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## Pregnancy characteristics and outcomes among women at risk for disability from health conditions identified in medical claims

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### Abstract

**Background**—Women with disabilities are at risk for poor birth outcomes. Little is known about specific potentially disabling health conditions and their effects on pregnancies. Using hospital claims, we identified women at risk for disability and evaluated the relationship between disability risk and demographic characteristics, pregnancy risks, and infant and maternal outcomes.

**Methods**—2006–2009 Massachusetts Pregnancy to Early Life Longitudinal data system linked birth certificate and hospital claims one year pre-pregnancy through delivery. Access Risk Classification System categorized ICD-9-CM/CPT codes into disability risk groups (no/limited vs. medium/high). Generalized estimating equations evaluated the association between disability risk and infant and maternal outcomes.

**Results**—Of 221,867 women, 14,701 (6.6%) were at medium/high risk of disability. Health conditions were classified as: circulatory (23%), musculoskeletal (10%), nervous system/sensory (13%), other physical (19%), two or more physical (5%), mental illness (24%), and comorbid mental/physical (6%). Women at risk of disability were more likely than others to have socioeconomic and pregnancy risks, and adverse infant and maternal outcomes. Socioeconomic and risk profile varied by health condition category. Adjusted risk ratios for preterm birth ranged from 1.2 (95% CI 1.0–1.4) for women with nervous system/sensory diagnoses to 1.6 (95% CI 1.4.1.8) for women with two or more physical diagnoses; risk ratios for maternal delivery hospitalization > 5 days ranged from 1.5 (95% CI 1.2–1.9) for women with musculoskeletal diagnoses to 3.0 (95% CI 2.5–3.6) for women with comorbid mental/physical diagnoses.

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**Conclusion**—Disability risk identified through claims is associated with poor infant and maternal outcomes. Risk profiles vary by underlying health condition.

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## Introduction

The percentage of women with physical, psychiatric, or intellectual disabilities who become pregnant has been increasing in recent years (Goldacre, Gray, & Goldacre, 2015; Iezzoni, Yu, Wint, Smeltzer, & Ecker, 2013; Mowbray, Oyserman, Bybee, MacFarlane, & Rueda-Riedle, 2001). A growing body of literature suggests, however, that women with disabilities may be at risk for poor infant and maternal birth outcomes. One line of evidence comes from studies of pregnant women with single potentially disabling health conditions, such as multiple sclerosis, epilepsy, (Kelly, Nelson, & Chakravarty, 2009) systematic lupus, rheumatoid arthritis, (Chakravarty, Nelson, & Krishnan, 2006) schizophrenia, (Vigod et al., 2014) or depression (Grigoriadis et al., 2013; Thornton, Tedman, Rigby, Bashforth, & Young, 2006). These studies all report elevated levels of poor outcomes among women with these conditions. On the other end of the spectrum, a recent large, population-based study of women with self-reported disability defined as being “limited by any physical, emotional, or mental disorder” was also associated with poor infant outcomes (Mitra et al., 2015). The specific types of disability, however, were not identified in the study.

Disability, a physical or mental impairment that substantially limits one or more major life activity (US Department of Justice, 2009), may be caused by a wide variety of physical, psychiatric, or intellectual conditions, each of which may have differential effects on pregnancy physiology, women’s experiences with pregnancy, and affect pregnancy outcome in different ways. Examining demographic characteristics, pregnancy risks, and maternal and infant outcomes by disability cause may provide a more comprehensive understanding of pregnancy among women with disabilities. Though research in this area is sparse, one population-based study of pregnancy and disability did classify women by type of disability. Redshaw, Malouf, Gao, and Gray (2013) used data from the 2010 English National Health Service Trust to evaluate the association between self-reported disability and experience of care during pregnancy and the perinatal period. While the authors found differences in pregnancy experience by type of disability, they had limited sociodemographic information and did not measure health behaviors and risk factors during pregnancy.

To fill this gap, we used population-based medical claims data to identify women at risk for disability due to health condition diagnoses, and to examine demographic characteristics, health risks, and maternal and infant outcomes among women with various causes of disability risk. The specific objectives of our study were to: 1) use linked birth certificate and medical claims data from the Massachusetts Pregnancy to Early Life Longitudinal data system to identify women at risk for disability using a claims-based algorithm and assess the association between disability risk and demographic characteristics, pregnancy risks, and infant and maternal outcomes; and 2) categorize health conditions underlying the risk for disability and evaluate the association between disability risk categories and outcomes.

## Materials and Methods

### Data Source and Study Population

The Massachusetts Pregnancy to Early Life Longitudinal (PELL) database is a longitudinal, population-based data system that links Massachusetts birth certificates and fetal death records to corresponding delivery and non-delivery hospital discharge records for the mother and infant. Details about the PELL data set can be found elsewhere (Barfield et al., 2008; Clements, Barfield, Kotelchuck, Lee, & Wilber, 2006). We used PELL data from January 1, 2006 to December 31, 2009 to examine the demographic characteristics pregnancy risks, and outcomes of the 2007–2009 Massachusetts birth cohort. The study population was comprised of all in-state deliveries to Massachusetts resident mothers during 2007–2009. Birth certificate data from 2007–2009 were linked to corresponding maternal or infant hospital discharge records from 2006–2009. More than 99% of births linked to their hospital discharge delivery records. This protocol was approved by the IRB of the Massachusetts Department of Public Health, University of Massachusetts Medical School, and Brandeis University.

### Measures

Disability risk status was classified using a modified version of the Access Risk Classification System (ARCS) algorithm (Palsbo, Sutton, Mastal, Johnson, & Cohen, 2008). ARCS uses International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and Current Procedural Terminology (CPT) codes from medical claims along with pharmacy claims to identify individuals who are likely to have one or more limitations in functioning and may need assistance or accommodations to access routine health services. Although disability cannot be assessed directly from claims, ARCS classifies disability risk based on presumed risk of functional limitation: Level A) no risk, medical needs are emergent or acute; Level B) low risk, one or a few chronic conditions that might cause some functional limitations; Level C) medium risk, one or more chronic conditions that can cause major functional limitations; and Level D) high risk, multiple chronic conditions and complex medical needs that likely severely impair a person's functional abilities. We implemented two modifications to the original algorithm. As pharmacy claims were not available in our data set, we did not include them in calculating the ARCS score. Additionally, all diagnoses of non-malignant neoplasms (ICD-9-CM codes 210 – 239) were excluded from the algorithm based on the presumption that these diagnoses alone would be unlikely to cause functional limitations in this population. Women were classified for each delivery, based on diagnoses on any claim one year prior to and including delivery. We dichotomized the ARCS levels into two disability risk categories: (1) no /low risk for disability (Levels A and B) and (2) medium/high risk for disability (Levels C and D). In the validation study of ARCS categories among adult HMO members ages 18 years of age and older, classification of Levels A/B vs. Levels C/D demonstrated 88% sensitivity and 30% specificity compared with self-reported disability (Palsbo et al., 2008).

Individuals identified as having being at medium/high risk for disability were further categorized by health condition causing the disability risk, using the 18 condition categories of the Clinical Classification Software (CCS) (Agency for Healthcare Research & Quality,

Rockville, MD). The four categories with the highest frequencies in the population were identified (diseases of the circulatory system, diseases of the musculoskeletal system and connective tissues, diseases of the nervous system and sense organs, and mental illness). Other categories were grouped together in an “other physical diagnosis” category. Individuals were then categorized into those with: diseases of the circulatory system only; diseases of the musculoskeletal system and connective tissue only; diseases of the nervous system and sense organs only; other physical diagnosis only; 2 or more physical diagnoses; mental illness only; and mental illness and physical diagnosis.

Maternal demographic characteristics at the time of delivery were derived from the birth certificate and included maternal age (<19, 20–34, 35+ years); education (some high school, high school graduate, some college, 4 years of college); race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic black, other); father named on the birth certificate (yes, no); and health insurance status (public, private). Pregnancy risks were also derived from the birth certificate and included smoking during pregnancy (yes, no) and no prenatal care in first trimester. Level of prenatal care was also measured by the Adequacy of Prenatal Care Utilization (APNCU) Index (adequate plus – received 110% of expected visits, adequate – 80–109%, intermediate - 50–79%, inadequate - <50%) (Kotelchuck, 1994). Diabetes during pregnancy (including both gestational (noted on 4.5% of birth certificates) and chronic (1.0%)) and hypertension during pregnancy, including (including both pregnancy-related (3.7%) and chronic (1.4%)) were also obtained from birth certificate data. The prevalence of other specific risk factors recorded on the birth certificate, including cardiac disease, hydramnios/oligohydramnios, hemoglobinopathy, hepatitis carrier, incompetent cervix, lupus erythematosus, previous infant with birth defects, previous infant 4000+ grams, previous preterm or small for gestational age (SGA) infant, renal disease, RH sensitization, rubella infection during pregnancy, seizure disorders, sickle cell anemia, uterine bleeding, and weight gain/loss inappropriate for mother, were too low to examine individually, so were combined in an “other risk” category.

Infant outcomes included preterm delivery (<37 weeks gestation), SGA (< 10<sup>th</sup> percentile of sex-specific birthweight for gestational age) and Apgar score < 7 at 5 minutes after delivery, derived from the infants’ birth certificate. For multiple births, (2.3% of deliveries) the worst outcome of births at the same delivery was selected. Maternal outcomes included Caesarean section and extended maternal delivery hospital stay (greater than five days, including time before and/or after delivery).

## Analysis

We present the number and percentages of women with each demographic and clinical characteristic overall and by ARCS category. Bivariate analyses compared between-group differences with chi-square statistics. Due to the number of health condition categories evaluated, large number of potential between-group comparisons, and the lack of pre-specified hypotheses of differences among health conditions groups, we did not perform post-hoc between-group tests to identify statistically significant differences in risks and outcomes among health condition groups. Discussion of between-group differences are therefore based on nominal, not statistically significant differences, and should be

considered exploratory in nature. Generalized estimating equations with Poisson links were fit to evaluate crude and adjusted association between disability risk categories and selected infant and maternal outcomes. Risk ratios and 95% confidence intervals are presented. All analyses were conducted with SAS® Software (Version 9.1, SAS institute, Cary, NC)

## Results

Overall there were 221,867 births in Massachusetts from 2007 – 2009. Of births, 79.2% were to mothers in ARCS Level A, 14.2% Level B, 3.6% Level C, and 3.0% Level D. The 14,701 (6.6%) women in levels C and D were classified at risk for disability, and the 207,166 (93.4%) of women in levels A and B were categorized not at risk. Of the 14,701 at risk for disability, 23% had a disease of the circulatory system, 10% a disease of the musculoskeletal system, 13% a disease of the nervous system/sensory system, 19% another physical diagnosis, 5% two or more physical diagnoses, 24% a diagnosis in the mental illness category (including psychiatric, developmental, and intellectual disability diagnoses), and 6% mental and physical diagnoses. The most frequent ICD-9-CM code categories in each category are presented in Table 1.

Overall, individuals at risk for disability differed from those not at risk with respect to all characteristics. Women at risk for disability were more likely to be less than 19 years of age and have lower levels of education compared with women not at risk. Women at risk for disability were more likely to be white, non-Hispanic or black, non-Hispanic, and to have public insurance at delivery, and less likely to have a father named on birth certificate compared with women not at risk. These women were more likely to smoke, have either no prenatal care in the first trimester, inadequate prenatal care or adequate plus prenatal care, have diabetes, hypertension, or other pregnancy risk factors, were nearly twice as likely to have a preterm birth or Apgar score < 7 at 5 minutes compared with women not at risk, and had nearly 50% higher risk of having an SGA infant. Women at risk for disability had a slightly elevated risk of having a Cesarean section delivery, and were over three times more likely to have an extended maternal delivery hospitalization (Table 2).

Table 3 presents demographic and clinical characteristics by health condition category. Women with diseases of the circulatory system were older than both women in other health condition categories and women not at risk of disability. The percentage who smoked during pregnancy, while lower than among women in other health condition categories, was still higher than the percentage among those not at risk of disability. Women in this group had high levels of prenatal care, the highest percentages of hypertension and diabetes during pregnancy, and high percentages with each of the adverse infant and maternal outcomes.

Women with diseases of the musculoskeletal system and women with other physical diagnoses had, in general, a similar profile as women with diseases of the cardiovascular system, with some exceptions. Of note, women with diseases of the musculoskeletal system had a higher percentage with public insurance, and women in both groups had higher percentages who smoked during pregnancy relative to women with diseases of the cardiovascular system. Women with diseases of the nervous system or sense organs had higher percentages with socio-economic risk factors and inadequate prenatal care than women with other physical diagnoses, but lower risk of adverse outcomes relative to women

in most other health condition categories. Women with two or more physical diagnoses also had elevated levels of some socioeconomic and pregnancy risk factors, had percentages with hypertension and diabetes second only to women with diseases of the circulatory system, and had the highest risk of having a preterm delivery or an extended maternal delivery hospitalization.

Women with mental illness and comorbid mental and physical diagnoses had the most adverse socioeconomic risk profile. These women also had by far the highest percentages with public insurance, with no father named on the birth certificate, who smoked during pregnancy, with no prenatal care in the first trimester and with inadequate prenatal care. Both groups had the highest percentages with pregnancy risks other than hypertension and diabetes. Women with comorbid mental and physical diagnoses in particular had a high risk for most adverse infant and maternal outcomes.

Table 4 presents the multivariable models describing association between disability category and infant outcomes. In crude analysis, risk ratios for the association between health condition category and preterm birth ranged from 1.4 for diseases of the musculoskeletal system to 2.9 for two or more physical diagnoses. Adjusting for demographic factors had little effect on the risk ratios in any group. Further adjusting for pregnancy risks attenuated the associations in all groups, resulting in risk ratios ranging from 1.2 for women with diseases of the nervous system/sense organs and women with diseases of the musculoskeletal system to 1.6 for women with other physical diagnoses, two or more physical diagnoses, comorbid mental and physical diagnoses. Patterns were similar although somewhat attenuated for the association between risk categories SGA, with adjusted risk ratios for the association between health condition categories and SGA ranging from 1.1 – 1.2. Adjusted risk ratios for the association between health condition categories and Apgar < 7 at 5 minutes ranged from 0.8 for women with diseases of the musculoskeletal system to 3.1 for women with comorbid mental and physical diagnoses.

Crude risk ratios for the association between health conditions and extended maternal delivery hospitalization ranged from 2.0 for women with diseases of the musculoskeletal system and women with diseases of the nervous system/sense organs to 6.0 for women two or more physical diagnoses. Adjusting for demographic characteristics had little effect on associations, while adjusting for pregnancy risks reduced the risk ratios to 1.5 for diseases of the musculoskeletal system and mental illness to 3.0 for two or more physical diagnoses and comorbid mental and physical diagnoses. The association between disability risk category and Cesarean section delivery was less strong, with adjusted risk ratios ranging from 1.1–1.3 (Table 5).

## Discussion

To our knowledge this is the first study to use a medical claims-based algorithm to identify disability risk among perinatal women. As with previous studies focusing on women with self-reported disability, women with claims-defined disability risk had elevated levels of indicators of lower socioeconomic status, pregnancy risks, and adverse infant and maternal outcomes relative to their counterparts not at risk for disability.



Disability can be caused by one or more of a diverse range of physical, intellectual, and psychiatric disorders. Evaluating women with disabilities as one group may therefore mask distinct risk profiles and pathways through which individuals with various disabilities may be at risk for adverse birth outcomes. We therefore classified women into eight categories based on type of health condition and presence of comorbidity, and identified clear risk profiles by causal condition. Women with mental illness and co-morbid mental and physical diagnoses had the highest proportions with socioeconomic risk factors, including young maternal age, low levels of education, public insurance, and having no father named on the birth certificate. Adjusting for these variables, however, had little effect on outcomes, indicating these factors did not account for the elevated risk of poor infant or maternal outcomes among women in these groups. Women in these groups were also most likely to smoke during pregnancy and have inadequate prenatal care. While adjusting for pregnancy risks attenuated the risk of preterm birth and extended maternal delivery hospitalization to some extent, in fully adjusted analyses these groups still had among the highest risk of adverse infant and maternal outcomes compared with women with no disability, suggesting that differences in factors not measured in this study had an effect on outcomes among women with mental illness. Other researchers have identified factors such as in quality of care, stigma, stressful life events, and social support that are related to poor infant and maternal outcomes among women with mental illness (Thornton et al., 2006; Vigod et al., 2014).

In contrast, women with disability from diseases of the circulatory system, diseases of the musculoskeletal system, or other physical diagnoses had a socio-demographic risk profile most similar to women not at risk for disabilities. Nevertheless, these women still had elevated levels of smoking during pregnancy, which could in part reflect some women having smoking-attributable diagnoses resulting in their ARCS categorization. Prenatal care was for the most part in the “adequate” or “adequate plus” categories in these groups, suggesting lack of access to prenatal care did not contribute to adverse outcomes. Indeed, it is possible that these women received care in high risk obstetrics programs and followed more closely because of their diagnoses. Women with circulatory diagnoses, and, to a lesser extent, women with two or more physical diagnoses, had a very elevated risk of hypertension during pregnancy, which in part may reflect hypertension attributable to the diagnoses resulting in their ARCS categorization. Adjusting for pregnancy risks attenuated the associations between disability and infant and maternal outcomes, suggesting that the excess risk was due in part to these pregnancy risks. Among women with diseases of the musculoskeletal system, the prevalence of pregnancy risks was only slightly elevated relative to women not at risk of disability, and adjusting for risks did not greatly attenuate the association. In these groups, however, there remained a 30–60% excess risk of preterm birth and 50% to 230% excess risk of extended maternal delivery hospitalization in fully adjusted models.

Mitra, Long-Bellil, Smeltzer, and Iezzoni (2015) proposed a framework to understand health in the perinatal period for women with physical disabilities, which identified individual level factors, (for example body structures and functions, level of activities and participation), and mediating factors (for example, access to information on pregnancy, provider knowledge and attitudes towards pregnancy among women with disabilities, family support, psychosocial

social factors such as stressful life events) that may influence birth outcomes. These factors, not identifiable in our database, are undoubtedly contributing to excess risk for poor outcomes in among women at risk of disability due to physical diagnoses; some may be also applicable to women with mental illness and comorbid physical and mental health diagnoses. Further research may identify the pathways through which women with specific disabilities are at risk for adverse birth outcomes.

While many of the study variables were not comparable between the two studies, our results were consistent to Redshaw et al. (2013) with respect to demographic profiles of various disability groups. Although Redshaw et al. identified disability through self-report, the authors, similar to this study, found that women with mental health disability were younger and less likely to have a partner than women with no disability, whereas women with physical conditions were more likely to be over 35 years of age and were similar to women with no disability with respect to the percentage with no partner. Patterns of prenatal care differed between the two studies; however, as Redshaw reported women with a mental health disability had more intense prenatal care than women with no disability. This discrepancy may reflect different health care systems in the U.S. and U.K. Nevertheless, similar to our study, the authors found women in all disability groups had higher risks of preterm birth compared with women with no disabilities.

Our results are subject to limitations. It is challenging to identify individuals with disability from medical claims (Iezzoni, 2002). A claims-based algorithm does not directly measure functional limitation, which is the defining feature of disability. The algorithm was created and validated in a population of men and women ages 18 years and older. While in this population the algorithm demonstrated adequate sensitivity compared with self-reported disability, the specificity was low, indicating that many of the individuals identified as at risk for disability by the algorithm did not have a disability. Such misclassification of disability status would result in an underestimate of the association between health condition category, pregnancy risks, and adverse birth outcomes. Moreover, our population is comprised of women of childbearing age. The algorithm has not been validated in this population and may have different sensitivity and specificity than in the general adult population. Some diagnoses may be particularly problematic in this population. For example, in the category of diseases of the circulatory system, hypertension, the most frequent diagnosis, may not limit function in this population, particularly as hypertension among women of childbearing age is more likely to be early stage and non-symptomatic (American Heart Association, 2014). Nevertheless, hypertension could have important physiologic complications which could contribute to adverse outcomes. Moreover, it is probable that some of these diagnoses were miscoded and reflect preeclampsia rather than underlying essential hypertension. Such misclassification will serve to dilute the association between disability and infant and maternal outcomes.

We identified eight disability risk groups, but even within these groups there is great heterogeneity. For example, women with diseases of the nervous system include women with pain, with epilepsy, and with vision disorders, all of which may affect pregnancy in different ways. Additional classification may identify groups more homogeneous with respect to pregnancy risk profiles and risk for poor birth outcomes.



In addition to the limitations of the algorithm in identifying women with disabilities, these results are subject to inherent limitations of administrative data. They are derived from birth certificate and ICD-9-CM and CPT codes from hospital discharge records and thus clinical corroboration of the data is not available. While these data represent the entire population of women who delivered in Massachusetts during 2007–2009, the findings may not generalize to other states.

Nevertheless, our study has important strengths. Our sample was population based and not subject to selection biases from studies representing convenience samples. Massachusetts birth certificate has extensive information to supplement the claims files, providing a rich, longitudinal data set with demographic and clinical information with which to examine birth outcomes.

## Implications for Practice and Policy

An important step towards addressing disability-related risks for poor pregnancy outcomes for both mothers and infants is through educating obstetrical clinicians about pregnancy risks of women with specific disabilities. Little research has examined pregnancy risks and outcomes among women with certain health conditions; thus, minimal clinical evidence is available about how to care for them during pregnancy. Maternal and child health programs can integrate the needs of women with specific disabilities in their clinician education efforts (Allen, 2011). This study highlights a need for the inclusion of women with potentially disabling health conditions in maternal and child health programs, policies, research and education.

## Conclusions

Our analysis provides new, population-based evidence about the heightened risk of women with potentially disabling health conditions for poor maternal and infant outcomes of pregnancy. This study also advances earlier studies by examining the association between potentially disabling health condition and demographic characteristics, pregnancy risks, and infant and maternal outcomes. Results of this study support the need for clinicians who provide care to women with disabilities to be aware of the increased risk for medical problems during pregnancy and their risk for poor birth outcomes. The findings provide insight to understanding the pathways through which disability affects maternal and infant outcomes, and will aid in the effort to develop effective clinical and policy interventions to improve these deleterious outcomes among women with disability.

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## Biographies

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**Table 1**

Five most frequent diagnoses among women in Access Risk Classification System level C and D, by health condition category, Massachusetts women, 2006–2009

<b>Health Condition Category</b>	<b>N</b>
<b>Diseases of the Circulatory System</b>	
Essential hypertension	2,282
Cardiac dysrhythmias	1,547
Conduction disorders	186
Heart failure	151
Ill-defined descriptions and complications of heart disease	89
<b>Diseases of the Musculoskeletal System and Connective Tissue</b>	
Other disorders of bone	537
Invertebral disc disorder	511
Diffuse Diseases of connective tissue	345
RA	289
Osteoarthritis	117
<b>Diseases of the Nervous System/Sense Organs</b>	
Pain, not otherwise classified	1,147
Epilepsy	975
Multiple Sclerosis	232
Other Retinal disorders	100
Blindness and low vision	74
<b>Other Physical Disorders</b>	
Ovarian dysfunction	506
Other diseases of lung	480
Other hernia of abdominal cavity	399
Disease of white blood cell	397
Regional enteritis	348
<b>Mental Illness</b>	
Episodic Mood Disorder	4,560
Drug induced mental disorders	534
Psychological Trauma	476
Schizophrenic disorder	223
Eating Disorder	125

**Table 2**

Maternal demographic characteristics, pregnancy risks, and infant and maternal outcomes, by disability risk status, Massachusetts births, 2007–2009

	Not at Risk for Disability (ARCS Levels A and B) N=207,155 N (%)	At Risk for Disability (ARCS Levels C and D) N=14,701 N (%)
<b>Age *</b>		
< 19	7,702 (3.7)	623 (4.2)
19–34	153,155 (73.9)	10,851 (73.8)
35+	46,298 (22.4)	3,227 (22.0)
<b>Education *</b>		
Less than HS	22,403 (10.8)	2,255 (15.4)
HS	51,817 (25.1)	4,879 (33.3)
Some college	41,375 (20.0)	3,393 (23.2)
College or higher	91,127 (44.1)	4,115 (28.1)
<b>Race *</b>		
White, NH	140,945 (68.0)	10,331 (70.3)
Black, NH	18,391 (8.9)	1,677 (11.4)
Hispanic	30,200 (14.6)	2,188 (14.9)
Other	17,630 (8.5)	505 (3.4)
<b>Other Socioeconomic</b>		
Father not named on BC *	18,099 (8.7)	2,594 (17.7)
Public insurance *	71,798 (34.9)	7,423 (51.1)
<b>Pregnancy Risks</b>		
Smoking *	13,631 (6.6)	2,606 (17.8)
No care in first trimester *	42,355 (20.8)	3,386 (23.5)
<b>Prenatal care index *</b>		
Inadequate	19,151 (9.4)	1,697 (11.8)
Intermediate	14,800 (7.3)	1,008 (7.0)
Adequate	92,444 (45.4)	5,229 (36.4)
Adequate plus	77,299 (38.0)	6,436 (44.8)
Hypertension *	10,471 (5.1)	2,238 (15.5)
Diabetes *	10,262 (5.0)	1,269 (8.8)
Other *	88,495 (42.7)	9,520 (64.8)
<b>Infant outcomes</b>		
Preterm birth *	16,247 (7.8)	2,303 (15.7)
Small for Gestational Age *	20,608 (10.0)	2,079 (14.3)
Apgar < 7 at 5 minutes *	2,241 (1.1)	351 (2.4)
<b>Maternal Outcomes</b>		
Cesarean Section	65,069 (31.5)	5,865 (40.0)

	<b>Not at Risk for Disability (ARCS Levels A and B)</b> N=207,155 N (%)	<b>At Risk for Disability (ARCS Levels C and D)</b> N=14,701 N (%)
Delivery length of stay > 5 days	6,353 (3.1)	1,387 (9.4)

\*  
p<0.05 NH: Non-Hispanic; BC: Birth certificate

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Maternal demographic characteristics, pregnancy risks, and maternal and infant outcomes, by health condition category, Massachusetts births, 2007–2009

Table 3

	Circulatory N = 3,403 (23%) N (%)	Musculo skeletal N=1,406 (10%) N (%)	Nervous system/sense organ N=1,970 (10%) N (%)	Other physical N=2,805 (19%) N (%)	2+ physical N=742 (5%) N (%)	Mental illness N=3,563 (24%) N (%)	Mental + physical N=812 (6%) N (%)
<b>Age</b>							
< 19	67 (2.0)	45 (3.2)	68 (3.5)	64 (2.3)	19 (2.6)	328 (9.2)	32 (3.9)
19–34	2,259 (66.4)	985 (70.1)	1,565 (79.4)	2,053 (73.2)	515 (69.4)	2,821 (79.2)	653 (80.4)
35+	1,077 (31.7)	376 (26.7)	337 (17.1)	688 (24.5)	208 (28.0)	414 (11.6)	127 (15.6)
<b>Education</b>							
Less than HS	331 (9.8)	153 (10.9)	290 (14.8)	263 (9.4)	81 (11.0)	926 (26.1)	211 (26.2)
HS	977 (28.8)	380 (27.1)	669 (34.1)	752 (26.9)	260 (35.3)	1,505 (42.4)	336 (41.6)
Some college	854 (25.2)	340 (24.2)	430 (21.9)	656 (23.5)	188 (25.5)	746 (21.0)	179 (22.2)
College or higher	1,229 (36.2)	532 (37.9)	573 (29.2)	1,123 (40.2)	207 (28.1)	370 (10.4)	81 (10.0)
<b>Other</b>							
<b>Socioeconomic</b>							
Father not named on BC	372 (10.9)	148 (10.5)	301 (15.3)	320 (11.4)	95 (12.8)	1,105 (31.1)	253 (31.2)
Public insurance	1,256 (37.4)	551 (39.3)	973 (49.7)	1,007 (36.4)	354 (48.6)	2,634 (75.0)	648 (80.3)
<b>Pregnancy Risks</b>							
Smoking	246 (7.2)	140 (10.0)	314 (16.0)	253 (9.1)	107 (14.5)	1,214 (34.2)	332 (40.9)
No care in first trimester	663 (19.9)	233 (16.8)	456 (23.5)	565 (20.5)	162 (22.1)	1,066 (30.9)	241 (30.5)
Prenatal care index							
Inadequate	312 (9.4)	110 (7.9)	213 (11.0)	245 (8.9)	64 (8.8)	614 (17.8)	139 (17.5)
Intermediate	169 (5.1)	103 (7.4)	158 (8.1)	170 (6.2)	41 (5.6)	308 (8.9)	59 (7.4)
Adequate	1,164 (35.0)	583 (42.0)	781 (40.2)	1,051 (38.2)	223 (30.6)	1,163 (33.8)	264 (33.3)
Adequate plus	1,681 (50.5)	591 (42.6)	790 (40.7)	1,283 (46.7)	400 (55.0)	1,359 (39.5)	332 (41.8)
Hypertension	1,330 (39.7)	110 (7.9)	129 (6.6)	244 (8.8)	168 (23.1)	164 (4.7)	93 (11.6)
Diabetes	412 (12.3)	101 (7.3)	156 (8.0)	238 (8.6)	82 (11.3)	198 (5.7)	82 (10.2)

	Circulatory N = 3,403 (23%) N (%)	Musculo skeletal N=1,406 (10%) N (%)	Nervous system/sense organ N=1,970 (10%) N (%)	Other physical N=2,805 (19%) N (%)	2+ physical N=742 (5%) N (%)	Mental illness N=3,563 (24%) N (%)	Mental + physical N=812 (6%) N (%)
Other	1,988 (58.4)	859 (61.1)	1,276 (64.8)	1,750 (62.4)	513 (69.1)	2,532 (71.1)	602 (74.1)
<b>Infant outcomes</b>							
Preterm	667 (19.6)	158 (11.2)	226 (11.5)	446 (15.9)	169 (22.8)	483 (13.6)	154 (19.0)
SGA	485 (14.4)	175 (12.5)	246 (12.5)	360 (13.0)	116 (15.9)	557 (15.3)	140 (17.3)
Apgar < 7 at 5 minutes	84 (2.5)	14 (1.0)	48 (2.5)	75 (2.7)	19 (2.6)	73 (2.1)	38 (4.7)
<b>Maternal outcomes</b>							
Delivery stay > 5 days	503 (14.8)	170 (4.8)	119 (6.0)	272 (9.7)	137 (18.5)	170 (4.8)	101 (12.4)
Cesarean section	1601 (47.2)	509 (36.3)	702 (35.7)	1251 (44.7)	347 (46.8)	1139 (32.2)	316 (39.0)

NH: Non-Hispanic; BC: Birth certificate

**Table 4**

Crude and adjusted association between health condition category and infant and maternal outcomes, Massachusetts Births, 2007–2009

	Crude RR (95% CI)	Adjusted Demographics RR (95% CI)	Adjusted demographics and pregnancy risks RR (95% CI)
<i>Infant outcomes</i>			
<b>Preterm Birth</b>			
Circulatory	2.5 (2.3–2.6)	2.4 (2.2–2.6)	1.3 (1.3–1.4)
Musculoskeletal	1.4 (1.2–1.7)	1.4 (1.2–1.7)	1.2 (1.0–1.4)
Nervous system/ Sense organ	1.5 (1.3–1.6)	1.4 (1.3–1.6)	1.2 (1.1–1.4)
Other physical	2.0 (1.8–2.2)	2.0 (1.8–2.1)	1.6 (1.4–1.7)
Mental Illness	1.7 (1.6–1.9)	1.6 (1.4–1.7)	1.3 (1.2–1.4)
Mental + physical	2.4 (2.1–2.8)	2.3 (2.0–2.7)	1.6 (1.4–1.8)
2+ physical	2.9 (2.5–3.3)	2.7 (2.4–3.2)	1.6 (1.4–1.9)
<b>Small for Gestational Age</b>			
Circulatory	1.4 (1.3–1.6)	1.4 (1.3–1.6)	1.1 (1.0–1.2)
Musculoskeletal	1.2 (1.1–1.4)	1.2 (1.1–1.4)	1.1 (1.0–1.3)
Nervous system/ sense organ	1.3 (1.1–1.4)	1.2 (1.1–1.3)	1.1 (1.0–1.2)
Other physical	1.3 (1.2–1.4)	1.3 (1.2–1.4)	1.2 (1.1–1.3)
Mental Illness	1.6 (1.4–1.7)	1.3 (1.2–1.4)	1.1 (1.0–1.2)
Mental + physical	1.7 (1.5–2.0)	1.5 (1.3–1.7)	1.2 (1.0–1.4)
2+ physical	1.6 (1.3–1.9)	1.5 (1.3–1.8)	1.2 (1.0–1.4)
<b>Apgar Score &lt; 7 at 5 minutes</b>			
Circulatory	2.3 (1.8–2.8)	2.1 (1.7–2.7)	1.6 (1.2–1.9)
Musculoskeletal	0.9 (0.5–1.5)	0.8 (0.5–1.4)	0.8 (0.5–1.3)
Nervous system/ sense organ	2.3 (1.7–3.0)	2.1 (1.6–2.8)	1.9 (1.5–2.6)
Other physical	2.5 (2.0–3.1)	2.4 (1.9–3.0)	2.1 (1.7–2.6)
Mental Illness	1.9 (1.5–2.4)	1.6 (1.2–2.0)	1.4 (1.1–1.8)
Mental + physical	4.3 (3.1–5.9)	3.6 (2.6–5.0)	3.1 (2.3–4.3)
2+ physical	2.4 (1.5–3.7)	2.2 (1.4–4.4)	1.7 (1.1–2.6)

RR: Risk Ratio; CI: Confidence Interval

**Table 5**

Crude and adjusted association between health condition category and maternal outcomes, Massachusetts Births, 2007–2009

	Crude RR (95% CI)	Adjusted Demographics RR (95% CI)	Adjusted demographics and pregnancy risks RR (95% CI)
<b>Maternal delivery hospitalization &gt; 5 days</b>			
Circulatory	4.8 (4.4–5.2)	4.5 (4.1–4.9)	1.9 (1.7–2.0)
Musculoskeletal	2.0 (1.6–2.4)	1.9 (1.5–2.3)	1.5 (1.2–1.9)
Nervous system/ sense organ	2.0 (1.7–2.3)	2.0 (1.7–2.4)	1.6 (1.4–2.0)
Other physical	3.1 (2.8–3.5)	3.0 (2.7–3.4)	2.3 (2.1–2.6)
Mental Illness	1.6 (1.3–1.8)	1.7 (1.4–2.0)	1.5 (1.3–1.8)
Mental + physical	4.0 (3.4–4.9)	4.3 (3.6–5.2)	3.0 (2.5–3.6)
2+ physical	6.0 (5.1–7.0)	5.9 (5.1–6.9)	3.0 (2.5–3.5)
<b>Cesarean Section</b>			
Circulatory	1.4 (1.4–1.5)	1.4 (1.3–1.4)	1.2 (1.2–1.3)
Musculoskeletal	1.1 (1.1–1.2)	1.1 (1.1–1.2)	1.1 (1.0–1.2)
Nervous system/ sense organ	1.1 (1.1–1.2)	1.2 (1.1–1.2)	1.1 (1.1–1.2)
Other physical	1.4 (1.3–1.4)	1.4 (1.3–1.4)	1.3 (1.3–1.4)
Mental Illness	1.0 (1.0–1.1)	1.1 (1.1–1.2)	1.1 (1.0–1.1)
Mental + physical	1.2 (1.1–1.3)	1.3 (1.2–1.4)	1.2 (1.1–1.3)
2+ physical	1.5 (1.4–1.6)	1.5 (1.4–1.6)	1.3 (1.2–1.4)

RR: Risk Ratio; CI: Confidence Interval