Multiple Risk Factors during Pregnancy: Race, Ethnicity and Socio-Economic Differences using the National Children's Study (NCS)

Linda Andrews, Kathleen McCann

Public Health Sciences, Social & Scientific Systems, Silver Spring, Maryland, USA

Data from The National Children's Study (NCS) Vanguard Study, a birth cohort study that enrolled and followed over 5,400 birth families, is readily available through the NCS Archive (https://ncsarchive.s-3.net) for approved research projects by qualified investigators. The NCS Archive data contains study visit data from preconception to 42 months post birth, as well as a sample repository of 161,511 biological and environmental samples. This presentation is an example of the use of the NCS Archive data for prenatal and pediatrics research, in this case with respect to multiple pre-pregnancy and behavioral risk factors and the association with pregnancy complications and the health and developmental outcomes of the offspring. Limited research exists on multiple risk factors but the results may suggest the importance of intervening with an integrated approach in clinical practices (1).

Data Source and Study Sample

Potential mothers were recruited to NCS pre-conception, during pregnancy or at childbirth and followed for up to four years. This analysis uses health data falling into three categories: 1) pre-pregnancy and behavioral factors putting a pregnancy at risk; 2) development of medical conditions complicating pregnancy; and 3) adverse birth and developmental outcomes of the child. The health information was collected during the pre-pregnancy visit, pregnancy visits, and birth visit, as well as from child health and developmental assessments.

This analysis includes six National Institute of Child Health and Human Development (NICHD) existing factors[1] that put a pregnancy at risk: pre-pregnancy high blood pressure, pre-pregnancy diabetes, pre-pregnancy thyroid disease, pre-pregnancy obesity, smoking during pregnancy, and advanced maternal age (35 or older)[2]. Pre-pregnancy asthma is included as an additional risk factor based on research associating its negative effects on pregnancy and infant outcomes (2).

Several health conditions can develop during the pregnancy and many are monitored within the NCS pregnancy visits and included in the analysis. These are gestational diabetes, high blood pressure, protein in the urine, preeclampsia, early labor, anemia, nausea, bladder or kidney infection, Rh disease or isoimmunization, Group B strep infection, herpes, and bacterial vaginosis.

Three child health outcome measures are considered: low birth weight (less than 2500 grams or 5 lbs. and 8 oz.), preterm birth (gestational age less than 37 weeks), and autism (as measured by the Modified Checklist of Autism in Toddlers or M-CHAT(3)).

We identified 3,994 mother child dyads that met the criteria of a singleton births and responded to the full array of conditions prior to pregnancy, as well as smoking status during pregnancy.

For the demographic analysis, maternal race-ethnicity, maternal age, maternal education level during pregnancy, and annual household income as reported during pregnancy were included.

Statistical Analysis

All analyses were performed using SAS SURVEY procedures to account for non-response and clustered sampling design in SAS Version 9.4 (SAS Institute Inc., Cary, NC) at 5% level of significance. Differences among categorical variables were analyzed using Rao-Scott Chi-Squared and Rao-Scott Modified Chi-Squared tests. The association among having two or more pre-pregnancy risk factors and pregnancy complications and child health outcomes was explored using logistic regression analyses and adjusted for a priori covariates. Sampling weights were not used in analysis due to unavailability of weights with the NCS Vanguard Study sample.

[1] *https://www.nichd.nih.gov/health/topics/high-risk/conditioninfo/factors. NICHD also includes polycystic ovary syndrome, infertility, autoimmune diseases, and HIV/AIDS, which the NCS Vanguard Study did not collect consistently across all study phases.*

[2] *Teen pregnancy also poses a risk to pregnancy but the NCS age eligibility criteria was 18 years or older.*

Risk Factors for Pregnancy Complications and Child Outcomes

Table 1 shows the prevalence of factors putting a pregnancy at risk. The most prevalent is obesity, followed by maternal age greater than 35 and asthma. When considering these factors in combination, Table 2 shows that the most prevalent combination is obesity/asthma, with 26.1% of mothers with two or more factors having both conditions (or 4.7% of all mothers), followed by the combination of obesity/maternal age older than 35 with 21.2% of mothers with two or more factors having both conditions (or 3.8% of all mothers). These combinations are not surprising given the prevalence of all three as shown in Table 1.

Table 3 displays the distribution of women with zero, one, or two or more risk factors across demographic and socio-economic characteristics. 1885 mothers (47.2%) did not report any of these risk factors, 1397 (35.0%) reported one factor, and 712 (17.8%) reported two or more risk factors. Significant differences among the risk factors groups do exist for most demographic characteristics. Non-Hispanic blacks are more likely to have two or more risk factors (25.7%) than non-Hispanic whites (17.3%) and Hispanics (17.0). When age is excluded as a risk factor and included as a characteristic, it is the younger mothers who are more likely to have two or more non-age related risk factors (15% for 18–24 year olds vs. over 11% for mothers 25 or older). Single mothers are more likely to have two or more risk factors (23.4% vs. 15.5% married mothers), as are less educated women (around 21% for high school or less vs. 14.8–18.8% for those with more than a high school education). With respect to income, women in the lowest income bracket are the most likely to have two or more risk factors (20.8% vs. 18.9% or lower for the other brackets). Living in a metropolitan area does not appear to have any significant effect on the number of risk factors.

Table 1. Prevalence of the Risk Factors for Pregnancy Complications and Child Outcomes (N=3994)

Factor	Definiton	Percent of Mothers	Std Error
Obesity	Pre-Conception Body Mass Index 30.0 or higher based on self-reported weight and height	22.3	1.5773
Maternal Age	35 or older	16.9	1.6840
Asthma	Pre-Conception, self reported	16.3	0.9627
Smoking	Cigarette usage during pregnancy, self reported	8.5	1.7682
Thyroid Diseases	Hypothyroidism, Pre-Conception, self-reported	6.1	0.4596
High Blood Pressure	Pre-Conception, self-reported	3.6	0.4139
Diabetes	Pre-Conception, self -reported	1.5	0.2291

Table 2. Mothers with two or more risk factors, pairwise sample sizes and percents (N=712)

	Diabetes		Obesity		Thyroid Diseases		Maternal Age		Asthma		Smoking	
	N	%	N	%	N	%	N	%	N	%	N	%
High Blood	8	1.1	74	10.4	5	0.7	39	5.5	32	4.5	20	2.8
Diabetes	-		34	4.8	7	1.0	13	1.8	15	2.1	10	1.4
Obesity	-		-		65	9.1	151	21.2	186	26.1	103	14.5
Thyroid Diseases	-		-		-		63	8.9	47	6.6	13	1.8
Maternal Age	-		-		-		-		97	13.6	42	5.9
Asthma	-		-		-		-		-		79	11.1

Note: For the purposes of this table, some participants are presented more than once. For example, a woman with diabetes, high blood pressure and obesity would be counted in diabetes/high blood pressure and diabetes/obesity, and high blood pressure/obesity.

Table 3. Demographic and Socio-Economic Characteristics of NCS Mothers by Number of Risk Factors

Variable	Numbers				Row Percents				P-value
	Total	No risk factors	1 risk factor	2 or more risk factors	Total	No risk factors	1 risk factor	2 or more risk factors	
Total	3994	1885	1397	712	100.00	47.2	35.0	17.8	
Race-Ethnicity									0.0226
Non-Hispanic White	2628	1243	931	454	100.00	47.3	35.4	17.3	
Hispanic	546	252	201	93	100.00	46.2	36.8	17.0	
Non-Hispanic Black	421	180	133	108	100.00	42.8	31.6	25.7	
Non-Hispanic Other Race/Multiple Race	383	199	130	54	100.00	52.0	33.9	14.1	
Mother's Age*									0.0052
18–24	909	475	298	136	100.00	52.3	32.8	15.0	
25–34	2411	1410	731	270	100.00	58.5	30.3	11.2	
35 or older	674	368	227	79	100.00	54.6	33.7	11.7	
Married									<.0001
Yes	2814	1398	979	437	100.00	49.7	34.8	15.5	
No	1168	478	417	273	100.00	40.9	35.7	23.4	
Lives within Metropolitan Statistical Area (MSA)									0.2048
Yes	3202	1529	1133	540	100.00	47.8	35.4	16.9	
No	782	350	261	171	100.00	44.8	33.4	21.9	
Education									<.0001
Less than HS or GED	422	193	142	87	100.00	45.7	33.6	20.6	
High School Graduate or GED	762	312	292	158	100.00	40.9	38.3	20.7	
Some College	1274	582	452	240	100.00	45.7	35.5	18.8	
College Graduate	1530	794	510	226	100.00	51.9	33.3	14.8	
Annual Household Income									0.0002
Less than $30,000	1299	567	462	270	100.00	43.6	35.6	20.8	
$30,000–$49,999	695	350	225	120	100.00	50.4	32.4	17.3	
$50,000–$99,999	1176	602	407	167	100.00	51.2	34.6	14.2	
$100,000 or more	636	277	239	120	100.00	43.6	37.6	18.9	

**For mother's age, age is not counted towards the 1 or 2+ risk factors since it is the characteristic being compared.*

Association of Two or Risk Factors with Pregnancy Complications and Child Outcomes

Table 4A provides both crude and adjusted logistic results. The "crude" models only account for the relationship of the outcome and the indicator of having two or more risk factors; whereas the "adjusted" models control for the covariates of socio-economic and demographic characteristics. Model 1 examines the association between developing pregnancy complications and having two or more pregnancy related risk factors. Models 2, 3, and 4 consider pre-term births, low birth weight, and the risk of autism, respectively.

Pregnancy Conditions. The association between developing one of the reported pregnancy complications[3] and having more than one risk factor was significant in the adjusted model (p-value<0.0001). The adjusted odds ratio was greater than one (1.603) indicating that the probability of developing a complication during pregnancy is more likely when having two or more risk factors, even while controlling for the socio-economic and demographic characteristics.

Child outcomes: When replacing the dependent variable with the child outcomes of preterm, low birth weight, or having a risk of autism, having two or more risk factors is not significant in any of the adjusted models.

[3] *The conditions include gestational diabetes, high blood pressure, protein in urine, preeclampsia, early labor, anemia, nausea, bladder or kidney infection, Rh disease or isoimmunization, Group B strep infection, herpes, and vaginosis. https://www.nichd.nih.gov/health/topics/pregnancy/conditioninfo/complications*

Table 4A. Association of Two or More Risk Factors with Pregnancy Complications and Child Outcomes

Two or more risk factors	Models		Crude Odds Ratio	P-Value	Odds Ratio adjusted for socio-economic and demographic characteristics	P-Value
Model 1	Develops pregnancy complications N(%)	Does not develop pregnancy complications N(%)				
Yes	369 (22.5)	343 (14.6)	1.696 (1.400 – 2.053)	<.0001	1.603 (1.301 – 1.976)	<.0001
No	1274 (77.5)	2008 (85.4)				
Model 2	Baby is Preterm N(%)	Baby is not Preterm N(%)				
Yes	67 (23.7)	631 (17.3)	1.481 (1.080 – 2.032)	0.0162	1.347 (0.981 – 1.849)	0.065
No	216 (76.3)	3013(82.7)				
Model 3	Baby has low birth weight N(%)	Baby does not have low birth weight N(%)				
Yes	32 (19.8)	594 (17.8)	1.135 (0.727 – 1.774)	0.5679	1.012 (0.626 – 1.637)	0.9588
No	130 (80.2)	2740 (82.2)				
Model 4	Child is at risk of Autism N(%)	Child is not at Risk of Autsim N(%)				
Yes	26 (24.8)	288 (17.5)	1.550 (1.071 – 2.242)	0.0214	1.243(0.825 – 1.871)	0.2893
No	79 (75.2)	1356 (82.5)				

Demographic and Socio-economic Characteristics in the Models

The four models control for the following socio-economic and demographic characteristics: race-ethnicity, marital status, lives within an MSA, education, and annual household income. Age is not included since age is one of the risk factor and would result in high collinearity between these two indicators. In Model 1 being married is associated with a lower probability (odds ratio=0.679) of developing pregnancy complications than being single while having a low-income (odds ratio=1.298) and being Hispanic (odds ratio=1.301) are associated with a higher probability. In Model 2, non-Hispanic blacks are associated with a higher probability of having preterm babies (odds ratio=2.328). Model 3 shows that being Black has a higher probability (odds ratio=2.725) of a low birth weight baby. Finally, Model 4 shows that being married is associated with a lower probability (odds ratio=0.513) of a child at risk of autism while having high school or less education (odds ratio 1.805) and being Hispanic (odds ratio=2.079) are associated with a higher probability of having a child with a risk of autism.

Table 4B. Significant Demographic Covariates

Model 1: Develops Pregnancy Conditions	OR (95% CI)	P-Value
Married	0.679 (0.567 – 0.814)	<0.0001
Low income (less than $50,000)	1.298 (1.088 – 1.549)	0.0049
Hispanic	1.301 (1.043 – 1.622)	0.0208
Model 2: Baby is Preterm	OR (95% CI)	P-Value
Black, non-Hispanic	2.328 (1.695 – 3.196)	<0.0001
Model 3: Baby has low birth weight	OR (95% CI)	P-Value
Black, non-Hispanic	2.725 (1.705 – 4.355)	0.0001
Model 4: Child is at risk of Autism	OR (95% CI)	P-Value
Married	0.513 (0.325 – 0.810)	0.0054
High School or Less	1.805 (1.025 – 3.179)	0.0413
Hispanic	2.079 (1.163 – 3.717)	0.0149

Pre-pregnancy and behavioral risk factors are all well-known risk factors for developing pregnancy complications and can affect the child's health outcomes. This analysis posed the question of how having two or more risk factors affect these outcomes. Once controlling for the covariates of demographic and socio-economic characteristics, we found that having two or more risk factors was associated with a higher probability of a negative outcome for pregnancy complications but not for the health and developmental outcomes for the child. The models do show that the demographic characteristics Black, Hispanic, less education, low income, and single are associated with poorer outcomes even when controlling for having multiple risk factors.

We would like to thank Susan Forrester, Lydia Rogers, and Lauren Prelewicz at Social & Scientific Systems, Dr. John Moye, Jr. at the *Eunice Kennedy Shriver* National Institute of Child Health & Human Development, and Dr. Christina Park at the Office of the Director at NIH for their assistance with poster preparation, and all the mothers for their participation in The National Children's Study.

1 Tomlinson M, O'Connor MJ, LeRoux IM, et al. Multiple Risk Factors during Pregnancy in South Africa: The Need for a Horizontal Approach to Perinatal Care. Prevention science: the official Journal of the Society for Prevention Research. 2014: 15(3):277-282. [PubMed: 23475562].

2 Murphy V, Namazy J, Powell H, Schatz M, Chambers C, Attia J, Gibson P. A Meta-Analysis of Adverse Perinatal Outcomes in Women with Asthma. British Journal of Obstetrics and Gynaecology 2011; 118:1314-1323. [PubMed: 21749633].

3 Kleinman JM et al. The Modified Checklist for Autism in Toddlers: A Follow-up Study Investigating the Early Detection of Autism Spectrum Disorders. J Autism Dev Disord. 2008 May; 38(5):827-39 [PubMed: 17882539].

For more information, please contact:

NICHD Website https://www.nichd.nih.gov/research/NCS/

NCS Archive Website https://ncsarchive.s-3.net/

Archive Email NCSArchive@s-3.net

THE NATIONAL CHILDREN'S STUDY

HEALTH GROWTH ENVIRONMENT

NIH *Eunice Kennedy Shriver* National Institute of Child Health and Human Development