Late Preterm Birth and Health at the Starting Gate

Population-based studies of children's health and developmental trajectories have focused almost exclusively on low birthweight as the sole indicator of health status at the "starting gate" (e.g., Case, Lubotsky & Paxson 2002; Conley, Strully & Bennett 2003; Case, Fertig & Paxson 2005), although there is increased recognition that fetal growth and health can have consequences for health over the lifecourse through mechanisms that are not necessarily reflected in birthweight (e.g., Barker 1992). Recent findings in the medical literature suggest that late preterm infants—those taking place at 34–36 weeks completed gestation, which account for about three quarters of all preterm births in the U.S. and over 8% of all births in the U.S. (CDC 2012)—are at risk for adverse neurodevelopmental trajectories despite appearing physically mature at birth. Only one third (32%) of late preterm infants in the U.S. in 2009 weighed less than 2500 grams (CDC 2012)—the standard threshold for low birthweight; as such, infants born late preterm have been overlooked in the social science literature on children's health trajectories.

Two of the most salient neonatal conditions linked to late preterm birth are respiratory disorders and hyperbilirubinemia (jaundice) (Raju et al. 2006), both of which have been linked to neurodevelopmental impairments (e.g., Buchmayer et al. 2009; Jangaard et al. 2008; Lipkin et al. 2002; Maimburg et al. 2008, 2010; Porter-Stevens, Raz & Sander 1999). Several very recent studies (e.g., Chyi et al. 2008; Lindstrom, Lindblad & Hjern 2011; Linnet et al. 2006; Morse et al. 2009; Nepomnyaschy et al. 2012; Petrini et al. 2009; Quigley et al. 2012; Talge et al. 2010; Van Baar et al. 2009; Woythaler, McCormick & Smith 2011) have found associations between late preterm birth and child cognitive and behavioral disorders—the types of conditions that have overtaken physical impairments as the major sources of child disability in the U.S. (Halfon et al. 2012). However, preterm birth is strongly associated with sociodemographic factors, and existing studies demonstrating links between late preterm birth and adverse outcomes have not been able to adequately control for those factors. Thus, some of the "effects" of late preterm birth may reflect unobserved confounding factors.

There is a great deal to be learned about the extent to which, and how, late preterm birth shapes children's health and developmental trajectories. A large, necessary, and important first step in delving into this black box is strengthening the evidence about associations between late preterm birth and the most relevant neonatal outcomes—those strongly associated with both late preterm birth and children's developmental disorders. In this study, we will investigate the effects of late preterm birth on two salient measures of health at the "starting gate"—respiratory disorders and hyperbilirubinemia—using a more rigorous research design than has been used to date and disentangling effects of late preterm birth from those of other pregnancy complications and obstetric interventions (particularly Caesarian section delivery). We will estimate both across- and within-family models. The latter will compare infants born to the same mother, implicitly controlling for all time-invariant maternal characteristics, and assess the extent to which the estimated effects of late preterm birth can be explained by time-varying factors including marital status, neighborhood poverty, health insurance, smoking, prenatal care, hospital of delivery, and relevant medical/obstetrical conditions. As far as we know, previous studies of length of gestation on infant or child health have rarely compared births to the same mother. The only exception of which we are aware used Swedish registry data to investigate the effects of gestational age (but not specifically on late preterm birth) on attention deficit diagnoses and found that effects found in cross-mother analyses largely remained in mother-specific analyses (Lindstrom, Lindblad & Hjern 2011). We will disentangle the effects of late preterm birth from those of slow fetal growth, other relevant medical risks, and Caesarian section (C-section) delivery, all of which are associated with late preterm birth but can confer direct threats to infant health independent of gestational length.

To conduct this study, we will use data from the New Jersey Department of Health and Senior Services that includes birth records for all births in the State of NJ from 1996 to 2006 (over 1 million births) linked to hospital discharge records. The electronic birth records contain identifying information for each mother, as well as the date of her last live birth, which allowed us to match in-state births to the same mother during the observation period. The electronic birth certificate (EBC) files contain data on the date and hospital of birth, demographic factors (including maternal education, marital status, age, race/ethnicity, nativity, and parity), health insurance type (public, private, none), medical risk factors, prenatal behaviors (smoking, prenatal care), obstetric procedures (e.g., labor induction, C-section after labor trial, C-section--no labor trial), complications of labor and delivery, birth outcomes (gestational age, birthweight, congenital anomalies), newborn interventions (e.g., oxygen assisted ventilation, surfactant therapy, phototherapy),and newborn diagnoses (e.g., hyperbilirubinemia, respiratory distress syndrome/hyaline membrane disease, transient tachypnea, persistent pulmonary hypertension) from a newborn discharge module. The focal outcomes will neonatal respiratory disorders and hyperbilirubinemia. The former will be considered both as a composite of the various relevant respiratory conditions, as well as using alternative and substantively meaningful single measures or categorizations.

We will estimate the effects of late preterm birth as conventionally defined, 34–36 completed weeks (i.e., 34 0/7–36 6/7 weeks) gestation, compared to full term birth, or 37–41 completed weeks of gestation (37 0/7–41 6/7 weeks). The EBC includes the date of the first day of the mother's last normal menstrual period (LMP), as reported by the mother, or as recorded on the prenatal record, as well as days of gestation, calculated by subtracting the date of the last normal menstrual period from the baby's date of birth. The EBC also includes a clinical assessment of gestational age, which, according to the EBC coding manual, measures the "development of the infant in weeks as judged by the clinician, using the best available information, (physical examination of the infant and/or ultrasound visualization)." This measure will allow us to cross-check our results based on the estimate of gestational age using LMP, the dating for which can be off as much as 1–2 weeks.

We will compare infants born at 34–36 weeks of completed gestation to those born at 37–41 weeks, but will assess sensitivity to slightly different cutoffs occasionally used in the literature. We will also conduct supplementary analyses of week of gestation within the 34–41 week range. Following the existing literature, we will limit those analyses to singleton births (to eliminate confounding effects of multiple births and assisted reproductive technology) and to infants with no major congenital anomalies (which may be associated with both late preterm birth and the outcomes of interest but could be causes, rather than consequences, of late preterm birth)..

The analysis sample for the across-mother analyses will consist of all singleton live births between 34 and 41 weeks of gestation (over 90% of the 1 million+ births in the dataset). That is, all births outside of the ranges for late preterm (34–36) and full term (37–41) will be excluded from the analyses. Many mothers will be in the sample more than once (for different births) but we will not account for mother-specific effects in this first set of models. These analyses will control for a number of sociodemographic characteristics, including marital status, education, parity, age, race/ethnicity, nativity, infant's sex, and insurance type (public, private, none), as well as hospital and year of birth. The standard errors for the hospital indicators will be adjusted for clustering. In some models we will include measures of prenatal smoking, prenatal care, and medical/obstetric risk factors for the pregnancy. We will estimate models for all mothers as well as models stratified by maternal education, race/ethnicity, nativity, marital status, parity, and age. We will estimate linear probability models but assess sensitivity to logistic and probit specifications. We will estimate all of the models both with and without specific sets of medical and obstetric variables that represent potential sources of confounding because they are associated with both length of gestation and neonatal outcomes independent of length of gestation. For additional specification checks, we will estimate models that restrict the sample to normal birthweight infants and that alternatively include/exclude prenatal care and smoking.

For the within-mother analyses, we will include mothers from the sample above who had at least two infants, with at least one that was late preterm and at least one that was full term and estimate individual OLS fixed effects models. As a robustness check, we will use the subsample of mothers from the across-mother analyses who had at least two births, with at least one infant who had the relevant condition and at least one infant who did not have the relevant condition, and estimate logistic fixed effects models. The advantage of fixed effects models of either type are that, because they account for observable and unobservable time invariant mother-specific factors and also allow controls for time-varying factors, they produce less biased estimated effects compared to the cross-mother analyses under Aim 1. The disadvantage is that they require sample restrictions noted above that make it difficult to generalize to the entire population. Thus, we view the two sets of analyses as providing complementary information to inform our understanding of the processes at play. As part of our investigation, we will estimate the across-mother analyses on the within-mother samples to assess the extent to which differences in estimated effects, if any, are a result of the sample restrictions in the fixed effects models.

Results indicate that late preterm birth increases the likelihood of any neonatal respiratory condition by about 12.6% and of hyperbilirubinemia by about 4.3% in cross-mother models that control for extensive covariates. The estimated effects decrease only slightly—to 11.5% and 3.7%, respectively—in mother fixed effects models that control for numerous time-varying covariates, suggesting that late preterm birth is truly detrimental to children's developmental trajectories.

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