%	0.005
Less than high school education	22.1%	17.4%	19.2%	19.0%	0.005
Education not available	35.7%	37.7%	36.7%	37.0%	0.005
Mother Hispanic ethnicity	8.8%	17.1%	15.0%	14.2%	0.024
Mother African American	45.7%	31.4%	35.8%	35.9%	0.002
Prior history of diabetes	1.6%	2.2%	2.2%	2.0%	0.009
Prior history of hypertension	1.0%	0.9%	0.9%	0.9%	<0.001
Prior history of schizophrenia	0.7%	0.4%	0.5%	0.5%	0.003
Prior history of depression	16.5%	13.0%	14.1%	14.1%	<0.001
Prior history of Bipolar disorder	5.8%	3.3%	4.1%	4.2%	0.004
Prior history of trauma	2.5%	1.5%	1.8%	1.8%	0.001
Prior history of anxiety	10.0%	8.7%	9.1%	9.1%	<0.001
Prior history of any mental health condition	22.1%	17.8%	19.5%	19.4%	0.002
Prior history of substance use treatment	9.8%	7.5%	8.5%	8.3%	0.008
Prior live births	42.7%	62.5%	56.4%	56.1%	0.005
Prior infant death	1.8%	1.9%	2.0%	1.9%	0.006
Participation in Baby Love Plus (Healthy Start)	19.5%	14.3%	15.8%	16.0%	0.006
Receipt of full Medicaid during pregnancy	40.2%	32.8%	35.8%	35.5%	0.005
Receipt of services from an LHD with a high risk maternity clinic	19.4%	22.3%	20.8%	20.8%	<0.001
LHD in region does not offer WIC	7.1%	6.8%	6.5%	6.8%	0.012
MCC staffing per 100,000 population in LHD service area	3.86	3.28	3.54	3.54	0.001
LHD revenue per capita	6.71	6.10	6.45	6.38	0.019
LHD revenue information missing	3.1%	3.5%	3.2%	3.4%	0.010

Because these initial analyses detected evidence that characteristics of women and children such as poverty and race/ethnicity are associated with selection into receipt of care coordination services, in addition to standard ordinary least squares (OLS) regression we employed econometric methods including propensity score matching and instrumental variable estimation to control for selection effects in examining outcomes potentially related to services receipt. For example, as shown in the third and fourth columns of Table 1, after propensity matching the means of all variables in the weighted MCC and control samples were very similar, with the standardized differences (reported in the fifth column) less than 0.02 for all risk factors.

Table 2 provides estimates of the effect of MCC on pregnancy outcomes of interest and measures of utilization of health care and other services. Effects for the full sample are presented for each outcome, shown in the first column without adjustment for risk factors and in the second column adjusted by Ordinary Least Squares (OLS) linear regression. The estimates in the last column are the preferred estimates obtained by inverse propensity weighted linear regression using the balanced, propensity weighted sample.

Table 2. Estimated Effects (Standard Errors) of MCC on Pregnancy Outcomes and Service Utilization

Pregnancy Outcome	Unadjusted Simple Regression Estimates	Adjusted Multiple Regression Estimates	Inverse Propensity Weighted Effects
Preterm birth	-0.0129* (0.0067)	-0.0197*** (0.0070)	-0.0175** (0.0073)
Low birthweight	0.0049 (0.0068)	-0.0059 (0.0071)	-0.0033 (0.0072)
Birthweight in grams	-37.80*** (13.44)	8.66 (13.80)	1.31 (14.60)
Prenatal tobacco use	0.029** (0.012)	0.024** (0.012)	0.021 (0.013)
Pregnancy weight gain	-5.51 (3.72)	-8.28* (4.82)	-7.37* (4.23)
Number of prenatal care visits	3.36*** (0.26)	3.07*** (0.26)	3.07*** (0.25)
Prenatal care initiation in first trimester	0.046*** (0.011)	0.048*** (0.011)	0.047*** (0.011)
Number of primary care visits in pregnancy	2.72*** (0.20)	2.80*** (0.20)	2.77*** (0.21)
Receipt of WIC in pregnancy	0.172*** (0.01)	0.146*** (0.011)	0.150*** (0.011)
Family planning services 3 mo after delivery	0.115*** (0.012)	0.131*** (0.013)	0.129*** (0.012)
Family planning services 4-6 mo after delivery	0.0706*** (0.009)	0.0603*** (0.0093)	0.0582*** (0.0091)
Baby expenditures in 1st 2 mo >$5,000	-0.0079 (0.0069)	-0.0141)* (0.0072)	-0.021* (0.0073)
Prenatal + 3 mo ppartum expenditures	1664*** (157)	1598*** (166)	1548*** (167)

Regarding preterm birth, the estimate for the full sample using standard controls (column 2) indicates that women who received MCC services were significantly less likely to have a preterm birth. In the propensity-weighted analyses, the effect among women at comparable risk remained statistically significant, with those who received MCC services having a 1.7 percentage point reduction in the probability of delivering a premature infant. This is more than a 20% reduction in the rate of preterm births compared with the control group rate of 8.3% thus is a relatively large effect. Results for low birthweight and birthweight analyzed as a continuous variable were in the direction of improved birth weight, but did not show significant effects for MCC participation in adjusted models.

Counter-intuitive effects were seen for prenatal tobacco use in the conventional models, with MCC recipients found to have a significantly higher probability of using tobacco. These adverse effects, however, were not seen in the propensity-weighted sample even at p=0.10. Regarding pregnancy weight gain, the estimates indicate that MCC is associated with a 7 pound decrease in weight again. Since the majority of women gain a greater than recommended number of pounds in pregnancy, this represents a beneficial effect on pregnancy weight gain that is marginally significant at the p=.10 level in both the multivariate and propensity weighted model.

Beneficial effects on services use were also found to be related to MCC receipt. Women who received care coordination services were more likely to obtain prenatal care in their first trimester, and to have a greater number of prenatal care visits, controlling for other covariates including health history. These women were also more likely to receive WIC services during their pregnancy, and to receive family planning services after delivery. These effects were statistically significant in both the OLS and the propensity-weighted analyses. The propensity-weighted analyses also revealed that infants of mothers receiving MCC were significantly less likely to engender Medicaid expenditures of greater than $5,000 in the first two months of life than other infants in the study sample ($p<0.05$). One the other hand, the analyses revealed that the average dollar amount of Medicaid expenditures during the prenatal and first 3 months postpartum were higher for women who received MCC services ($1,548 in propensity-weighted analyses) than those not receiving MCC, which might be expected since care coordination facilitated use of both prenatal care and primary care.

The research team also assessed trends in maternal service use and outcomes among North Carolina women whose deliveries were covered through Medicaid over the study period, which was characterized by economic recession. As shown in Table 3 below (and confirmed in additional multivariate analyses), Medicaid covered a relatively consistent proportion of total North Carolina births throughout the study period, and over time actually covered women for a greater proportion of their pregnancies. However, women covered through Medicaid also became less likely to receive medical care at local health departments and had fewer OB visits. Conversely, the number of behavioral health encounters for pregnant women with these needs trended slightly upward during the study period. Maternal and infant health outcomes were stable or slightly better over time. Despite some decreases in services, these findings suggest that North Carolina's maternal and child safety net met critical maternal needs during the study period.

Table 3. Descriptive Statistics on Trends in Maternal Service Use and Outcomes among Medicaid-Enrolled Women over the Study Period

Characteristic	10/2008-9/2009 Year 1 N	Year 1 % /mean	10/2009-9/2010 Year 2 N	Year 2 % /mean	Difference /years	Chi-Sqr
Among all NC births:						
Delivery covered by any kind of Medicaid	128,385	50.5%	122,542	51.1%	0.5%	
Delivery covered by full Medicaid	64,882	27.0%	62,594	27.4%	0.4%	
Delivery covered by Medicaid waiver	64,882	54.0%	62,594	54.9%	0.8%	
Delivery covered by emergency Medicaid	64,882	19.0%	62,594	17.7%	-1.3%	
% of pregnancy covered by full Medicaid	1,212	67.4%	1,291	75.0%	7.6%	***
% of pregnancy covered by waiver Medicaid	2,524	57.3%	2,654	62.0%	4.8%	***
% of pregnancy covered by any Medicaid	3,544	64.5%	3,596	74.1%	9.5%	***
Among women enrolled in Medicaid:						
Maternal age in years	4,033	24.7	3,954	24.8	0.2	
First time mother	4,033	40.6%	3,954	43.8%	3.1%	**
African American	4,033	32.8%	3,954	33.0%	0.2%	
Hispanic	4,031	22.2%	3,951	21.2%	-1.0%	
Behavioral Health Need						
Mom-Depression indicator	4,033	9.0%	3,954	9.7%	0.7%	
Mom-Bipolar indicator	4,033	2.9%	3,954	2.7%	-0.1%	
Mom-Schizophrenia indicator	4,033	0.3%	3,954	0.3%	0.1%	
Mom - Anxiety indicator	4,033	5.6%	3,954	5.8%	0.2%	
Mom-Trauma/stress indicator	4,033	1.1%	3,954	1.0%	-0.1%	
Mom any mental health indicator	4,033	13.4%	3,954	13.6%	0.2%	
Mom- Substance use-related disorder	4,033	5.4%	3,954	6.4%	1.0%	

* $p < .05$ ** $p < .01$ *** $p < .001$

Results presented above are presented in 2 manuscripts which are under review in peer-reviewed scholarly journals (see section VI below, Products From This Research). Additional project analyses are ongoing, and these empirical results will also be presented in manuscripts that will be submitted to peer-reviewed journals (see list in section VI). For example, further analyses suggest that there is likely heterogeneity in the benefits of MCC by population subgroup. We are decomposing this heterogeneity to determine whether greater benefits occur in women by race/ethnicity, age, and urban/rural residence.

V. Discussion and Interpretation of Findings

A. Conclusions to be Drawn From Findings

Findings from the project analyses suggest that coordination of care in pregnancy can significantly reduce the risk of experiencing premature deliveries among Medicaid-enrolled women. The analyses also suggest that maternity care coordination can have beneficial effects on pregnancy weight gain. Currently nearly 60 percent of overweight and 40 percent of normal weight women experience excessive weight during pregnancy, which predisposes them to postpartum weight retention and a higher risk of delivering a macrosomic infant. The finding that maternity care coordination is associated with reduced pregnancy weight gain suggests that more widespread availability of such services could reduce the incidence of these adverse health consequences among mothers and their newborns.

Although MCC was not shown to be associated with significant effects on birthweight or low birthweight risk in the present study, findings related to prenatal tobacco use are instructive. Conventional regression analyses showed that women who received MCC services were more likely to smoke in pregnancy, despite care coordinators' efforts to increase women's access to prenatal care and supportive services such as smoking cessation. The fact that propensity-weighted analyses did not produce this result suggests that selection bias is likely to influence results from the standard types of regression analyses that comprise much previous research in this area.

Study findings also suggest that care coordination facilitates early prenatal care enrollment and a greater number of prenatal care visits, as well as receipt of WIC services during pregnancy and family planning services after delivery. While this increased health services use was reflected in somewhat higher expenditures for women during pregnancy and the postpartum period, this was offset by reduced incidence of preterm birth among infants, which resulted in a lower risk of costly medical expenditures such as those resulting from NICU stays in the first 2 months of life.

B. Explanation of Study Limitations

While the project used analytic methods such as propensity-weighted models, it is important to bear in mind, however, that these methods are not equivalent to randomized controlled trials. Although it was possible to incorporate a rich array of variables from the linked data sources in the propensity estimations, selection bias from unmeasured covariates may still be a concern. However, falsification tests did not find any differences prior to conception on two broad measures of health prior to pregnancy, primary care visits and Medicaid expenditures.

C. Comparison of Findings With Other Studies

Results from this project suggest that coordination of care in pregnancy can significantly reduce the risk of experiencing premature deliveries in this population. While positive effects on birth outcomes have been associated with care coordination in some previous studies (Buescher et al., 1991; Keeton et al., 2004; Newman et al., 2008; Scheideberg, 1997; Van Dijk et al., 2011), to our knowledge this is the first study to analyze state-wide birth certificate and claims data using propensity score methods to reduce the influence of selection bias.

D. Possible Application of Findings to Actual MCH Health Care Delivery Situations (Including Recommendations)

In view of the apparent advantage conferred by care coordination related to preterm birth, it may be desirable to expand access to MCC services among high-risk populations, depending on the cost-effectiveness of the intervention. In our North Carolina sample, for example, only about one-third of Medicaid-enrolled women received care coordination services during the study period. Since the average Medicaid cost in North Carolina for a preterm infant in the first year of life is five times greater than the cost to care for a full-term baby ($19,299 vs. $3,588), prevention of additional preterm births among high-risk women through expansion of care coordination services would result in significant savings.

E. Suggestions for Future Research

In 2011, North Carolina replaced the MCC program with Pregnancy Care Management, a pregnancy medical home model. The Affordable Care Act now also mandates new services including selected screening tests and preventive services to preconceptional and pregnant women not in Medicaid without cost-sharing requirements (http://www.healthcare.gov/news/factsheets/2010/07/preventive-serviceslist.html#CoveredPreventiveServicesforWomenIncludingPregnantWomen) that may be beneficial in reducing the incidence of preterm birth. Future research should investigate whether these services and alternative service system structures have similar, or superior, advantageous effects on maternal and infant health and health care utilization.

VI. Products From This Research

A. Manuscripts submitted for publication in peer-reviewed journals

1. Hillemeier, MM, Domino ME, Wells R, Goyal RK, Kum HC, Cilenti D, Whitmire JT, Basu A. Effects of Maternity Care Coordination on Pregnancy Outcomes: Propensity-Weighted Analyses. Under review in the *American Journal of Public Health*.

2. Cilenti D, Kum HC, Wells R, Whitmire JT, Goyal RK, Hillemeier MM, Domino ME. Trends in North Carolina Maternal Health Services and Outcomes During the Great Recession. Under review in the *Maternal and Child Health Journal*.

B. Manuscripts in progress for submission to peer-reviewed journals

1. Hillemeier MM, Domino ME, Wells R, Cilenti D, Kum HC, Whitmire T, Goyal R. Maternity Care Coordination: Effects on Medicaid-Enrolled Women's Utilization of Prenatal Care and Other Health Services. To be submitted to *Health Services Research*.

2. Wells RS, Kum HC, Hillemeier MM, Domino ME, Cilenti D, Goyal R. Disparities in Local Health Department Capacity: Effects on Medicaid-Enrolled Women's Health Services Use and Outcomes. To be submitted to *Medical Care Research and Review.*

3. Domino M, Wells RS, Hillemeier MM, Cilenti D, Kum H-C, Goyal R, Basu A. Does Heterogeneity Exist in the Effectiveness of Care Coordination Services for Pregnant Women in Improving Health Services Use and Health Outcomes? To be submitted to *Health Economics*.

4. Goyal R, Wells RS, Domino M, Hillemeier MM, Cilenti D, Kum HC, Whitmire JT, Basu A. Does Care Coordination Affect Health Services Use in the First Year of Life? To be submitted to *Medical Care.*

5. Hillemeier MM, Domino ME, Wells, R, Goyal R, Kum HC, Cilenti D, Whitmire JT, Basu A. Maternity Care Coordination: Effects of Number of Visits and Timing During Pregnancy on Health and Health Care Utilization. To be submitted to *Paediatric and Perinatal Epidemiology*.

C. Presentations

We have communicated our findings through two national meetings. First, preliminary findings were presented by Dr. Domino at the American Society of Health Economists (ASHEcon) national meetings in June 2012. Second. Drs. Domino and Cilenti disseminating our research findings at the Association of Maternal and Child Health Programs (AMCHP) in May 2013.

We also disseminated our findings through two webinars, offered to public health researchers and practitioners in both North Carolina and nationwide. These webinars offered us a chance to review our findings as well as to receive feedback on our research questions and methods from audiences very knowledgeable in the intervention under examination and in public health settings.

References Cited

Agency for Healthcare Research and Quality. 2010a. "Findings on children's health care quality and disparities." Rockville MD: Available at: http://www.ahrq.gov/qual/nhqrdr09/nhqrdrchild09.htm.

—. 2010b. "National healthcare disparities report." Rockville MD: US Department of Health and Human Services AHRQ Pub. No. 10-0004.

Berry, E., C. Brady, S.D. Cunningham, L.L. Derrick, M. Drummonds, B. Pettiford, A. Roberts, and S.E. Wilson. 2010. "National Healthy Start Initiative: A national network for effective home visitation and family support services." Washington DC: National Healthy Start Association.

Buescher, P. A., M. S. Roth, D. Williams, and C. M. Goforth. 1991. "An evaluation of the impact of maternity care coordination on Medicaid birth outcomes in North Carolina." *Am J Public Health* 81:1625-9.

Burger, J. 2009. "Child health programs in jeopardy." Available at: http://www.bakersfield.com/news/local/x1216783118/Child-health-programs-in-jeopardy.

Collins, J. W., Jr., and R. J. David. 2009. "Racial disparity in low birth weight and infant mortality." *Clin Perinatol* 36:63-73.

Hedderson, M. M., J. A. Darbinian, and A. Ferrara. "Disparities in the risk of gestational diabetes by race-ethnicity and country of birth." *Paediatr Perinat Epidemiol* 24:441-8.

Hillemeier, M. M., C. S. Weisman, G. A. Chase, and A. M. Dyer. 2007. "Individual and community predictors of preterm birth and low birthweight along the rural-urban continuum in central Pennsylvania." *J Rural Health* 23:42-8.

Hines, L. 2009. "State funding cuts imperil prenatal care program." Available at: http://www.pe.com/localnews/inland/stories/PE_News_Local_S_planning23.36c334e.html.

Institute of Medicine. 2003. "Unequal treatment: confronting racial and ethnic disparities in healthcare." Washington DC: National Academies Press.

—. 2006. "Preterm birth: causes, consequences, and prevention." Washington DC: National Academies Press.

—. 2009. "Weight gain during pregnancy: reexamining the guidelines." Washington DC: National Academies Press.

Johnson, K., S. F. Posner, J. Biermann, J. F. Cordero, H. K. Atrash, C. S. Parker, S. Boulet, and M. G. Curtis. 2006. "Recommendations to improve preconception health and health care--United States. A report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care." *MMWR Recomm Rep* 55:1-23.

Johnson, K., and J. Rosenthal. 2009. "Improving care coordination, case management, and linkages to service for young children: opportunities for states." Washington, DC: Commonwealth Fund.

Keeton, K., S. E. Saunders, and D. Koltun. 2004. "The effect of the Family Case Management Program on 1996 birth outcomes in Illinois." *J Womens Health (Larchmt)* 13:207-15.

Kitzman, H., D. L. Olds, C. R. Henderson, Jr., C. Hanks, R. Cole, R. Tatelbaum, K. M. McConnochie, K. Sidora, D. W. Luckey, D. Shaver, K. Engelhardt, D. James, and K. Barnard. 1997. "Effect of prenatal and infancy home visitation by nurses on pregnancy outcomes, childhood injuries, and repeated childbearing. A randomized controlled trial." *JAMA* 278:644-52.

Kramer, M. R., and C. R. Hogue. 2009. "What causes racial disparities in very preterm birth? A biosocial perspective." *Epidemiol Rev* 31:84-98.
MacDorman, MF & S Kirmeyer. 2009. "The challenge of fetal mortality." *NCHS Data Brief*:1-8.
Margolis, P. A., R. Stevens, W. C. Bordley, J. Stuart, C. Harlan, L. Keyes-Elstein, and S. Wisseh. 2001. "From concept to application: the impact of a community-wide intervention to improve the delivery of preventive services to children." *Pediatrics* 108:E42.
Martin, J. A., B. E. Hamilton, P. D. Sutton, S. J. Ventura, T. J. Mathews, S. Kirmeyer, and M. J. K. Osterman. 2010. "Births: final data for 2007." *Natl Vital Stat Rep* 58:1-125.
May, P. A., J. H. Miller, K. A. Goodhart, O. R. Maestas, D. Buckley, P. M. Trujillo, and J. P. Gossage. 2008. "Enhanced case management to prevent fetal alcohol spectrum disorders in Northern Plains communities." *Matern Child Health J* 12:747-59.
Metropolitan King County Council. 2008. "Public health services in jeopardy from King County budget shortfall." Available at: http://www.kingcounty.gov/council/news/2008/July/JP_health.aspx.
Moos, M. K. 2004. "Preconceptional health promotion: progress in changing a prevention paradigm." *J Perinat Neonatal Nurs* 18:2-13.
Newman, R. B., S. A. Sullivan, M. K. Menard, C. S. Rittenberg, A. K. Rowland, J. E. Korte, and H. Kirby. 2008. "South Carolina Partners for Preterm Birth Prevention: a regional perinatal initiative for the reduction of premature birth in a Medicaid population." *Am J Obstet Gynecol* 199:393 e1-8.
Olds, D. L., J. Robinson, R. O'Brien, D. W. Luckey, L. M. Pettitt, C. R. Henderson, Jr., R. K. Ng, K. L. Sheff, J. Korfmacher, S. Hiatt, and A. Talmi. 2002. "Home visiting by paraprofessionals and by nurses: a randomized, controlled trial." *Pediatrics* 110:486-96.
Piper, J. M., E. F. Mitchel, Jr., and W. A. Ray. 1996. "Evaluation of a program for prenatal care case management." *Fam Plann Perspect* 28:65-8.
Rosenbach, M., S. O'Neil, B. Cook, L. Trebino, and D. K. Walker. 2010. "Characteristics, access, utilization, satisfaction, and outcomes of Healthy Start participants in eight sites." *Matern Child Health J* 14:666-679.
Scheideberg, D. 1997. "Improved perinatal outcomes with perinatal case management." *J Nurs Care Qual* 12:36-45.
Schulman, E. D., D. J. Sheriff, and E. T. Momany. 1997. "Primary care case management and birth outcomes in the Iowa Medicaid program." *Am J Public Health* 87:80-4.
Silva, R., M. Thomas, R. Caetano, and C. Aragaki. 2006. "Preventing low birth weight in Illinois: outcomes of the family case management program." *Matern Child Health J* 10:481-8.
US Department of Health and Human Services. 2000. "Healthy People 2010 2nd ed. Washington DC: US Government Printing Office.
—. 2010. "Healthy People 2020 Draft Objectives." Washington DC: US Govt Printing Office.
Van Dijk JW, Anderko L, Stetzer F. The impact of Prenatal Care Coordination on birth outcomes. *J Obstet Gynecol Neonatal Nurs*. 2011;40(1):98–108. doi:10.1111/j.1552-6909.2010.01206.x.
Wood, D., N. Halfon, C. Donald-Sherbourne, R. M. Mazel, M. Schuster, J. S. Hamlin, M. Pereyra, P. Camp, M. Grabowsky, and N. Duan. 1998. "Increasing immunization rates among inner-city, African American children. A randomized trial of case management." *JAMA* 279:29-34.