

The human capital benefits of neonatal care for moderate risk infants

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Abstract

We document significant human capital gains from a common intervention for moderate-risk newborns — Special Care Nurseries (SCN). Using instrumental variables that exploit strict clinical decision rules for SCN admission, and linked population data from Australia's Northern Territory, we find that SCN admission increases the probability of avoiding developmental vulnerability on five teacher-assessed domains at the start of full-time schooling by 19 percentage points — a 30% improvement over baseline — and raises scores of physical health and wellbeing by over one-third of a standard deviation. Mechanisms involve improved health trajectories: SCN reduces hospital admissions for infectious and respiratory illness and accidents, while enabling treatment of conditions requiring surgery. These gains are concentrated among boys, consistent with greater male vulnerability to in-utero health shocks. Given that SCN care typically adds only one week of hospital care, these findings suggest it may offer substantial long-term human capital returns at relatively low marginal cost.

Key words: Early life health interventions, Human capital development, Health outcomes, Neonatal Care, Instrumental variables, Administrative record data

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1. Introduction

Health at birth is an important determinant of human development and is causally linked to later life health and economic well-being (Almond et al., 2018; Almond and Currie, 2011; Bleakley, 2010; Heckman and Masterov, 2007). A key indicator of poor neonatal health is low birthweight (LBW). The social costs of LBW are high (Almond et al., 2005). Infants born with LBW have an elevated risk of developmental delays, morbidity and mortality (Petrrou, 2019, 2003; Petrrou et al., 2019; Petrrou and Khan, 2012; Saigal and Doyle, 2008; Stein et al., 2006; World Health Organization, 2022), as well as lower test scores, cognitive skills, years of schooling, and earnings (Almond et al., 2010; Behrman and Rosenzweig, 2004; Bharadwaj et al., 2013; Black et al., 2007; Figlio et al., 2014; Maruyama and Heinesen, 2020; Oreopoulos et al., 2008; Rosenzweig and Zhang, 2009; Royer, 2009; Torche and Echevarría, 2011).

To address the high costs of LBW, the World Health Organization recommends additional neonatal care for all LBW babies (Darmstadt et al., 2023; World Health Organization, 2022).¹ In developed economies, neonatal care is typically structured into four levels. Level I is the standard nursery care provided to healthy and full-term newborns. Level II involves admission to a Special Care Nursery (SCN) with the purpose of providing extra monitoring and stabilizing of moderate-risk infants such as those born prematurely and/or below the LBW threshold of 2,500 grams (g). The highest two levels of care assign babies to Neonatal Intensive Care Units (NICU) which address needs for high-risk infants such as those with critical illnesses and/or below the very low birthweight (VLBW) threshold of 1,500g (Barfield et al., 2012).

Our study investigates the longer-term human capital and health benefits of the recommended additional neonatal care for moderate-risk babies: admission to a SCN. Using novel linked administrative data from one of Australia's most health-disparate jurisdictions, and an instrumental variable approach, we estimate the causal impact of SCN admission on human capital development in children's first year of primary school (average age of five). To identify the causal impact of SCN admission, we leverage the strict clinical decision-making criteria physicians use when admitting at-risk infants to advanced neonatal care. These rules generate exogenous changes in the probability of assignment to a SCN at two different thresholds, below 2,300g and between 2,300g and 2,500g. Our empirical strategy identifies a treatment effect of SCN admission for children with birthweights in this region where thresholds are important determinants of SCN assignment. Our approach is like Clark and Del

¹ The WHO also recommended to reduce the prevalence of LBW globally by 30%, relative to the 2012 prevalence rate, by 2030 although little evidence exists to date that countries worldwide will achieve the World Global Nutrition Target (Blencowe et al., 2019; Okwaraji et al., 2024).

Bono (2016) who exploited two test score thresholds used by selection committees for admission to elite secondary schooling in the Aberdeen region (Scotland) to evaluate the long-term benefits of attending an elite school. Theirs and our approach can be understood as a heavily parameterized regression kink design (see Card et al. (2017, 2015)).

Our paper produces three main findings. First, we find statistically and economically meaningful impacts of SCN admission on human capital outcomes, as measured by the Australian Early Development Census (AEDC), a teacher assessment of the skills of all students in their first year of full-time schooling across five domains. SCN admission increases the probability of avoiding developmental vulnerabilities by 19.1 percentage points which is more than a 30% increase from the baseline probability of this outcome (61 percent of the children in our sample are not developmentally vulnerable on any AEDC domain). Across several domains of developmental progress including physical health & wellbeing, social competence and emotional maturity, our estimates imply that SCN increases scores by over one-third of a standard deviation.

Second, the estimates emerge most prominently for baby boys. This is a credible finding, as male fetuses are more fragile and sensitive to in utero shocks and health issues at birth. This finding supports the conclusion that early life medical care provides attention for those most in need and suggests that the channel through which early-life medical attention improves school-relevant human capital is by boosting health.

Testing the health channel with detailed analyses of hospital admission diagnoses (ICD-10 codes) following Doyle et al. (2025), we thirdly find improved health among the marginal moderate-risk baby. Babies admitted to a SCN are significantly less likely to die in their first year of life and to be re-admitted to hospital in the first month of their life. They are also significantly less likely to be admitted to hospital for a variety of the most common early-childhood conditions (e.g. infectious and respiratory disease). Yet, they are significantly more likely to have received surgery before their fifth birthday. As these children are not more likely to be admitted for accidents, we conclude that surgery is not related to care provided for treating accidents, but potentially for conditions flagged early in the life of these moderate-risk infants, either during their SCN stay or because of their follow-up care.

Our study contributes to our understanding of the efficacy of early-life health interventions in a few important ways. First, we are aware of only one other study that quantifies the impact of neonatal care provided to moderate-risk infants. Yu et al. (2025) document improved health in the first two years of life for babies admitted to a SCN in New South Wales, Australia's most populous jurisdiction. Prior studies evaluating neonatal care

interventions focus on treatment targeting high-risk infants assigned to neonatal intensive care units, identified for babies born around the very low birthweight threshold (1,500g) (Almond et al., 2010; Bharadwaj et al., 2013; Daysal et al., 2022).

Almond et al. (2010) exploit the very low birthweight (VLBW) cutoff in U.S. data and find that additional treatment for infants just below 1,500g reduces one-year mortality by nearly 20%. Applying a similar estimation approach on Chilean and Norwegian data, Bharadwaj et al. (2013) find that infants born around the VLBW threshold but who receive extra care score 0.15–0.22 standard deviations higher on math and language tests in late adolescence. Daysal et al. (2022) confirm these findings in the Danish neonatal care context and further document spillover benefits for siblings’ academic outcomes.

Unlike these previous papers, we focus on extra care provided not for the most vulnerable newborns, but newborns around the LBW threshold whose health status leaves ambiguity around whether they need additional care. It is important to better understand the short- and longer-term impacts of providing extra monitoring and stabilizing of these moderate-risk infants given a significant share of live births receive this type of care. In Australia, the number of infants treated by a SCN is above 15 percent which is around five times greater than neonatal intensive care unit admissions.²

Second, we study the longer-term causal impacts of SCN care in the context of the Northern Territory, where we can link perinatal files with the Australian Early Development Census (AEDC), a reliable and validated developmental instrument that strongly predicts later-life cognitive performance (Brinkman et al., 2014, 2007). These early-life measures of cognitive and noncognitive skills are of interest to both policymakers and researchers, as they are both malleable to early interventions and predictive of a variety of later-life outcomes (Cunha and Heckman, 2007; Elkins and Schurer, 2020; Elkins et al., 2017; Fletcher and Schurer, 2017; Heckman et al., 2013, 2006; Heckman and Kautz, 2012; Heckman and Masterov, 2007; Schurer, 2017; Schurer et al., 2019). By focusing on these outcomes when children start full-time schooling (average age of five), our study captures an important intermediate stage linking neonatal care to later-life outcomes.

The Northern Territory is a unique, but policy-relevant setting as it has the highest prevalence of low birthweight infants in Australia (Gao et al., 2014a; Kildea et al., 2016) and persisting education inequalities (Cobb-Clark et al., 2023a; Schurer et al., 2018; Su et al.,

² Australian Institute of Health and Welfare (2023) reports from several Australian territories imply around 15% of live births receive SCN care and around 3% of live births receiving NICU care.

2019). A large proportion of children in this setting face extreme disadvantage and deprivation. Health expenditures per capita are twice as high in the Northern Territory as Australia's national average, and many pre-school children suffer from ear and other infections that have been linked to poor performance at school entry.³ Investing early in the health trajectories of these children could thus be a cost-effective medical strategy to reduce health and educational inequalities before they widen irrevocably.

Our paper proceeds as follows. In Section 2, we describe the institutional set up from which the natural experiment of exogenous allocation to early life medical care emerges. In Section 3 we introduce the empirical framework, the assumptions under which the model yields a causal effect, the linked administrative data, the outcome variables of interest, and the logic of our sample selection process. In Section 4, we demonstrate the validity of our causal model, explain the main estimation results and provide evidence on the robustness of our estimates. In Section 5 we present heterogeneity and auxiliary data analyses that could help uncover the potential mechanisms. The implications of our findings are discussed in Section 6 and in Section 7 we present conclusions for policymakers.

2. Institutional setting of neonatal care in the Northern Territory

The Northern Territory is in the central and northern-central region of Australia (Figure 1). Sparsely populated for its geographical size, the Northern Territory has an estimated resident population of 248,000 people, and about 3,600 babies are born in the territory annually. Like other jurisdictions in Australia (six states, and one more territory other than the Northern Territory) and other comparable OECD countries, neonatal care in the Territory offers all levels of standard care recommended by the WHO including SCN for moderate-risk newborns and NICU for high-risk newborns. There are three hospitals that offer such special or intensive care services: two public hospitals (*NAMES SUPPRESSED*), and one private (*NAME SUPPRESSED*)

³ About two in five children born in the Northern Territory are Aboriginal and Torres Strait Islander descent, who have three times the rate of low birthweight (15%) relative to non-Aboriginal babies (5%) (Hare et al., 2020). Improvements in birthweight percentile are continuously associated with improvements in schooling for this vulnerable population (McEwen et al., 2018). There are many risk factors to neonatal health of Aboriginal infants, including maternal health problems during pregnancy (Hare et al., 2020), public policy interventions (Doyle et al., 2022a; Doyle and Schurer, 2023), and highly variable weather conditions that create barriers of access to remote communities (Doyle, 2023). Yet not all Aboriginal children are faltering, two in three are thriving in early childhood. Only about 1/20 children, most of which live in very remote communities have very high risk of low birthweight due to prematurity (1 in 4), very high risk of frequent hospitalisation before the age of five and poor school attendance already in Year 1 (60%) (Roper et al., 2023a). State and territory health expenditures per capita on Aboriginal populations is the greatest in the Northern Territory with \$11,082 spent annually on in patient and community health services, more than twice the national average (\$5,328 per person) (Australian Institute of Health and Welfare, 2024).

hospital.⁴ Neonatal care at these hospitals can be accessed by babies born in other hospitals (*NAMES SUPPRESSED*) by transfers, but our analysis will focus on babies born in hospitals with these units. Figure 1 illustrates the location of the hospitals in the Northern Territory.

Once admitted to a SCN, newborns are monitored closely by nurses, who can watch several babies at a time. In general, newborns in the SCN are healthier and stronger than those initially admitted to a NICU, with the ability to breathe without support. While the primary aim of a SCN is medical care, there is also a focus on discharge planning and educating the parents of the newborn. Staff are available for advice about caring for newborns including feeding and bathing. Babies admitted to a SCN therefore benefit both directly and indirectly from admission, through medical treatment to improve health and survival probabilities through better informed carers.

Babies are generally admitted to the SCN if they have low birthweight or if they are premature. They may also be admitted due to other reasons such as difficulty breathing or low APGAR scores. According to the “Admission and Discharge Planning for Babies in Neonatal Intensive Care and Maternity Ward RDH Guidelines” (NT Department of Health)⁵, newborns should be admitted to the SCN if:

- a) They weigh less than 2,300g. Newborns between 2,200g and 2,300g may be transferred to the Maternity Ward after a period of observation in the SCN where they have proven to be thermodynamically stable with stable blood glucose levels.
- b) They are born with a birthweight between 2,300g and 2,500g and meet one of the below qualifications:
 - Is born prematurely, which is defined as less than 36 weeks gestation by confirmed dates
 - Did not breast feed successfully at birth or where the "Borderline low birthweight newborns admitted to the Maternity Unit Breastfeeding Plan" is unsuccessful
 - Is at risk of sepsis⁶
- c) Suffers from apnoea, birth asphyxia, a respiratory distress, or hypoglycaemia.

⁴ As of 6 June 2025, the maternity services at one private hospital have closed. This means private patients will no longer be able to give birth in or stay at the private hospital.

⁵ From conversations with Northern Territory obstetricians and midwives, we confirmed that these clinical guidelines are being used in all three hospitals of our data and have not substantially changed since 1994. We interviewed Dr Charles Kilburn, Head of Paediatrics at the [NAME SUPPRESSED] who provided us with a copy of the clinical guidelines from the NT Department of Health in 2016.

⁶ For example, vaginal birth when the mother is Group B streptococcus positive without adequate antibiotic cover in labour, meconium-stained liquor, prolonged ruptured membranes.

Given these guidelines, the probability of SCN assignment changes discontinuously across various birthweight thresholds. The 2,500g (LBW) threshold has been used as a “rule of thumb” to determine levels of neonatal care since the 1930s, when a Finnish paediatrician advocated it as a useful indicator for adverse neonatal outcomes. Importantly, these cutoffs are not based on strict biological criteria or any discontinuous changes in health at the thresholds (see Almond et al. (2010) and McEwen et al. (2018) for discussion of the evolution of these rules of thumb).

Nearly all babies in the Northern Territory are born in a hospital, even if the mother lives in a (very) remote community. Public hospital birthing services are offered in Darwin, Alice Springs, Katherine, Barkly, Nhulunbuy (Gove District), and up until 2006 in Tennant Creek. Women who do not live in these regions, are required to travel to the nearest hospital in Alice Springs or Darwin by week 38 and wait there until their baby is born. Women from more remote regions where birth complications are expected are directly transported to Darwin (Gao et al., 2014b; Kildea et al., 2016).⁷

3. Empirical framework

3.1. Estimation model

Our empirical strategy exploits the clinical decision-making rules to identify the causal impact of SCN neonatal care on developmental outcomes assessed at the average age of five. We start out with a model expressed in Eq. (1) in which we link human capital as the outcome variable to special care nursery assignment as the main treatment variable and various controls on the right-hand side of the equation.

$$HC_i^k = \alpha + \tau SCN_i + X_i' \gamma + g(BW_i) + u_i \quad (1)$$

⁷ For remote-dwelling women antenatal care is provided in local health centres by remote area midwives, Aboriginal health workers (AHW), remote area nurses, District Medical Officers (DMO), or specialist outreach obstetricians visited three to four times a year. However, perinatal and postnatal care for remote-living women is fully provided either in the Darwin or Alice-Springs based hospitals or in the remote areas of Gove, Katherine, or Tennant Creek. To fund the travel, pregnant mothers can apply for funding from the Patient Assistance Transport Scheme (PATs), an Australian Government initiative. Pregnant women in remote communities are transported to outer-regional hospitals at 38 week's gestation to await labour and birth. PATs provides funding for (commercial) airfares (also for escorts) and accommodation in Darwin (Gao et al., 2014a). For instance, for women brought to Darwin, they will attend antenatal care and will give birth in the delivery suite at the [NAME SUPPRESSED]. After birth, women will be discharged to family or a hostel. Most women will be transported home as soon as possible, although some airlines may refuse to transport infants less than seven days old.

Human capital at age 5 HC_i^k is assumed here to be a function of a child's health and school factors (vector X_i'), a non-linear function of birthweight ($g(BW_i)$) and whether the child received early life medical care (here proxied by SCN_i). However, estimating Eq. (1) using Ordinary Least Squares (OLS) is likely to yield a biased estimate of τ because poor early-life health conditions both determine SCN assignment and are also related to human capital outcomes through other channels. Possible candidates for these unobservable factors are maternal health problems, poverty or geographic isolation due to remoteness that might be harmful for the baby's health at birth and their development until they enter school. Each of these factors that are hard to observe in our setting are likely to affect children's long-term developmental outcomes. Since SCN assignment is more likely for newborns with other unobserved health challenges, it is likely that the OLS estimate of τ would be downward biased. In other words, we would expect to find a negative correlation between SCN assignment and human capital outcomes without a valid causal identification strategy.

To address the endogeneity in SCN admission, we use the clinical decision-making rules outlined above to isolate exogenous variation in assignment to SCN treatment. The clinical decision-making rules provide valid instrumental variables. Because the relationship between birthweight and SCN admission changes at both the 2,300g and 2,500g thresholds, our strategy is comparable to a regression kink design (see Card et al. (2017, 2015)), an approach that identifies causal effects in settings where the regressor of interest is a kinked function of an assignment variable. While regression discontinuity design requires a discontinuity in the assignment rule, regression kink design assumes a kink in the relationship between the policy variable and the underlying variable.

Our approach exploits two kinks that are relatively close to each other, and we rely on a small sample which makes it hard to determine the shape of the relationship around the threshold. Our setting is almost identical to Clark and Del Bono (2016) who estimated the causal impact of elite school admission for a cohort of children in Aberdeen, Scotland. In their study, the relationship between student admission test scores, the assignment variable, and entry into elite school, the treatment variable of main interest, follows a similar pattern as we observe for birthweight and SCN admission.

We first model SCN admissions considering the importance of the key birthweight thresholds. We exclude babies at higher (3,500g or more) or very low birthweights (below 1,500g) since these thresholds can impact other treatment decisions. Specifically, our method isolates exogenous variation in SCN treatment using the change in gradient of the relationship

between birthweight and SCN admission at the LBW threshold of 2,500g and again at the threshold of 2,300g. We include indicators for these thresholds and interact these indicators with functions of birthweight which allows for both level shifts at the thresholds as well as shifts in the birthweight-SCN gradient. We estimate the following first stage equation:

$$SCN_i = \theta_0 + \theta_1 1[BW_i < 2300] + \theta_2 1[2300 \leq BW_i < 2500] + \theta_3 1[BW_i < 2300] \times g(BW_i) + \theta_4 1[2300 \leq BW_i < 2500] \times g(BW_i) + \delta g(BW_i) + X_i' \gamma + \varepsilon_i \quad (2)$$

In total, we have four instrumental variables including indicators for birthweights below 2,300g, birthweights between 2,300g and 2,500g and the interaction of these indicators with a non-linear function of birthweight.

Our second-stage equation includes the predicted value of SCN admission ($\widehat{SCN}_i$) from Eq. (2) as the key regressor of interest into our model of human capital development:

$$HC_i^k = \alpha + \rho \widehat{SCN}_i + X_i' \gamma + g(BW_i) + u_i \quad (3)$$

In Eq. (3) we approximate the non-linearity in birthweight by the natural logarithm of the weight recorded at birth (a quadratic function is used in a robustness check). The vector X_i contains a wide range of controls from school and medical records. We distinguish three different sets of control variables:

- School controls: School fixed effects, year of assessment, age at assessment, English as a second language, and birth order⁸.
- Baby perinatal controls: Gender, Aboriginal status, gestation age (dummy variables for each category), whether there were any labour complications, the APGAR scores at 1 minute and at 5 minutes, and the hospital at which the baby was born
- Mother perinatal controls: Aboriginal status, age, age squared, number of previous pregnancies, indication of smoking at first antenatal visit, week of pregnancy at first antenatal visit, whether she has any medical condition.

⁸ Birth order is controlled for as basic control variable in the human capital development equation, as previous literature has shown that first-borns tend to be more intensely nurtured and therefore their cognitive (Zhang et al., 2023) and non-cognitive skills (Black et al., 2018) are better developed by the time they enter school.

Of main interest is the estimated parameter ρ , the causal estimate of SCN admission on human capital development, under the assumptions of the model. To yield an unbiased and consistent estimate of the true effect of SCN admission, the following assumptions must hold:

- **Strength:** The instruments are strong and predictive in determining SCN admission over and above the included control variables. This assumption can be tested under the joint null hypothesis of $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0, \theta_4 = 0$ (against a two-sided hypothesis) and the report of the F-test statistic, which should be large in magnitude.
- **Validity:** The instruments are not correlated with unobserved determinants of human capital. This assumption implies that the instruments affect developmental outcomes only through their effect on the probability of being admitted to the SCN. For the 2SLS estimation to generate consistent results, the non-linear function of birthweight ($g(BW)$) added as control must capture correctly the underlying relationship between outcomes and birthweight after conditioning on all other observed health and demographic factors. We check for this assumption by testing for the robustness of our estimates by including a variety of control variables or to use alternative specifications of the non-linearity in birthweight and sample bandwidth selection. We will also conduct falsification tests (i.e. SCN should not have an impact on pre-determined outcomes such as congenital disease).
- **Monotonicity:** Monotonicity requires that the instruments affect the probability of SCN admission only in one direction. In our setting this means that, conditional on other covariates, the newborns with lower birthweights are more likely to receive SCN admission. To meet this assumption, we drop all newborns below the very low birthweight (VLBW) threshold of 1,500g since these individuals may die prior to admission to a SCN, be transferred to another hospital, or receive care outside of the hospital's SCN (such as in the NICU). In each of these cases, we would observe the newborns to be less likely to be admitted to a SCN. We also drop those born over 3,500g, as some newborns may be admitted to SCN units for health reasons associated with being heavy (Eriksen 2014).

In addition to these standard assumptions, our approach, requires that there is no manipulation around the two birthweight thresholds. One concern is that doctors incorrectly record birthweights so that they fall below the thresholds to ensure SCN assignment for a particular patient. This behaviour could exist due to preferential treatment or an attempt to

maximise reimbursement amounts for the hospital.⁹ We test for this identification threat using the extended version of the McCrary density test (Cattaneo et al., 2018; McCrary, 2008).

If there is heterogeneity in the treatment effect, we expect to identify the effect of SCN for the borderline newborn. This local average treatment effect (LATE) is specific to newborns for whom admission to SCN is influenced by the value of the four instruments. These compliers are admitted to SCN care only because their birthweight was just under the two relevant birthweight thresholds.¹⁰

3.2. Data

We use data made available through the Northern Territory's Child and Youth Development Research Partnership (CYDRP).¹¹ This data repository linked information for 313,933 individuals born on or after 1 January 1986 who were observed in at least one of the administrative data collections as residing in the NT.¹² Linkage was conducted by SA-NT Datalink (Schneider et al., 2019), using probabilistic methods to match the records for individuals across all data collections requested, with clerical review of uncertain matches. This process is confirmed to result in 99.6% accuracy for completed links (SANT DataLink, 2020).¹³

3.2.1. Measures for human capital when children start full-time schooling

⁹ Manipulating records for the purpose of increasing reimbursement is sometimes referred to as upcoding in the Diagnosis-Related Group (DRG) literature (Jürges and Köberlein, 2015). This hypothesis has been rejected for other jurisdictions (e.g. Germany, see Reif et al. (2018)).

¹⁰ We are grateful for the suggestion made by a seminar participant at the University of Copenhagen regarding the relative strength of the two thresholds as instrumental variable. In two robustness checks, we used only one of the two thresholds to test whether our findings are sensitive to either the lower bound (2,300g) or the upper bound (2,500g) threshold. For these analyses the estimation sample will be restricted to either 1,500-2,499g or the 1500g to 3,500g birthweight range. These results are presented in the Supplement.

¹¹ CYDRP is a research collaboration between Menzies School of Health Research and multiple NT Government agencies, including the Departments of Health; Education and Training; Children and Families; Corrections; People, Sport and Culture; Chief Minister and Cabinet; Treasury and Finance; NT Police and Attorney-General and Justice. research datasets are released to approved projects where researchers can merge and analyse records for the same child across multiple datasets.

¹² More than 50 projects have used extracts from the CYDRP data repository. The extension of the repository back to 1986 means that the latest extract (Extract 3) contains records for young adults including young women some of whom will also have records of their own children represented in the repository. In addition, Extract 3 contains selected records for other mothers born before 1986, bringing the full dataset to 370,000 individuals. See Menzies CYDRP Research Brief (Menzies School of Health Research, 2022).

¹³ SA-NT Datalink creates a unique project-specific linkage key (PSLK) for everyone matched in the requested data collections and provides this to data custodians. Each data custodian then creates a de-identified dataset containing only the linkage keys and approved research variables for matched individuals. Versions of the data repository have been used in several studies concerning the wellbeing outcomes of children and youth (Cobb-Clark et al., 2023b; Doyle et al., 2022b; He et al., 2024; Leckning et al., 2023; Roper et al., 2023b; Silburn et al., 2018; Su et al., 2019).

To measure human capital, we use teacher-assessed data on the child's development collected in the Australian Early Development Census (AEDC), which is part of the data linkage. The AEDC is a national developmental census of all Australian children in their first year of full-time schooling. The first national collection was in May 2009, which then was repeated in 2012, 2015, and 2018.

The AEDC collects a range of demographic and contextual data on each child as well as developmental assessment items. The AEDC is not intended as an individual assessment or diagnosis tool although the data are collected at the individual level. Children are assessed in the context of their demographic, cultural, language and school environment on five developmental domains that are designed to measure aspects of their readiness for schooling.

- Domain 1: Physical health & wellbeing: illness or injury, dressed inappropriately, too tired or sick, hungry, well-coordinated, overall physical appearance, daily hygiene, etc.
- Domain 2: Social competence: plays with various children, cooperative, gets along with peers, respect for adults, accepts responsibility
- Domain 3: Emotional maturity: bullies, takes things, restless, temper tantrums, worried, cries a lot.
- Domain 4: Language & cognitive skills (school-based): numeracy, literacy, music, reads simple words, reads sentences, writing voluntarily, interested in math, interested in number games
- Domain 5: Communication skills & general knowledge: knowledge about the world, curiosity, and ability to follow simple instructions.

The first domain is a proxy for health capital, although it also includes a notion of whether the child is neglected, e.g. not being fed well. The second and third domains refer to the concept of socio-emotional skills, while the last two domains capture standard cognitive skills, although not task-based but teacher-assessed.

The AEDC can inform policymakers on the types of early childhood circumstances and programs that delay or enhance a child's readiness for school. The data can help identify the cohorts of children most at risk of developmental delay and poor school outcomes, informing the allocation of resources, funding and interventions. The Australian Government uses these data to identify schools and areas where children are most developmentally vulnerable, i.e. the proportion of children who score below the 10th percentile cut-off score on a specific domain.

Children scoring between the 10th and 25th percentile cut-off score are assessed as ‘developmentally at risk’ while all other children are ‘developmentally on track’.

In this study, we use different measures that were derived from the AEDC domain scores. (1) Two separate indicator variables that flag children who are neither developmentally vulnerable on any of the five domains (score rank > 10th percentile of the national distribution) and who are developmentally on track on all five domains (score rank > 25th percentile of the national distribution); (2) Score for each domain (score between 0 and 10); and (3) a summary indicator of multiple strengths which combines information from all five domains of child development providing an important summary of children’s strengths (score between 0 and 100).¹⁴ All score measures were standardized to a mean of zero and a standard deviation of one.

There are many advantages of the AEDC instrument to proxy for human capital. First, it is a census of all children and collected when children enter school. Thus, there is no selection into the measurement or ability to avoid the assessment. It is collected at the national level. Second, the AEDC is a meaningful predictor of children’s outcomes at later stages of their development¹⁵. The accuracy of the data collection depends on the teachers completing the assessment (Brinkman et al., 2007), which emphasizes the importance of the teacher or the school within which the assessment was made (Brinkman et al., 2014, 2007).

3.2.2. Perinatal records and data linkage with AEDC

The Perinatal Files (owned by the NT Department of Health) include the population of 83,080 newborns between 1996, when SCN admission was reliably recorded, and 2017 (Figure A 1 Sample selection process).¹⁶ Each year, there are between a minimum of 3,456 (1996) and a maximum of 4,038 (2012) births in the NT. Fewer than 1% of babies were stillborn (N=748). For 1.5% of babies, it is not known whether they were admitted to a SCN (N=1,231).

¹⁴ A group of early childhood experts reviewed the 96 items in the AEDC to determine which items provided an indication of whether a child showed advanced skills, or ‘better than expected development’, for his or her age. A total of 39 questions were identified and the MSI was calculated using these items. <https://www.aedc.gov.au/resources/detail/understanding-the-multiple-strength-indicator>

¹⁵ The AEDC outcomes predict accurately both cognitive and behavioural outcomes measured later in a child’s life. For instance, Brinkman et al. (2013) found that all five of the AEDC domains predict literacy and numeracy outcomes for children as measured by the National Assessment Program Literacy and Numeracy (NAPLAN) in years three, five and seven. Brinkman (2012) also showed that the AEDC performs as well as or better than established instruments such as the SDQ, PEDS, PedsQLTM and PPVT-III.

¹⁶ Perinatal record files include births from 1986-2017 (N=116,555) but we include only babies born from 1996 onward as SCN admission was only recorded since 1996.

Restricting this sample to all babies born in the three hospitals that offer SCN services (referred to as Hospital A, B, and C), reduces the sample to 68,860 newborns (82.9% of all babies born in the NT).¹⁷

The AEDC records include the population of 17,673 children who were assessed by teachers at the average age of five. These data include the records of four censuses collected in 2009 (N=4,806), 2012 (N=4,444), 2015 (N=4,671), and 2018 (N=3,752). From these data, 25 observations were dropped due to duplicates, 643 individuals (3.6%) were dropped because they had missing scores on all five domains. Of 17,005 children with at least one valid AEDC domain assessment, 10,364 children (60.9%) could be linked to their perinatal records.¹⁸ The reason why we could not link records of all children is that many children in Northern Territory schools were not born there, and therefore we cannot see their perinatal records. For instance, in 2009, 4,806 children were assessed in the Territory for their AEDC, but only 3,474 (72.3%) babies were born in 2004, the most likely birth year for the 2009 assessment.

The children in this matched sample are more likely to be Aboriginal (44.7% vs 38.4%, $p < .001$). They are otherwise similar in their birth outcomes. Importantly, they have similar risks of being admitted to a SCN ($p = .183$) and length of hospital stay after birth (5.1 days vs. 5.0 days, $p = 0.524$) (Table A 1, Appendix). Consistent with this observation is that children born in the Territory and with available AEDC records were more likely to be located in an area of high levels of socioeconomic disadvantage (33.4% vs 21.9%, $p < .001$) or remoteness (26.3% vs 13.8%, $p < .001$), and they were more likely to speak English as a second language (38.0% vs 23.7%, $p < .001$) (Table A 2, Appendix).

Of these 10,364 children, 8,502 were born in the three hospitals with a SCN between 2002 and 2013, including one child born in 2014. Restricting this sample to children with complete assessments of every domain on the AEDC leaves us with a sample of 7,958 children. Restricting the sample further to children with birthweights ranging between 1,500g and 3,500g, our main estimation sample, we are left with 5,004 children. Of these 73 children were

¹⁷ There were 529 newborns admitted to a SCN who were born in Tennant Creek Hospital (N=37), Gove District Hospital (N=184), Katherine Hospital (N=266), and hospital not applicable (N=42). These were dropped from the analysis as it is not clear why, when, how these babies were transferred from these remote hospitals to either Darwin-based or Alice Springs based hospitals.

¹⁸ Data linkage is based on the child's First Name and Surname, Sex, Country of Birth, Date of Birth, School name, and the Unique Record Number. Previous reports demonstrated that the pattern of linkage and the shifts in the demographics of the linked data demonstrate the expected pattern, but some effects are greater than anticipated. Aboriginal children have a higher rate of linkage (particularly to the perinatal data where their proportion increases from 47 to 59%). This reflects the greater interstate mobility of non-indigenous children as well as their higher representation in the NT non-government school sector.

dropped because they had missing values on key characteristics. We are left with a final estimation sample of 4,931 children. Of these, 23.6% were admitted to a SCN after birth.

3.2.3. Data records suitable to explore mechanisms

An important mechanism through which early-life medical interventions may affect young children's school-relevant human capital, is through better health. This was implied in the findings of Yu et al (2025) in the New South Wales context. Special care nursery admission improved infants' health in the first two years of life, at least in those hospitals with the most intervention intensive nurseries.

We will study several outcomes in the health channel. We ask whether SCN admission reduces the likelihood of premature death (e.g. at perinatal separation or within the first year of life), the likelihood of hospital re-admission within the first month of life or first year of life, and the likelihoods of admissions for specific diseases (by diagnosis using ICD-10 codes for primary diagnosis as in Doyle et al (2025), following Miller et al. 2016). Data will be derived from three administrative sources on birth cohorts 2002-2013, as for the AEDC analyses.

- Perinatal separation records (marked dead at discharge)
- Death registry (death by age 1, dead by age 5)
- Hospitalisation records which include both emergency and inpatient records

To identify diagnoses, in particular infections, respiratory illness, and accidents (among others), we use codes from the International Statistical Classification of Disease and Related Health Problems (ICD-10) codes, encompassing diagnoses from multiple ICD chapters. Infections are a broad category of diagnoses. We follow Doyle et al. (2025) (who build on Miller et al. (2016)), who define six sub-categories of infection: bacterial, viral, upper respiratory, lower respiratory, soft tissue and gastrointestinal.¹⁹ We amend the definitions slightly, to include additional infection-related diagnoses which were present in our data, but not in Miller et al.'s list (see Appendix G in Doyle et al. for full list of codes). In separate analyses we only study

¹⁹ Otitis media and other ear infections are included in upper respiratory infections, and skin infections are included in soft tissue infections. Miller et al's definition also includes genitourinary infections, however we exclude these from our analysis as the number of admissions for genitourinary infection among children aged 0-7 in our population is negligible.

respiratory disease, where otitis media and other ear infections are included in upper respiratory infections. For these auxiliary analyses we rely on a sample of 22,601 observations.

4. Results

4.1. Summary statistics on selected sample

Table 1 presents descriptive statistics on perinatal information for the estimation sample, separately for babies who were admitted to a SCN and babies who were not. Babies admitted to a SCN were less likely to be female (47.6% vs 55.8%, $p < .001$), more likely to be Aboriginal (54.2% vs 40.6%, $p < .001$), and have, as expected, worse birth outcomes in terms of birthweight (2,625g vs 3,095g, $p < .001$), gestation age (36.6 weeks vs 38.9 weeks, $p < .001$), the 5-minute APGAR score, birth complications (56.9% vs 38.4%, $p < .001$), and whether the mother has a medical condition (57.3% vs 47.0%, $p < .001$). Consequently, they have longer hospital stays postnatally (11.7 days vs. 3.1 days, $p < .001$). They do not differ however in their birth order ($p = .087$), number of siblings ($p = .235$), birth month ($p = .818$), mother's age ($p = .716$), and the number of previous live births that the mother had ($p = .084$). These statistics suggest that babies admitted to a SCN are systematically unhealthier and require more medical attention at birth than babies not admitted to a SCN. It is thus not surprising that these babies have worse AEDC outcomes across all domains (Table 1).

4.2. Validity of the empirical approach

Figure 2, which maps the relationship between birthweight and the probability of admission to a SCN (for the full (a) and estimation (b) sample), reveals two important insights. First, there is a negative relationship between birthweight and the risk of admission to the SCN. The lower birthweight, the greater the risk of admission. For instance, a baby born with 3,500g has a 13.1% chance of admission, while a baby born just above the 2,500g threshold, let's say at 2,600g has a 28.9% chance of admission. Second, the relationship between birthweight and admission to SCN changes around birthweights of 2,300g and 2,500g. Newborns lighter than the LBW threshold are increasingly likely to be admitted to a SCN. This increase in probability of admission is likely not only due to birthweight variations, but to other health factors that are associated with prematurity or proxied by low APGAR scores. Children born within the 2,300g and 2,500g window have a strongly increasing probability of being admitted to a SCN, ranging

between 50% and 90% in both full and estimation samples. Below 2,300g, all children in our sample are admitted to a SCN (Figure 2, (b)), regardless of their gestation age (Figure 3).²⁰

Thus, the defining characteristic of this ‘first-stage’ relationship is that the fitted probability of treatment increases sharply over the marginal area. Figure 3 also shows that gestation age is an important predictor of admission to the SCN regardless of birthweight, stressing the importance of controlling for gestational age (non-linearly) or testing for the robustness of results when dropping babies born below 35 weeks of gestation.

Auxiliary regression results demonstrate that the first stage is strong, both in the full available sample and specifically in the estimation sample, with F-test statistics of 1,641.3 in the full sample without additional controls, of 516.8 in the full sample with a full set of baby and mother perinatal controls, and of 118.5 in the estimation sample with a full set of control variables (see Table A 3, columns (1), (3) and (4)). We will later show that the ‘first stage’ is still strong and robust in a model of human capital development measured when children start full-time schooling.

Another important assumption is that there is no evidence of heaping/bunching around the birthweight thresholds. We find no evidence of non-random heaping around either of the two birthweight thresholds. Figure 4 (a) depicts the full distribution of birthweight (in 20g bins) for all newborns recorded in the perinatal files. If there was systematic manipulation by doctors, we would see a spike in observations just below the 2,500g and 2,300g thresholds, which is not the case. This conclusion does not change when presenting the histogram by 5g bins and a shorter birthweight range of 2,100g and 2,700g (Figure 4 (b)) or when taking a closer look at each of the key thresholds at 2,300g and 2,500g in Figure 5. We see clearly that there is rounding in recording birthweights, with spikes at 0g distance for both the 2,300g and 2,500g thresholds (which do not trigger SCN admission), and birthweights within 25g intervals away from the thresholds. However, there is no density mass to the left of the thresholds providing visual support for the no-manipulation assumption.

Formal testing for heaping around the thresholds supports this conclusion. A McCrary density test for equal distributions around the 2,300g and 2,500g threshold, which means there

²⁰ It should be noted that in the full available sample, which includes babies born between 1996 and 2017, the probability of assignment to a SCN ranges between 97% (birthweight categories 2,200g, 2,100g, 1800g and 1,600g) and 95% (birthweight categories 2,000g, 1,900g), so there is a group of babies that are not admitted to SCN even if they should have been. They belong to the group of defiers, which could bias the estimation results if there is treatment effect heterogeneity. However, in our estimation sample of babies born between 2002 and 2013, the probability of admission below the 2,300g threshold 100% for each birthweight category with two exceptions: for 1,900g it is 95.5% and for 2,200g it is 98.8%. Thus, the risk of estimation biases due to the presence of defiers is very small.

is no heaping below or above the threshold, is not rejected for both thresholds. The relevant p -values for the two tests are for the 2,300g threshold: $p = 0.431$ and for the 2,500g threshold: $p = 0.349$. Similar p -values are obtained for allowing a different birthweight range (Table A 4, Appendix).

Another concern is that clinicians might use other observable characteristics to assign newborns to a SCN if they are close to the nominated birthweight thresholds, or that there are other reasons that may cause assignment to the SCN (parental manipulation). To test for this possibility, we follow the literature and present tests for threshold effects in baseline baby and mother characteristics (see Table A 5, Appendix). For this purpose, we estimated Eq. (3) where the outcome is one of 11 baseline characteristics, controlling for the same factors as in Eq. (3) (excluding the outcome of interest). Statistical inference on the estimated coefficient on SCN rules out this possibility entirely. Out of 11 baseline characteristics, there are no statistically and economically significant discontinuities at the birthweight thresholds.

4.3. Estimation results

Table 2 presents the estimated relationship between SCN admission and human capital development. The first three columns present OLS estimates of τ as described in Eq. (1), with school fixed effects and AEDC assessment-related controls ((1)), adding baby perinatal control ((2)), and mother perinatal controls ((3)). The fourth and fifth column presents the 2SLS estimates of ρ as described in Eq. (3), without and with mother perinatal controls. Standard errors are clustered by the school where the AEDC assessment occurred. Full estimation results are presented in Table A 6 (Appendix).

As expected, not controlling for the baby-health related selection into SCN admission, yields a negative estimate of τ , which is statistically significant ($p < .05$) (Panel A, Column (1)). SCN admission is significantly associated with a reduction in the probability of being ‘not developmentally vulnerable on any domain’ and being ‘developmentally on track on all five domains’ by 4.3 (SE 1.7, $p < 0.050$) and 8.1 (SE 1.6, $p < 0.010$) percentage points (ppt), respectively. It is also associated with a significant reduction in scores in every AEDC domain, with reductions of between 0.11 SD for ‘communication skills & general knowledge’ (SE 0.029, $p < .010$) and 0.166 SD for ‘emotional maturity’ (SE 0.036, $p < .010$) (Panel B, column (1)). SCN admission is also associated with a significant reduction in the ‘multiple strengths index’ (-0.147 SD, SE 0.032, $p < .010$).

Once controlling for baby's health as recorded in the perinatal files, all estimated associations are closer to zero in magnitude and no longer statistically significant. The only exception is emotional maturity. The estimated coefficient remains statistically significant and of the same magnitude across all models, even when controlling for mother's characteristics (column (3)).

These estimates demonstrate the health-related endogeneity in SCN admission. Babies with poorer health at birth are more likely to be admitted to the SCN and are also less likely to be assessed as developmentally on track on all five domains when starting full-time schooling.²¹ This leads to a downward bias in estimating the potential benefits of early life medical care that is being provided in SCN.

Once controlling for the negative selection in SCN admission yields a different result (Table 2, columns (4) and (5)). 2SLS estimates show a positive causal impact of SCN admission on human capital development. Babies admitted to SCN (who were at the margin of admission with birthweights around 2,300-2,500g) are 19.1 ppt (SE 8.3, $p < .05$) more likely to be not vulnerable on any domain, and 16.8 ppt (SE 7.6, $p < .05$) more likely to be 'developmentally on track on all five domains', than babies not admitted. The base probability of these outcomes in the control group (see Table 1) is 61.1% and 40.3%, respectively. This means that relative to the base probability of 61.1%, SCN admission increases the probability of 'not being developmentally vulnerable' by 31.3%, or almost one in three additional children (41.7%, or two in five for being developmentally on track).

The estimated treatment effects are positive and large in magnitude for each domain, but they are only statistically significant for 'physical health & wellbeing'. SCN admission increases this outcome by 0.357 SD (SE 0.176, $p < .05$), a sizeable increase. The estimate is 0.315 SD (SE 0.164, $p < .10$) for 'social competence', and 0.288 SD (SE 0.163, $p < .10$) for 'emotional maturity', which is not statistically significant, but also large in magnitude. The estimate on the 'multiple strength index' is 0.248 SD (SE 0.164), but it is not statistically significant at any conventional level. The estimates are insensitive to including or excluding an extended set of control variables (compare column (4) and (5)).

How can we reconcile the stark differences in estimation results between the OLS model and the 2SLS model which accounts for negative selection into SCN? Figure 6 depicts the relationship between birthweight and AEDC outcomes which are not explained by baby

²¹ In the estimation sample of N=4,931 babies born, the F-test statistics in both models is 67.7 and 68.9. Without school fixed effects and AEDC related controls, the F-test statistic is 118 (see Table A 3, Appendix).

health.²² The dashed, downward sloping line demonstrates the counterfactual path of what would have happened to the child's human capital development if the baby with birthweight lower than 2,300g had not been admitted to a SCN. The solid line above for birthweight ranges below 2,300g depicts the 'treatment effect scenario' for babies admitted to SCN. Even though there is still a negative relationship between birthweight and human capital development for babies with birthweights below 2,300g, SCN admission lifts their potential outcomes discontinuously (relative to babies with birthweights at 2,500g or above). Thus, SCN admission offsets a downward trend in human capital development that is caused by poor health at birth.

Figure 6 highlights that the method identifies the treatment effect only for babies born in the vicinity of the 2,500g and 2,300g birthweight thresholds. This local average treatment effect (LATE) is representative for babies that are relatively healthy but who potentially need some extra medical attention. The treatment effect is not representative for very unhealthy babies, e.g. babies born around the very low birthweight threshold.

4.4 Robustness checks

We conducted various robustness checks to our preferred 2SLS specification reported in column (5) of Table 2. Robustness checks include (1) narrowing of birth-weight-range restrictions, (2) an alternative specification of the non-linear effects of birthweight, and (3) changes in the estimation sample restrictions.

4.4.1. Narrowing birth-weight-range restrictions

Our main specification included all babies born within a birthweight range of 1,500g and 3,500g. We thus excluded potentially sicker babies indicated by very low birthweight (1,000g) or excessively high birthweight (4,000g). Figure 7 shows the treatment effect obtained for eleven different birthweight-range-specifications, here for illustration purposes for the two of the three statistically significant outcomes 'not being developmentally vulnerable on any domain' ((a)) and the domain score of 'physical health & wellbeing' ((b)).²³ Albeit 95%

²² Outcomes are standardized to mean zero and standard deviation one. Each of the circles in these figures represent the average residuals from a regression of the AEDC outcome on baby perinatal controls within 100g birthweight bins.

²³ Robustness checks for all other outcomes are presented in Figure A 3 in the Appendix.

confidence intervals are somewhat sensitive to the sample size reductions that result from restricting the sample to babies born within a narrower birthweight range (e.g. 2,000g-3,000g), the estimated coefficients remain of similar size.

4.4.2. Alternative specification of the non-linear effects of birthweight

The results are robust to an alternative specification of the non-linear effect of birthweight. Table 3, column (2) reports the treatment effect when the non-linearity is specified as a quadratic polynomial (instead of the natural logarithms, column (1)). The conclusions remain the same. The estimated treatment effect of SCN admission on both indicator variables slightly drops (with slightly larger standard errors) but increases in absolute value for ‘physical health & wellbeing’ and ‘social competence’. The F-test statistics for the strength of the instruments remain high (68.9 to 62.8).

4.4.3. Estimation sample restrictions

The estimates are also robust to excluding healthier children (e.g. children admitted to SCN for other health conditions than low birthweight) or much healthier children (e.g. those born in the private hospital) that might be driving the treatment effect. Although we control for the possibility by including controls for baby health status, one concern is that babies admitted to the SCN with birthweights ranging between 2,300g and less than 2,500g because they are of very low gestation age, or they may have other significant health issues such as breathing problems. Table 3, column (3) and column (4) report 2SLS estimates when dropping premature babies and babies who are either premature or have APGAR scores at five minutes below nine (which indicates potentially breathing and other issues). If anything, the estimation results are larger in magnitude and estimated with greater efficiency. Dropping these babies reveals also potential benefits of SCN admission in terms of human capital gains in the ‘communication skills & general knowledge’ domain (e.g. column (4), 2SLS estimate is 0.272 SD, $p < .10$) and therefore also on the ‘multiple strength index’ (e.g. column (4), 2SLS estimate is 0.292 SD, $p < .10$). The F-test statistics grow stronger in these two specifications (75.03 and 76.73, respectively).

Another concern is that babies born in private hospitals might be different from babies born in public hospitals. Excluding these babies increases the magnitude of the 2SLS estimates and their 95% confidence intervals are narrower, with five outcomes showing statistically

significant effects ($p < .05$), including significant treatment effects also for the scores of ‘social competence’ by 0.410 SD ($p < .05$) and the ‘multiple strengths index’ by 0.343 SD ($p < .050$). The F-test statistics is 66.7 in this model.

We also explore the possibility of only using the lower-bound threshold (2,300g) or the upper-bound threshold (2,500g) as instrumental variable (and its interaction with log birth weight). For these analyses we need to restrict the samples to 1,500g-2,499g and 2,300g-3,000g, respectively. Both thresholds and sample restrictions yield satisfactory F-test statistics of 17.0 (lower-bound) and 77.5 (upper bound), and both models yield estimates in line with our benchmark model estimate (see Table A 7). However, because of the smaller sample sizes and a very narrow window of observations just above the lower threshold or just below the lower threshold, confidence intervals are wider and thus yield greater uncertainty for these estimates.

5. Mechanisms

5.1. Heterogeneity in the treatment effect to identify potential mechanisms

We have shown so far that SCN admission causally improves human capital development for the borderline child (born around the 2,300g and 2,500g birthweight threshold), and that it is particularly happening by reducing the risk of developmental vulnerability and boosting the chance of being developmentally on track. In this section, we explore the possible heterogeneity in the treatment effect of SCN admission. This exploration allows us to speculate about the potential mechanisms through which SCN admission might improve human capital. Three different group comparisons are considered: (1) Male vs female newborns; (2) Babies born into families located in (very) remote²⁴ areas vs outer-regional areas (Greater Darwin); and (3) Babies born to first-time mothers vs mothers with previous births. The estimation results are reported in Table 4.²⁵

²⁴ Remoteness was constructed from information on post codes and remoteness taken from the Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure, July 2016. Postcodes of mothers’ address are provided in the Perinatal Files. Outer regional includes all postcodes in the greater Darwin area including Palmerston: 800 810 812 0815 820 828 829 830 832 834 835 836 837 838 839 841 909 4868 5263 5710 6430; Remote: 840 845 846 847 850 853 870 873 874 875 886 4825 6721; Very remote: 822 852 854 860 862 872 880 885 4828 5723 6728 6740 6743 6765. Babies located in remote or very remote post codes are flagged when their mothers’ address list the following post codes: 840 845 846 847 850 853 870 873 874 875 886 4825 6721 822 852 854 860 862 872 880 885 4828 5723 6728 6740 6743 6765. There are about 20 babies whose post code at birth is located outside the Northern Territory.

²⁵ We explored heterogeneity by Aboriginal status of the mother, and by Hospital location. There are no notable differences in the treatment effect between Aboriginal and non-Aboriginal mothers. The results by hospital location mirror those obtained for remote versus non-remote location (see Table A 7, Appendix).

The heterogeneity analysis demonstrates that the 2SLS estimates of SCN admission are largest for male newborns, both in magnitude and statistical terms (Table 4, columns (2) vs (3)).²⁶ The treatment effect on the chance of ‘not being vulnerable on any domain’ is 31.7 ppt for boys (SE 14.6, $p < .05$) but only 7.8 ppt for girls (SE 9.4, not statistically significant). The treatment effect on the ‘physical health & wellbeing’ domain is three times larger for boys (0.617 SD, SE 0.300, $p < .05$) than for girls (0.195 SD, SE 0.202, not statistically significant). The estimated treatment effects on ‘social competence’ and ‘emotional maturity’ are four times greater for boys than for girls (although the estimates are inefficiently estimated with wide 95% confidence intervals which include zero for both boys and girls).

Furthermore, our results are tentative in suggesting that the treatment effect might be stronger for babies born into families where the mother listed an address post code at birth that locates her in a remote (which would include Alice Springs but also the wider area around Darwin and Katherine) or very remote region (Table 4, columns (4) vs (5)). The results are consistent with the hypothesis that most mothers who live outside the regions where birthing services are being offered in a hospital (very remote regions), or who live in a remote area that offers neonatal services but are at higher risk of birth complications, are required to travel to and give birth at the only available teaching hospital.²⁷

Furthermore, we find evidence of significant heterogeneity in the treatment effect by mother’s parity status. The treatment effects are statistically significant ($p < 0.05$) on five outcomes for babies born into families with multiple children. The estimates are around two times larger in magnitude for families with multiple children than for first-time mothers. For instance, the impact of SCN admission on the chance of ‘not being developmentally vulnerable on any domain’ is 25.5 ppt (SE 12.1, $p < .05$) for babies born to mothers with multiple children, but only 13.8 (SE 10.6, not statistically significant) for babies born to first-time mothers.²⁸

²⁶ The F-test statistics on a test of the strength of the four instruments for the regression models for boys and girls are 25.3 and 46.8, respectively.

²⁷ In interview with Professor Sue Kildea, it was stated that there are only four hospitals in the Northern Territory where women can give birth: Darwin, Alice Springs, Katherine, and Nhulunbuy. Women who live outside of these four areas need to travel to the nearest hospital at 38 weeks to wait for their baby to be born (although those with higher-risk pregnancies are sent to Darwin, which is equipped to manage complications). ABC News article by Lauren Roberts, “Women living in remote locations across Australia must travel for birth. Experts say it shouldn’t be the case”, 2 June 2021. We explored the heterogeneity by hospital location (see Table A 7, Appendix), but for privacy reasons we are not allowed to report these results (suppressed). What we can say, however is that significant treatment effects are obtained for the public hospitals and not for the private hospital.

²⁸ The differences for the other four significant effects are as follows: ‘physical Health & wellbeing’ 0.532 SD vs 0.299 SD; ‘social competence’ 0.483 SD vs 0.321 SD; ‘emotional maturity’ 0.475 SD vs 0.231 SD; and ‘communication skills & general knowledge’ 0.547 SD vs -0.140 SD.

5.2. Using auxiliary data on death, hospital admissions, and diagnoses to understand the health channel

We used information from perinatal files (death at discharge from hospital after birth), death registry (age at death to construct indicators for having died before age 1 and before age 5), and hospital admission data (both inpatient and emergency, using also ICD-10 codes for primary diagnosis at discharge, similar as in Doyle et al. 2025). Summary statistics of the outcomes for babies admitted and not admitted to a SCN are reported in Table 5, demonstrating significant differences for most of these outcomes in the raw data.²⁹ For these health outcomes, we estimated the same models as in our benchmark human capital specification (OLS and 2SLS) without and with control variables (Table 6). Standard errors were clustered at the child's post code (135 separate units).

The 2SLS estimation results show that SCN admission significantly reduces the risk of death before the infant's first birthday by 1.1 ppt (SE 0.400, $p < 0.01$, Panel A) and the risk of being (re-) admitted to hospital within one month after birth by 2.7 ppt (SE 0.600, $p < 0.01$). There is no significant impact of SCN admission on the risk of admission in the first or second year of life, but these estimates are positive with a magnitude of 2.8 and 2.6 ppt (albeit estimated with a large standard error, see Panel B, column (5)).

Hospital admissions are likely driven by follow up problems that were identified during the perinatal period, and not because of a greater risk of specific diseases. For instance, the most common early childhood health issues for which babies are admitted to hospital—the risk of admission for infectious disease is almost 20% and the risk of admission for respiratory issues is almost 10%. This admission risk for infectious disease is reduced through SCN admission by 16.2 ppt (SE 0.031, $p < 0.01$) and the admission risk for respiratory issue is reduced by 19.2 ppt (SE 0.024, $p < 0.01$). Other important childhood conditions such as Ear, Nose, and Throat

²⁹ Babies admitted to a SCN are, as expected, more likely to have died before the age of five ($p = 0.010$) than babies not admitted to a SCN, they are younger at first admission to hospital (exclusive birth admission) ($p < 0.001$), and they have greater risk of admission to hospital at any point after (but excluding) birth and the first month of life ($p < 0.001$). Babies admitted to SCN have lower risks of hospital admissions due to infectious diseases (1.4% versus 8.3%, $p < 0.001$), gastro issues (0.9 versus 5.8%, $p < 0.001$), and respiratory issues (including lower and upper respiratory issues) (2.5 versus 12.0%, $p < 0.001$) and Ear, nose and throat issues (including otitis media) (0.2% versus 0.7%, $p < 0.001$). They are also less likely to be admitted for accidents (0.9% versus 3.7%, $p < 0.001$) (Table 5, comparisons of columns (1) and (2)). In this unadjusted comparison of means, babies admitted to SCN are no different in their risk of admissions for surgery (2.9% versus 2.4%, $p = 0.056$) but they are at greater risk for hospital admissions with a primary diagnosis code that indicates contact with the health care services (observation, check-up, screening, awaiting admission to adequate facility).

(ENT, incl. otitis media), accidents and other factors that involve observation, monitoring and parental factors such as suspicion of neglect, are also significantly reduced (Panel C, Table 6).

SCN admission however increases the risk of hospital admission for surgery (Panel C, Table 6), with a likelihood increase of 3.8 ppt (SE 1.8, $p < 0.05$). This suggests that babies admitted to SCN are more likely to receive health-improving, potentially elective medical attention, which might lead to better health and human capital by the time the child enters full-time schooling.

In a robustness check, we demonstrate that our findings are not driven by a selective choice of birthweight bandwidth (Figure A 5). We also conducted placebo tests and other sanity checks to demonstrate that hospital admission outcomes are not picking up random or any variations in health. For instance, some health conditions for which the child will be admitted into hospital cannot be affected by medical attention at birth (e.g. congenital condition), while other hospital admissions are mechanistically related to medical attention at birth (e.g. admissions related to perinatal issues). We indeed find an insignificant, precise zero estimate of SCN admission on hospital admissions for congenital disease (estimate 0.2 ppt, SE 0.8). This suggests that the model does not randomly pick up SCN effects where none can be expected. Furthermore, the model picks up very strong SCN effects for health outcomes that were flagged as emerging from the perinatal period. The estimate for the impact of SCN on hospital admissions for perinatal issues is almost 100 ppt (97.6 ppt, SE 2.2, $p < 0.01$) (Panel D, Table 6).

6. Discussion

We found statistically significant and robust human capital benefits of Level II neonatal care, care that is provided in a special care nursery, an early-life health intervention post birth. Differences in detectable benefits were observed by gender, family size, and by the remoteness of the family's location at birth. The benefits of SCN admission for moderate-risk infants are significantly greater for baby boys and babies who are second- or higher-order born, and babies from remote and very remote locations.

The magnitude of the gains of human capital for boys, babies born into larger families, and in remote locations are not quite as large, but roughly comparable to the estimated treatment effects on cognitive skills of highly disadvantaged children from the most famous parenting and pre-school interventions such as the Abecedarian (0.8 SD) and Perry Preschool Projects (1.0 SD) (for a review, Duncan and Magnuson (2013)). They are larger in magnitude

than the human capital effects found in Bharadwaj et al. (2013) and Daysal et al. (2022) (~ 0.20 SD). This is perhaps not surprising as both studies focused on human capital outcomes in adolescence (Year 10 and Year 9, respectively), whereas we study them in early childhood, at the age when children enter school.

Our findings suggest that the treatment provided in SCN, both to the infant and the mother, is helping to offset the greater health vulnerability of these groups at birth. Yu et al. (2025) established that babies admitted to SCN units that take a more intensive approach to treating babies are observed to have better health within the first two years of life. Arguably, their setting is different from the Northern Territory context where a greater share of families lives in remote or very remote areas, but New South Wales also has a large share of hospital services located in outer regional (like Darwin) and remote locations (like Alice Springs). Our mechanism analyses suggest that some part of the gains in human capital operates through improved health outcomes, and better access to advanced care when needed (e.g. surgery) between leaving the hospital at birth and entering full-time schooling.

Our findings that the treatment effect is stronger for baby boys is in line with the ‘fragile-male’ hypothesis (Kraemer, 2000). The vulnerability of the male fetus in utero and poorer outcomes at birth has been shown over decades (Boklage, 2005; Di Renzo et al., 2007; Eriksson et al., 2010; Ingemarsson, 2003; McCarthy, 2019). Boys grow faster than girls from an early stage of gestation. This makes them more vulnerable if their nutrition is compromised (Pedersen, 1980; Tanner, 1989). More newborn boys than girls experience intrauterine growth restriction and have co-occurring placental abnormalities. More of them die during the perinatal period (Di Renzo et al., 2007; Ingemarsson, 2003).

The vulnerability of babies born into larger family sizes (higher parity) is also not surprising. Wagner et al. (1985) summarised that ‘perinatal morbidity and mortality rates are higher in large families as birthweights decrease’ and that ‘mothers of large families are at higher risk of several physical diseases.’ Björkegren and Svaleryd (2023) show that although first-borns tend to have worse health at birth, second and higher born children have significantly worse health at ages 0 to 2, with greater likelihood to be hospitalised for infections, diseases of the respiratory system, eyes and ears. Buckles and Kolka (2014) identify high parity as a predictor of reduced investment in infant health, including reduced likelihood to breastfeed, seek perinatal care, and take vitamins. They suggest ‘that providers may want to increase efforts to encourage these behaviours at women with higher parity’. Breining et al. (2020), who study the birth order effect for boys on their later life criminal behaviour, explain that the parity effects may come from differences in parental investments.

Thus, SCN might offset the potential negative health consequences for these more vulnerable groups. Two recent studies on the health benefits of unconditional cash transfers show similar results. Using linked administrative data from South Australia and a sharp RDD design, de Gendre et al. (2021) and Barr et al. (2022) also find that unconditional cash transfers at birth lead to stronger health benefits of baby boys, although only de Gendre et al. (2021) finds that cash transfers are also more beneficial for families with higher parity.

What is surprising is that we find no relevant heterogeneity in the treatment effect between Aboriginal and non-Aboriginal infants. It is surprising because neonatal health is significantly worse for Aboriginal infants (Gao et al., 2014a; Kildea et al., 2016). However, it is reassuring, as it might mean that the same mechanisms work regardless of Aboriginality status. What we do find, at least tentatively, is that the benefits of SCN admission are greater for babies born into families located in remote or very remote locations. These remote areas have reduced services and extremely high rates of poverty (Kildea et al., 2016). One could expect that doctors may choose to delay the discharge from the SCN for these newborns to conduct follow-up examinations which are too costly once the infant returns home. In contrast, babies born into families that are living in areas in closer proximity to hospital services, may have increased opportunity to receive follow-up care, and therefore the babies are discharged earlier. Thus, the initial investment after-birth for children living nearby may not be as large or as critical for their development.

7. Conclusions for policymakers

From a policy perspective, these findings imply that, although costly, early-life health interventions for moderate-risk infants have benefits beyond widely documented improved survival probabilities post birth, which we find in our data as well. We find a reduced risk of re-admissions in the first month of life for admissions not related to perinatal issues. In our case, admissions for the most common childhood diagnoses (infections, respiratory issues) and accidents are significantly reduced but the chance for admission for surgery is significantly increased. This suggests that some health care expenditures are avoided while health care expenditures seem to increase for advanced levels of care. In line with our findings, Yu et al. (2025) estimated for the NSW health care context that on average costs for hospital admissions for SCN admitted babies are significantly larger, but their study also finds a significantly reduced risk of emergency department admissions in Year 1.

An important consideration for policymakers is the question of whether medical treatment for at-risk newborns is cost effective, or whether resources should be diverted into prevention of low birthweights. In the past 15 years an academic and public discussion has emerged on the cost-effectiveness of newborn treatments in NICU and SCN. Although this discourse is mainly targeted at very low birthweight babies, e.g. ‘Should every baby be saved?’ (Lantos, 2022, 2021; Muraskas, 2008), neonatology is one of the top ten cost items of hospital expenditures. In Australia, one day in a SCN costs the public health insurance provider (Medicare) around A\$3,000 (2014 data, the maximum birth year in our sample). In our data, the marginal moderate-risk infant stays an additional 6.9 ($p < .01$) to 11.6 ($p < .01$) days in hospital post birth (relative to an average of three days for babies not admitted to the SCN). For baby boys the additional days is estimated to lie between 6.0 and 13.1 ($p < .01$) days, and for baby girls to lie between 8.3 ($p < .05$) and 10.6 ($p < .01$) days (Table A 9, Appendix). This means that the cost of the additional medical care provided to moderate risk infants in Level II neonatal care ranges between \$21,000 and \$34,800, or up to \$39,300 for baby boys.

Since improved school readiness is associated with higher levels of academic achievement, such investment may have important long-term benefits in terms of better developmental, schooling, and labour market prospects that should be considered in cost-benefit evaluations. One of the most celebrated parenting interventions, the Abecedarian program, cost \$70,000 (in 2002 US\$) per child and achieved similar gains in cognitive skills for very disadvantaged children. The Perry Preschool program, that led to similar gains in cognitive skills, cost \$18,000 per child (in 2002 US\$) (Duncan and Magnuson, 2013), a number that is comparable to the SCN expenditure in our data. The Infant Health and Development Program (IHDP), a randomized controlled trial that evaluated extra treatment for LBW newborns (Brooks-Gunn et al., 1995, 1992), cost approximately \$18,500 per child (in 2005 US \$) and was found to have an effect around 0.30 SD for certain disadvantaged subgroups (low-education mothers). SCN admission in Australia cost up to A\$39,300 (in 2014 Australian dollar), a figure that translates to a cost of \$28,071 in 2002 Australian dollar, or \$15,244 in 2002 US dollars.³⁰ This amounts to between 21.7% (relative to the Abecedarian program) and 84.7% (relative to the Perry Pre-school Program), with comparable magnitudes in terms of human capital development.

³⁰ Average exchange rate between Australian dollar and US dollar in 2002 was 0.54305, retrieved from this webpage on 23 September 2025: <https://www.ofx.com/en-au/forex-news/historical-exchange-rates/yearly-average-rates/>. Inflation between 2002 and 2014 was by a factor 1.38 in Australia, a number retrieved from the Reserve Bank of Australia Inflation calculator: <https://www.rba.gov.au/calculator/>.

Although our back-of-the envelope cost calculation is by no means comprehensive or representative of the full Australian moderate-risk newborn population, it emphasizes that early-life health interventions can have unanticipated positive externalities on human capital formation, at a cost that is lower or at least not exceeding the cost of successful parenting or pre-school interventions. Similar positive spill-over effects of a medical treatment on human capital formation were found by Miguel and Kremer (2004) in their evaluations of deworming programs in Kenya. These did not only significantly reduce the proportion of moderate to heavy infections by around 25 percentage points, which was its primary objective, they also increased primary school participation by over 7.5%, resulting in a gain of 0.14 years of education. Although the literature on the unintended positive consequences of early-life medical interventions is small to date, such studies can provide policymakers with a comprehensive picture of the likely benefits of otherwise very costly interventions.

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Exhibits

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Tables

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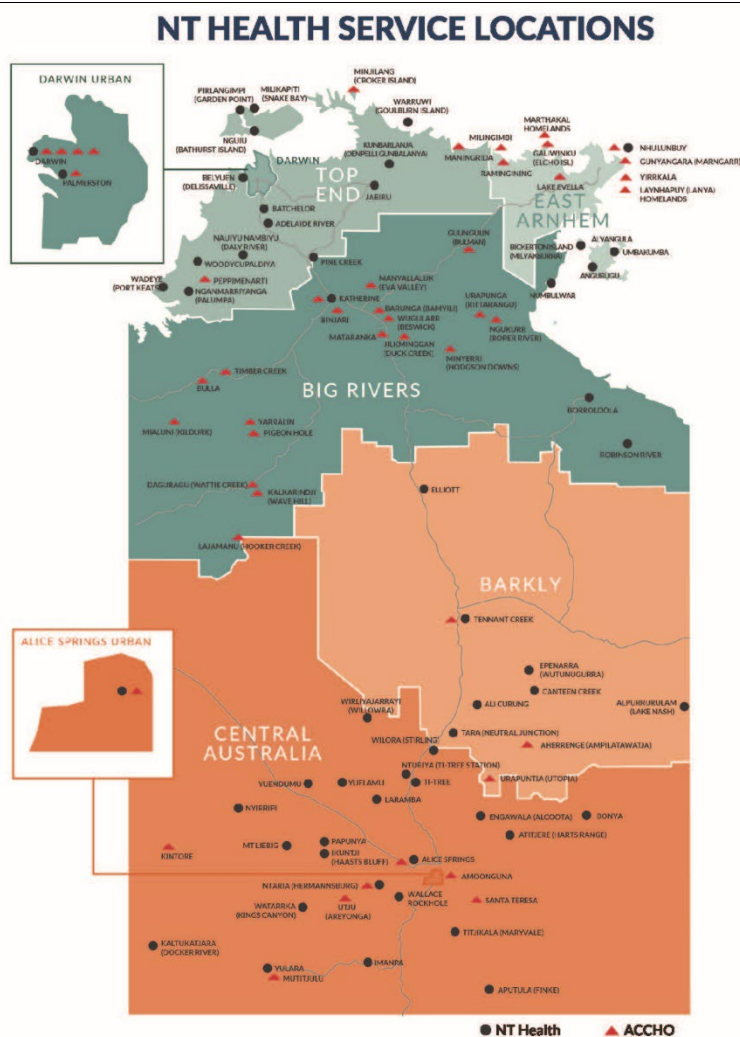
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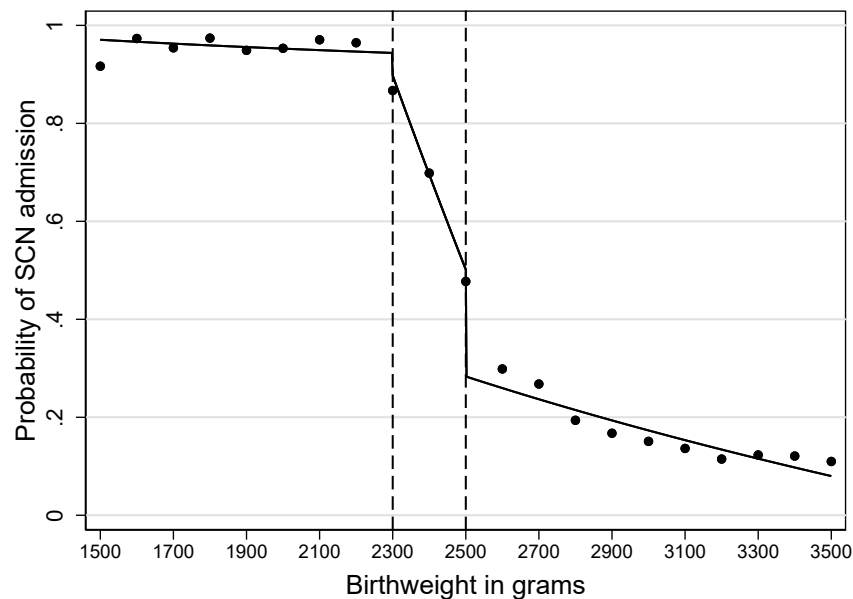
Table 6 Estimation results for risk of death, health care utilisation and disease (months 1-60)

Figure 1 Location of hospitals included in our study in the Northern Territory

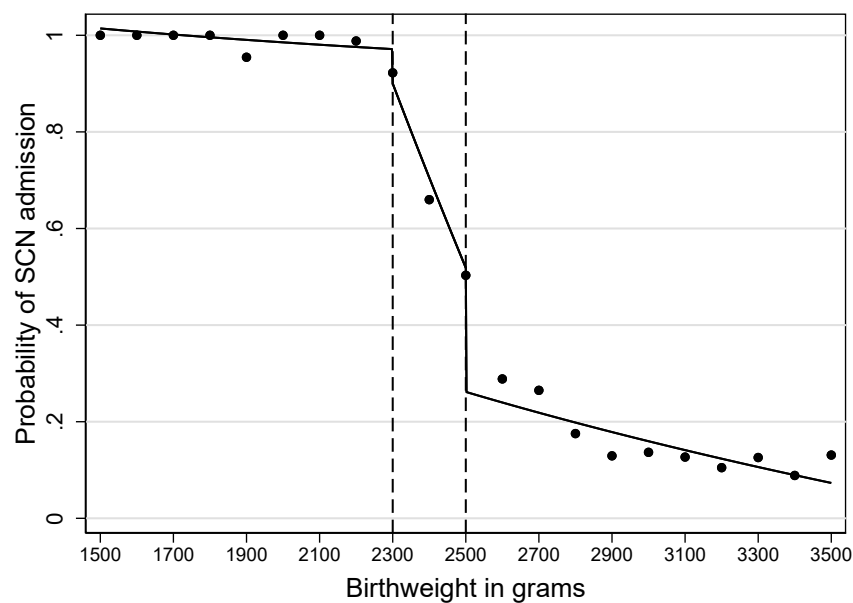


Note: Figure sourced from the NT Health Report Annual Health 2022-2023.

Figure 2 Relationship between special care nursery admission and birthweight



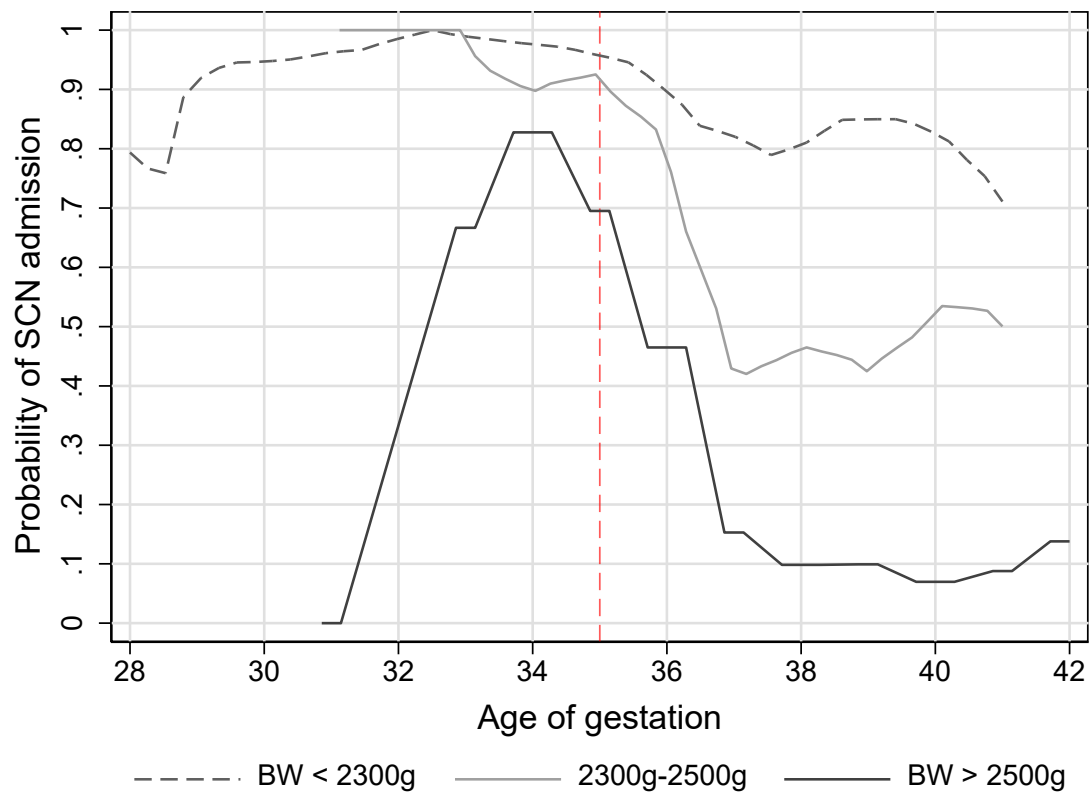
(a) Full available sample



(b) Estimations sample

Note: (a) First stage of all babies born in the Northern Territory between 1996 and 2017 within a birthweight range of 1,500g and 3,500g (N=41,975, average birthweight 2,981g, risk of SCN admission 24.3%). (b) Estimation sample with valid AEDC data (N=4,926, average birthweight 2,986g, risk of SCN admission 23.3%). Each data point represents the mean risk of being admitted to the SCN for a band of 100g birthweight intervals. Lines represent linearly fitted value. Vertical lines represent the clinical decision cutoff rules (2,300g, 2,500g). There are a small number of outlier observations of babies that were not admitted to SCN (or where mothers left against the advice of the doctor) even though its birthweight was below 2,300g.

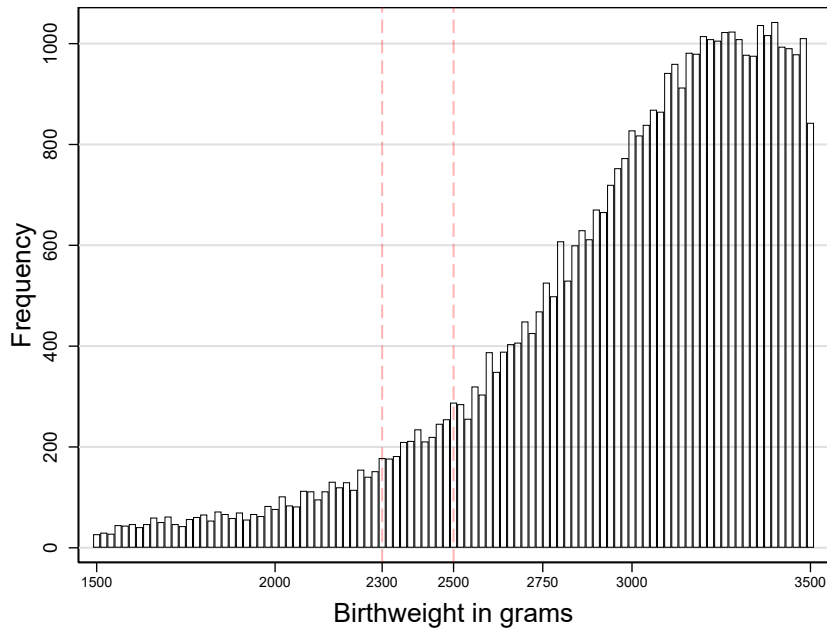
Figure 3 Risk of admission to SCN by categories of birthweight and over gestation period



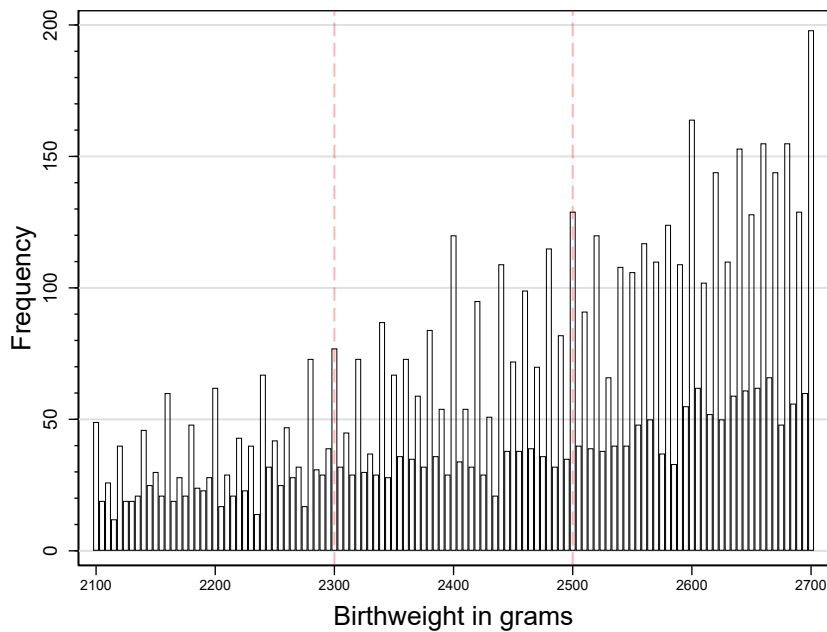
Note: Estimation sample of 4,931 babies born in the Northern Territory between 2002 and 2014. This figure presents the risk of admission to a SCN by gestation of baby by three categories of birthweight: (1) below the 2300g threshold, between 2,300g and 2,500g threshold, and above 2,500g. Red dashed line (vertical) indicates 35th week of gestation. Babies below this 35th week cutoff are all admitted to SCN if birthweight is also below 2,300g, and so are babies between the 2,300g and 2,500 g threshold. Babies above the 2,500g threshold are different in their risk of admission to SCN, even if premature.

Figure 4 Distribution of birthweight to test for evidence of heaping

(a) Birthweight distribution (20g bins) between 1,500g and 3,500g



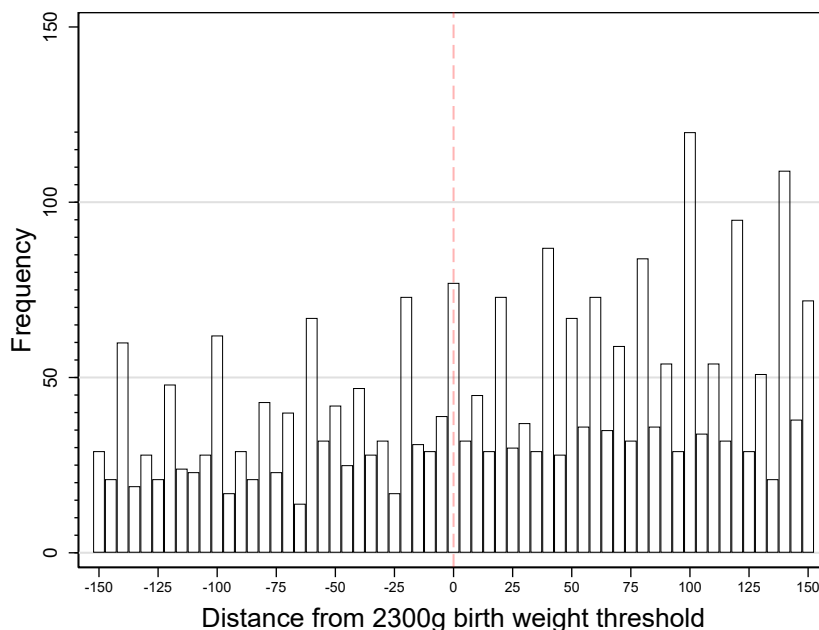
(b) Birthweight distribution (5g bins) between 2,100g and 2,700g



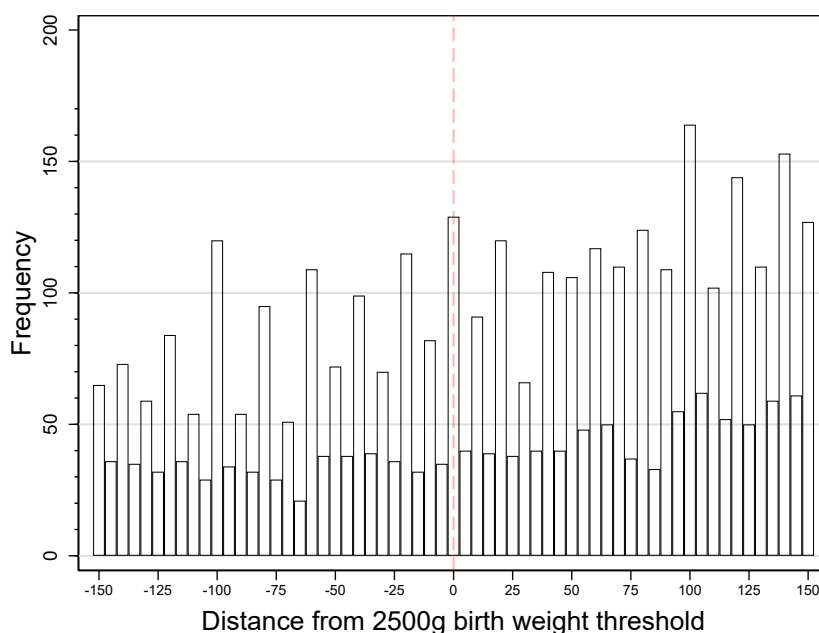
Note: Sample includes babies born in the Northern Territory between 1996 and 2017 (N=41,975, average birthweight 2,981g, risk of SCN admission 24.3%). (a) Each bin represents 20g of birthweight. (b) Each bin represents 5g of birthweight bins. Figure (a) equivalent for estimation sample is presented in Figure A 1 Appendix. Figure (b) cannot be presented in 5g bins for estimation sample due to small sample numbers in each bin.

Figure 5 Distribution of distance of recorded birthweight from clinical thresholds

(a) Distance in grams from the 2,300g birthweight threshold

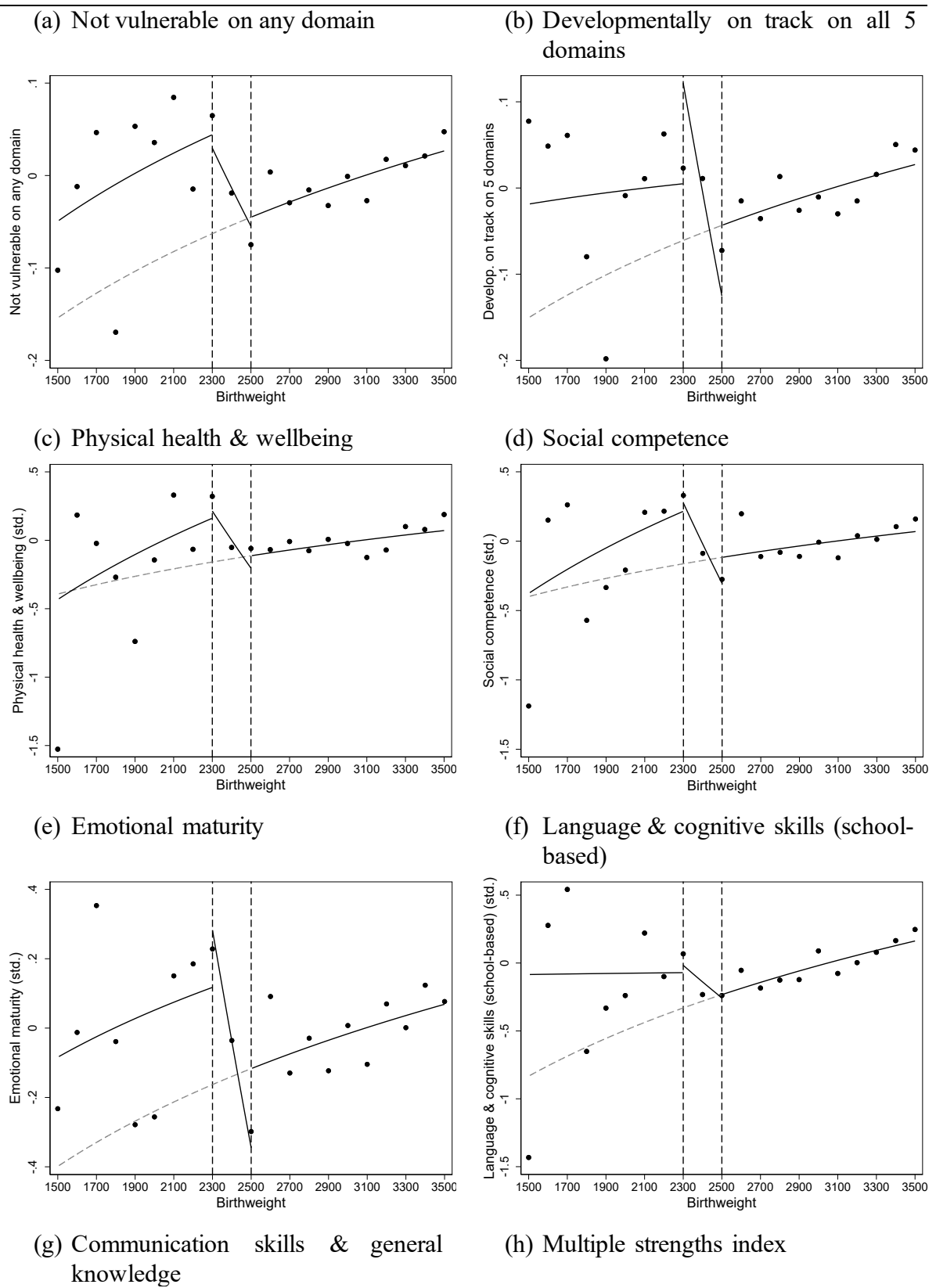


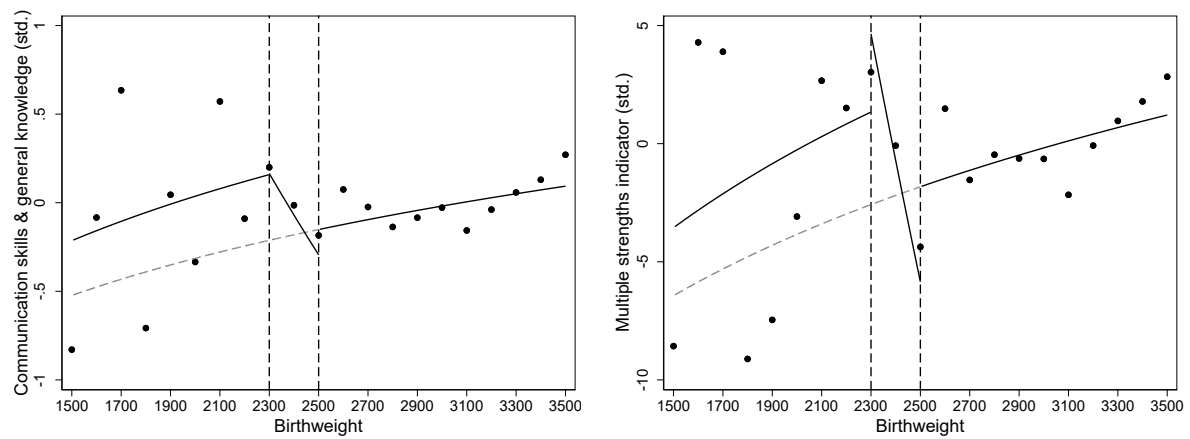
(b) Distance in grams from the 2,500g birthweight threshold



Note: Figures (a) and (b) plot the distance in birthweight from the 2,300g and 2,500g, respectively, thresholds. Each bar represents a 5g bin. The 0-anchor point includes only observations with either 2,300g (a) or 2,500g (b) birthweight. A McCrary test for equal distributions around the 2,300g and 2,500g threshold, which means there is no heaping below or above the threshold, is not rejected for both thresholds. The relevant p-values for the two tests are for the 2,300g threshold: $p=0.431$ and for the 2,500g threshold: $p=0.349$ (Table A 4).

Figure 6 Estimated impact of special care nursery admission on AEDC outcomes, by domain

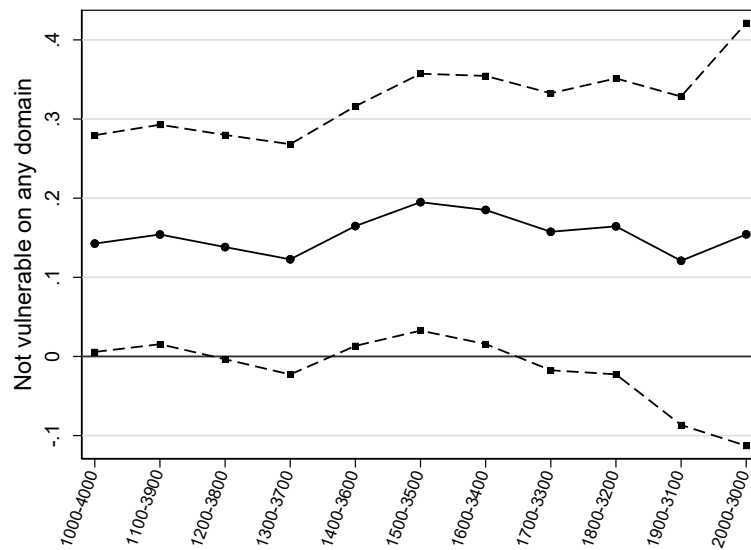




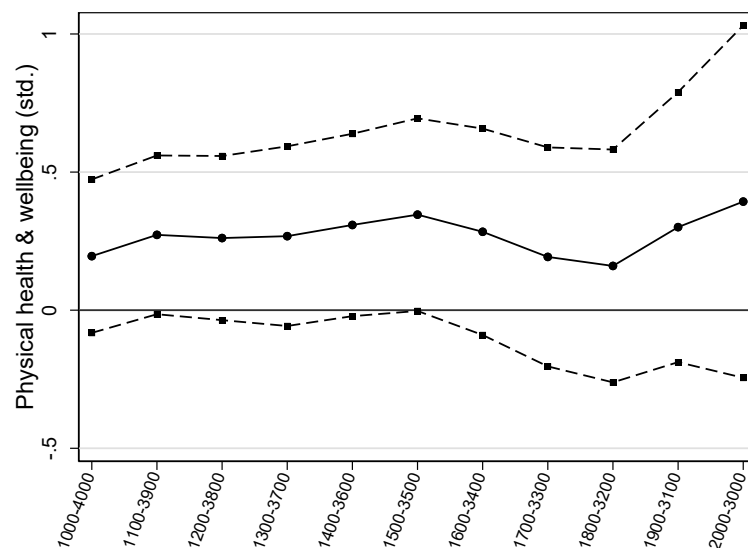
Note: These figures present graphically the estimation results of Table 2. Estimation sample consists of 4,931 babies born in the Northern Territory between 2002 and 2014 within a birthweight limit of 1,500g and 3,500 g. The solid line below 2,300g refers to the potential outcomes due to treatment, the dashed line below 2,300g refers to the counterfactual scenario (in absence of treatment). Each dot presents the average probability of SCN admission by birthweight bin of 100g.

Figure 7 Sensitivity of estimation results to bandwidth range selection

(a) Probability of not vulnerable on any domain



(b) AEDC domain score: Physical health & wellbeing



Note: Reported are robustness checks for baseline estimates from Table 2, column (5) (Panel A and Panel B) for alternative ranges of birthweight sample restrictions (between 1,000g and 4,000g). The baseline model restricted birthweight between 1,500g and below 3,500g. Bullet points and solid line represent 2SLS point estimates, squares and dashed lines represent 95% confidence intervals. Robustness checks for all other outcomes are presented in Figure A 2 in the Appendix.

Table 1 Comparison between babies not admitted and babies admitted to the SCN

Variable	Not in SCN (1)	In SCN (2)	<i>p-value</i> (1)=(2) (3)	Nr. obs. (4)
<i>Panel A: Perinatal Files</i>				
<i>Baby Characteristics</i>				
Female	0.558	0.476	0.000	4931
Aboriginal	0.406	0.542	0.000	4931
Non-Aboriginal	0.489	0.376	0.000	4931
Aboriginal status not defined	0.105	0.082	0.016	4931
Number of siblings	2.643	2.700	0.235	4931
Birth order	1.839	1.904	0.087	4931
Baby length of stay	3.092	11.693	0.000	4927
Birthweight	3095	2625	0.000	4931
BW below 2300g	0.001	0.282	0.000	4931
BW between 2330 & 2500 g	0.024	0.179	0.000	4931
Gestation age	38.904	36.592	0.000	4931
Premature (<37 weeks)	0.035	0.489	0.000	4931
Apgar score at 1 minute	8.502	7.565	0.000	4931
Apgar score at 5 minutes	9.093	8.626	0.000	4931
Baby birth year	2008.0	2007.7	0.004	4931
Baby birth month	6.392	6.365	0.818	4931
Hospital A	0.527	0.583	0.001	4931
Hospital B	0.208	0.168	0.002	4931
Hospital C	0.266	0.250	0.277	4931
Any birth complications	0.384	0.569	0.000	4931
<i>Mother characteristics</i>				
Medical condition	0.470	0.573	0.000	4931
Age mother	27.5	27.6	0.716	4931
Mother Aboriginal	0.371	0.517	0.000	4931
Number of previous pregnancies	2.659	2.897	0.001	4931
Previous pregnancy info missing	0.004	0.003	0.549	4931
Week gestation at 1 st antenatal visit	12.7	13.6	0.001	4931
Week gestation at 1 st antenatal visit missing	0.010	0.024	0.005	4931
Number of previous live births	1.180	1.269	0.084	4931
Evidence of smoking 1 st first visit				4931
<i>Panel B: AEDC records</i>				
Assessed AECD in another state	0.082	0.085	0.770	4931
Age at assessment: 4.1-5.0	0.173	0.165	0.532	4931
Age 5.1-5.3	0.240	0.225	0.289	4931
Age 5.4-5.6	0.239	0.237	0.903	4931
Age 5.7-5.9	0.216	0.227	0.444	4931

Age 5.10-6.0	0.092	0.092	0.952	4931
Age 6.1-6.3+	0.040	0.054	0.051	4931
Attended no preschool	0.078	0.092	0.130	4931
Attended some preschool	0.849	0.815	0.008	4931
Preschool info missing	0.073	0.092	0.040	4931
English as Second Language	0.369	0.466	0.000	4931

AEDC outcomes

Developmentally on track on 5 domains (score>25 th percentile)	0.403	0.277	0.000	4931
Not vulnerable on any domain (score>10 th percentile)	0.611	0.511	0.000	4931
Physical health & wellbeing (0-10)	8.6	8.2	0.000	4931
Emotional maturity (0-10)	7.8	7.4	0.000	4931
Social competence (0-10)	7.9	7.4	0.000	4931
Language & cognitive skills (school-based) (0-10)	7.5	6.8	0.000	4931
Communication skills & general knowledge (0-10)	7.4	6.7	0.000	4931
Multiple strengths indicator (0-100)	57.5	49.5	0.000	4931

Socio-Economic status index of area

Most disadvantaged area (0,1)	0.306	0.387	0.000	4865
Second most disadvantaged area (0,1)	0.164	0.170	0.655	4865
Median disadvantaged area (0,1)	0.198	0.185	0.302	4865
Second least disadvantaged area (0,1)	0.185	0.154	0.012	4865
Least disadvantaged area (0,1)	0.146	0.105	0.000	4865
Major city (0,1)	0.035	0.029	0.272	4931
Inner regional (0,1)	0.014	0.007	0.030	4931
Outer regional (0,1)	0.547	0.457	0.000	4931
Remote (0,1)	0.183	0.206	0.091	4931
Very Remote (0,1)	0.221	0.301	0.000	4931

Note: This table reports means and proportions of children born between 2003 and 2013 (one in 2014) with linked perinatal and AEDC records, children born in one of three hospitals that offer SCN care. Column (1) reports mean values for babies who were not admitted to SCN and Column (2) for babies admitted to SCN. Column (3) reports the p-value for a t-test statistics of equality of mean between column (1) and column (2). Sample size is reported in column (4).

Table 2 Estimation results of effect of special care nursery assignment on AEDC outcomes

	OLS Only AEDC controls (1)	OLS + Basic perinatal (2)	OLS Full set of controls (3)	2SLS AEDC + Baby Perin. (4)	2SLS Full set of controls (5)
<i>Panel A: Binary indicator = 1 if score > 10th (not vulnerable) or 25th (on track) percentile:</i>					
Not vulnerable on any domain (mean 0.611)	-0.043** (0.017)	-0.004 (0.019)	-0.007 (0.018)	0.175** (0.085)	0.191** (0.083)
On track on 5 domains (mean 0.403)	-0.081*** (0.016)	-0.019 (0.020)	-0.022 (0.019)	0.147* (0.081)	0.168** (0.076)
<i>Panel B: Scores of AEDC domain (in Std. Dev.)</i>					
Physical health & wellbeing	-0.133*** (0.037)	-0.051 (0.048)	-0.053 (0.048)	0.330* (0.180)	0.357** (0.176)
Social competence	-0.149*** (0.034)	-0.057 (0.041)	-0.065 (0.041)	0.278* (0.168)	0.315* (0.164)
Emotional maturity	-0.166*** (0.036)	-0.103** (0.047)	-0.113** (0.048)	0.261 (0.168)	0.288* (0.163)
Language & cognitive skills (school-based)	-0.123*** (0.028)	-0.001 (0.035)	-0.007 (0.033)	0.098 (0.153)	0.139 (0.145)
Communication skills & general knowledge	-0.106*** (0.029)	-0.022 (0.041)	-0.027 (0.039)	0.190 (0.180)	0.223 (0.176)
Multiple strength indicator	-0.147*** (0.032)	-0.027 (0.038)	-0.036 (0.036)	0.208 (0.170)	0.248 (0.164)
N individuals	4,931	4,931	4,931	4,931	4,931
First stage F-stat. ^a				67.65	68.86
<i>Control variables</i>					
Child AEDC ^b	✓	✓	✓	✓	✓
Baby perinatal ^c	✗	✓	✓	✓	✓
Mother perinatal ^d	✗	✗	✓	✗	✓

Note: Reported are estimated effect of special nursery admission on human capital development when the child starts full-time schooling. Panel A: linear probability models where the outcome variable is binary: Not vulnerable on any domain (score > 10th percentile, mean of control group: 0.611) and developmentally on track on 5 domains (score > 25th percentile, mean for control group: 403). Panel B reports the results for the score measures of the five AEDC domains and the multiple strengths indicator. Each row and column report the estimated coefficient obtained from a separate regression model. Outcomes in Panel B were standardised to mean zero and standard deviation one. 2SLS results use four instruments as outlined in Eq. (2).^a First stage F-statistics of hypothesis that four instruments (<2300g, between 2300 and 2500 g, both interacted with log birthweight) have zero influence on the probability of admission to the SCN. Control variables include: ^b Child AEDC data (year and age of assessment, English as second language, attended pre-school, was assessed in another state, school fixed effects); ^c baby perinatal controls (log birthweight, gender, Aboriginal baby, birth order, months of birth, birth hospital, categories of gestation age, APGAR scores for 1 and 5 minutes post birth and labour complications); ^d Mother perinatal controls (Aboriginal mother, age mother (and squared), number of pregnancies, week of first antenatal visits, any indication of smoking at first antenatal visit, any health condition). Standard errors clustered by school identifier (446 unique values) are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3 Robustness checks for main estimation results

	Specification of birthweight non-linearity		Drop ‘unhealthy’ babies or babies born in a private hospital		
	Benchmark Log BW	Quadratic polynomial of BW	Full term babies only	Full term & APGAR 5 min: 9 or 10	Public hospital only
	(1)	(2)	(3)	(4)	(5)
<i>Panel A: Binary indicator = 1 if score > 10th (not vulnerable) or 25th (on track) percentile:</i>					
Not vulnerable on any domain	0.191** (0.083)	0.167* (0.089)	0.206** (0.082)	0.187** (0.085)	0.205** (0.084)
On track on 5 domains	0.168** (0.076)	0.137* (0.083)	0.175** (0.077)	0.196** (0.079)	0.185** (0.079)
<i>Panel B: AEDC domain in levels (Std. Dev.)</i>					
Physical health & wellbeing	0.357** (0.176)	0.422** (0.199)	0.351** (0.162)	0.317** (0.155)	0.398** (0.187)
Social competence	0.315* (0.164)	0.338* (0.174)	0.271* (0.154)	0.280* (0.166)	0.409** (0.174)
Emotional maturity	0.288* (0.163)	0.237 (0.177)	0.283* (0.157)	0.269 (0.164)	0.341* (0.174)
Language & cognitive skills (school-based)	0.139 (0.145)	0.063 (0.152)	0.193 (0.138)	0.203 (0.143)	0.168 (0.149)
Communication skills & general knowledge	0.223 (0.176)	0.189 (0.172)	0.288* (0.164)	0.272* (0.163)	0.277 (0.177)
Multiple strengths indicator	0.248 (0.164)	0.243 (0.168)	0.268* (0.161)	0.292* (0.167)	0.343** (0.169)
Observations	4,931	4,931	4,694	4,304	3,952
F-test statistic	68.86	62.78	75.03	76.73	66.73

Note: Reported are estimated effects of special nursery admission on human capital development when the child starts full-time schooling. Panel A: linear probability models where the outcome variable is binary: Not vulnerable on any domain (score>10th percentile, mean of control group: 0.611) and developmentally on track on 5 domains (score>25th percentile, mean for control group: 0.403). Panel B reports the results for the score measures of the five AEDC domains and the multiple strengths indicator. Each row and column report the estimated coefficient obtained from a separate regression model. Outcomes in Panel B were standardised to mean zero and standard deviation one. 2SLS results use four instruments as outlined in Eq. (2). Column (1) reports the benchmark estimates. Column (2) uses an alternative functional form for the non-linearity in birthweight (quadratic polynomial). Column (3) babies with gestation 35+ weeks. Column (4) babies with gestation of 35+ weeks and APGAR score of 9 or 10 at 5 minutes. Each model controls for full set of control variables. Standard errors clustered by school identifier are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 Heterogeneity analysis by sub-groups

	Benchmark	Male	Female	Remote area	Not-remote area	1 st time mother	Mother: 2+ children
	(1)	(2)	(3)	(6)	(7)	(8)	(9)
<i>Panel A: Binary indicator = 1 if score > 10th (not vulnerable) or 25th (on track) percentile:</i>							
Not vulnerable on any domain	0.191** (0.083)	0.317** (0.146)	0.078 (0.094)	0.210** (0.099)	0.176 (0.143)	0.138 (0.106)	0.255** (0.121)
On track on all 5 domains	0.168** (0.076)	0.198* (0.113)	0.138 (0.097)	0.114 (0.074)	0.270* (0.147)	0.190** (0.092)	0.137 (0.102)
<i>Panel B: Score of AEDC domain</i>							
Physical health & wellbeing	0.357** (0.176)	0.617** (0.300)	0.195 (0.202)	0.306 (0.226)	0.445 (0.287)	0.299 (0.235)	0.532** (0.254)
Social competence	0.315* (0.164)	0.456 (0.296)	0.110 (0.182)	0.553** (0.227)	0.018 (0.266)	0.231 (0.221)	0.483** (0.231)
Emotional maturity	0.288* (0.163)	0.402 (0.289)	0.074 (0.163)	0.418* (0.223)	0.167 (0.244)	0.157 (0.209)	0.475** (0.226)
Language & cognitive skills (school-based)	0.139 (0.145)	0.152 (0.248)	0.047 (0.173)	0.221 (0.173)	0.007 (0.251)	0.091 (0.172)	0.230 (0.226)
Communication skills & general knowledge	0.223 (0.176)	0.255 (0.289)	0.119 (0.189)	0.247 (0.214)	0.249 (0.300)	-0.140 (0.212)	0.547** (0.251)
Multiple strengths index	0.248 (0.164)	0.195 (0.253)	0.172 (0.180)	0.402* (0.213)	0.035 (0.275)	0.084 (0.194)	0.449* (0.232)
Observations	4,931	2,274	2,657	2,220	2,694	1,957	2,974

First stage F	68.86	25.27	46.75	31.96	32.83	25.00	44.20
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Note: Reported are estimated effects of special nursery admission on human capital development when the child starts full-time schooling. Panel A: linear probability models where the outcome variable is binary: Not vulnerable on any domain (score>10th percentile, mean of control group: 0.611) and developmentally on track on 5 domains (score>25th percentile, mean for control group:403). Panel B reports the results for the score measures of the five AEDC domains and the multiple strengths indicator. Each row and column report the estimated coefficient obtained from a separate regression model. Outcomes in Panel B were standardised to mean zero and standard deviation one. 2SLS results use four instruments as outlined in Eq. (2). This table reports the estimated treatment effects of SCN on human capital development at full-time school entry, measured by AEDC domains, by sub-groups. Outcomes are standardised to mean 0 and standard deviation 1. The 2SLS results use four instruments as outlined in Eq. (2). First stage F-statistics from this first stage are reported in the table, F-statistic IV. Similar results are obtained when dropping babies born before week 35. Clustered standard errors by school identifier reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5 Summary statistics for health outcome mechanism analysis

<i>Variables</i>	Separated by SCN status			
	Not in SCN (1)	In SCN (2)	<i>p-value</i> (3)	Nr. obs. (4)
Female	0.539	0.482	0.000	22609
Remote location at birth	0.419	0.495	0.000	22609
<i>Risk of death</i>				
Marked dead at discharge (perinatal)	0.001	0.002	0.035	22609
Died before age 1 (death register)	0.002	0.004	0.088	22609
Died Before age 5 (death register)	0.004	0.007	0.010	22609
<i>Hospital admissions (excl birth)</i>				
Age of first admission (in months) for those admitted	13.287	1.483	0.000	12314
<i>Extensive margin</i>				
Any admission post birth	0.408	0.512	0.000	22609
Any admission within 28 days	0.017	0.008	0.000	22609
Any admission between 1-12 mths	0.219	0.316	0.000	22609
Any admission between 12-24 mths	0.167	0.228	0.000	22609
<i>Intensive margin</i>				
Total number of admissions	0.942	1.411	0.000	22609
Number of admissions within 28 days	0.017	0.008	0.000	22609
Number of admissions between 1-12 mths	0.358	0.582	0.000	22609
Number of admissions between 12-24 mths	0.242	0.359	0.000	22609
Length of stay hospital (excl. birth)	3.347	6.525	0.000	22609
<i>Primary diagnosis (identified with ICD10 codes)</i>				
Any infection	0.237	0.058	0.000	22609
Infectious disease	0.083	0.014	0.000	22609
Digestive disease	0.017	0.003	0.000	22609
Any skin issues	0.025	0.004	0.000	22609
Urinary issues	0.009	0.005	0.000	22609
Gastro issues	0.058	0.009	0.000	22609
Any respiratory issue	0.121	0.024	0.000	22609
Asthma	0.007	0.002	0.000	22609
Lower respiratory issue	0.092	0.019	0.000	22609
Bronchiolitis	0.050	0.010	0.000	22609
Upper respiratory disease	0.027	0.006	0.000	22609
ENT (incl. otitis media)	0.007	0.002	0.000	22609
Perinatal condition	0.078	0.719	0.000	22609
Congenital condition	0.010	0.018	0.000	22609
Accidents	0.037	0.009	0.000	22609
Surgery	0.024	0.029	0.056	22609
Any socioeconomic factors	0.013	0.032	0.000	22609
Any admission through outpatient service	0.082	0.125	0.000	22609

Note: this table presents means and proportions of hospital admissions between the ages of birth and month 6 for babies who had been admitted to a special care nursery (2) and babies not admitted (1). *p-values* of a t-test statistic of equality of means between (1) and (2) reported in column (3).

Table 6 Estimation results for risk of death, health care utilisation and disease (age month 1 to months 60)

	OLS No controls	OLS Basic Peri controls	OLS Full controls	2SLS Basic controls	2SLS Full controls	Mean Outcome in control group
Outcomes	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Risk of death</i>						
Recorded dead at discharge	0.001** (0.001)	-0.004** (0.002)	-0.004** (0.002)	0.006 (0.005)	0.006 (0.005)	0.001
Died < 1 yr	0.002** (0.001)	0.000 (0.001)	0.000 (0.001)	-0.011** (0.004)	-0.011** (0.004)	0.002
<i>Panel B: Risk of hospital admissions (extensive margin)</i>						
Any (until month 60)	0.105*** (0.012)	0.039*** (0.009)	0.040*** (0.010)	0.027 (0.036)	0.024 (0.036)	0.408
Any (28 days) excl. birth	-0.009*** (0.003)	-0.006 (0.005)	-0.005 (0.005)	-0.028*** (0.006)	-0.027*** (0.006)	0.017
Any (month 1-12)	0.098*** (0.013)	0.035*** (0.008)	0.036*** (0.008)	0.029 (0.033)	0.028 (0.034)	0.219
Any (month 12-24)	0.061*** (0.011)	0.032*** (0.010)	0.031*** (0.010)	0.028 (0.035)	0.026 (0.034)	0.167
<i>Panel C: Risk of a specific diagnosis (within month 1-60)</i>						
Infectious disease	-0.069*** (0.016)	-0.066*** (0.016)	-0.066*** (0.016)	-0.162*** (0.031)	-0.162*** (0.031)	0.083
Respiratory issues	-0.095 (0.039)	-0.087 (0.033)	-0.086 (0.033)	-0.192*** (0.024)	-0.192*** (0.024)	0.121
Ear, nose, throat	-0.005*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)	-0.017*** (0.005)	-0.017*** (0.005)	0.007
Bronchiolitis	-0.041*** (0.013)	-0.041*** (0.012)	-0.040*** (0.012)	-0.090*** (0.022)	-0.090*** (0.022)	0.050
Asthma	-0.005***	-0.004***	-0.005***	-0.010**	-0.010**	0.007

Accident	(0.001) -0.028***	(0.001) -0.021***	(0.001) -0.021***	(0.005) -0.042***	(0.005) -0.043***	0.037
Surgery	(0.002) 0.005	(0.003) 0.008	(0.003) 0.008	(0.014) 0.038**	(0.014) 0.038**	0.024
Other factors ^a	(0.003) 0.018***	(0.005) 0.037***	(0.005) 0.037***	(0.018) -0.035***	(0.018) -0.036***	0.013
	(0.003)	(0.005)	(0.005)	(0.008)	(0.008)	
<i>Panel D: Sanity checks of methods – Outcomes that must be affected (perinatal issues) or cannot be affected (congenital issues)</i>						
Perinatal issues	0.641*** (0.035)	0.491*** (0.035)	0.490*** (0.035)	0.975*** (0.022)	0.976*** (0.022)	0.078
Congenital issues	0.008*** (0.002)	0.016*** (0.004)	0.016*** (0.004)	0.002 (0.008)	0.002 (0.008)	0.010
N	22,601	22,601	22,601	22,601	22,601	
F-stat 1 st stage ^b				130.926	127.810	
Basic controls ^c	×	✓	✓	✓	✓	
Extended controls ^d	×	×	✓	×	✓	

Note: This table reports the estimated treatment effects of special nursery admission on the likelihood of death, health care utilisation, and diagnosis of disease. Panel A reports results from linear probability models where the outcome variable is binary: likelihood of being recorded dead at discharge from perinatal records, the likelihood of being registered dead within one year of birth. Panel B reports the results for the binary measures of admissions to hospital at various times after birth (within 1 month after birth (excluding birth), admission between month 1 and 12, admission within month 12 and 24 (excluding birth)). Panel C reports the results for binary outcomes of a specific primary diagnosis at discharge from hospitalisation (using ICD-10 codes). Panel D reports the results for two reality checks, as there should be no impact on the likelihood of congenital disease and there should be an almost 100% impact on perinatal issues, as these were treated already in the SCN. ^aOther factors refers to admissions that indicate observation, follow-up, awaiting admission to adequate service or admissions due to homelessness or neglect) and is our proxy for attachment to the health care system or issues that could have been prevented. 2SLS results use four instruments as outlined in Eq. (2). ^b First stage F-statistics of hypothesis that four instruments (<2300g, between 2,300 and 2,500 g, both interacted with log birthweight) have zero influence on the probability of admission to the SCN. Control variables include: ^c baby perinatal controls (log birthweight, gender, Aboriginal baby, birth order, months of birth, birth hospital, categories of gestation age, APGAR scores for 1 and 5 minutes post birth and labour complications); ^d Mother perinatal controls (Aboriginal mother, age mother (and squared), number of pregnancies, week of first antenatal visits, any indication of smoking at first antenatal visit, any health condition). Standard errors clustered by post code of residence (135 distinct values) are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

APPENDIX

Figures:

Figure A1 Sample selection process

Figure A2 Birthweight distribution for the estimation sample (N=4,931) in 20g bins

Figure A3 Sensitivity of estimation results with respect to birthweight range (1000g-4000g)

Figure A4 Admission to hospital by age

Figure A5 Sensitivity of estimation results with respect to birthweight range (1000g-4000g) for key health care system outcomes

Tables:

Table A1 Comparison of co-variates between samples not matched and matched with AEDC

Table A2 Comparison of AEDC outcomes between those not born and those born in the NT

Table A3 First stage estimation results for different samples

Table A4 McCrary Density testing for manipulation around the low-birth-weight thresholds

Table A5 Testing for discontinuities in baby and mother characteristics

Table A6 Full estimation results on impact of special care nursery admission on AEDC on probability of not being developmentally vulnerable on any AEDC domain

Table A7 Additional heterogeneity and robustness checks

Table A8 Full estimation results on impact of special care nursery admission on hospitalisation

Table A9 Impact of SCN admission on baby length of stay in hospital post birth

Figure A 1 Sample selection process

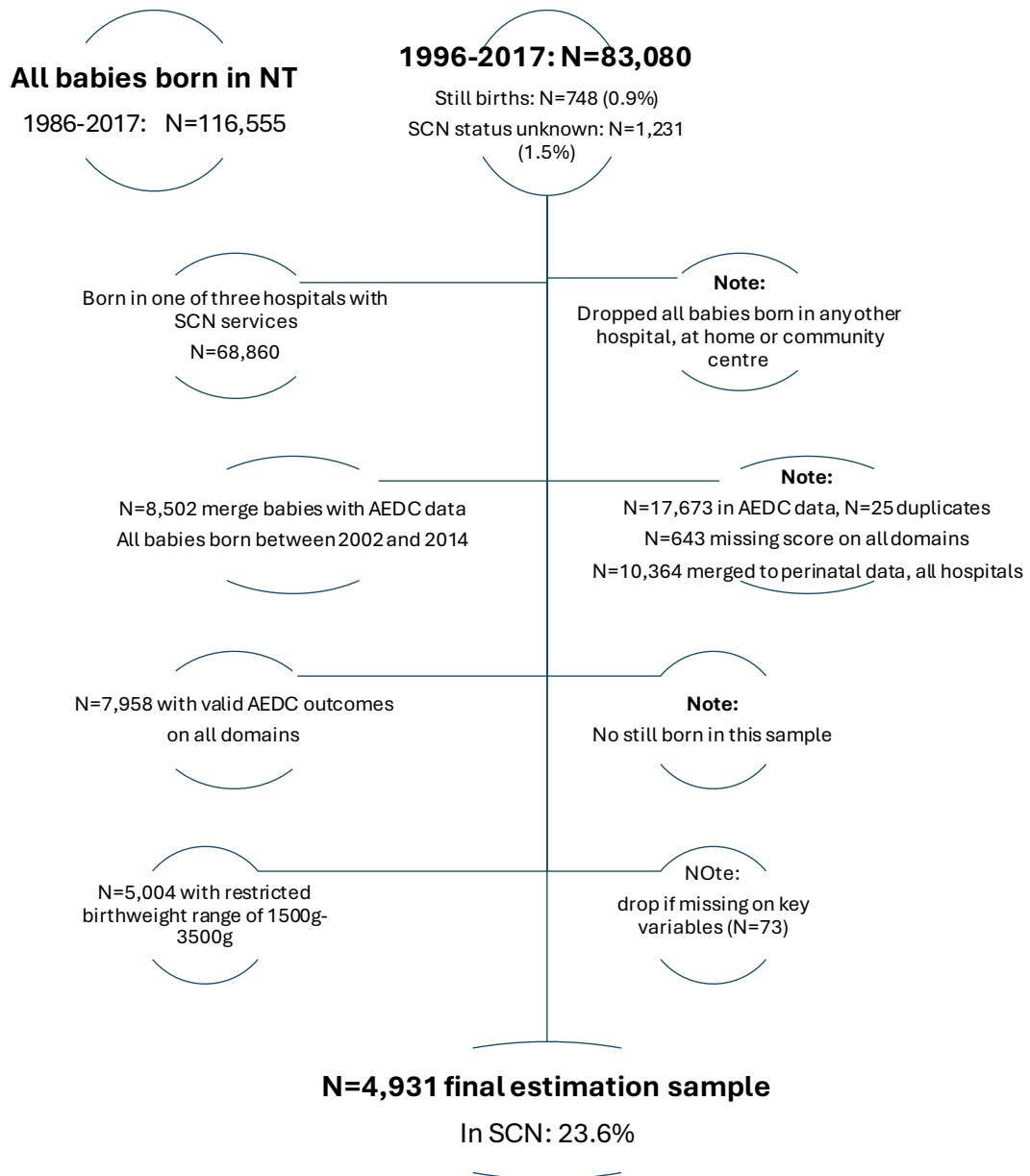
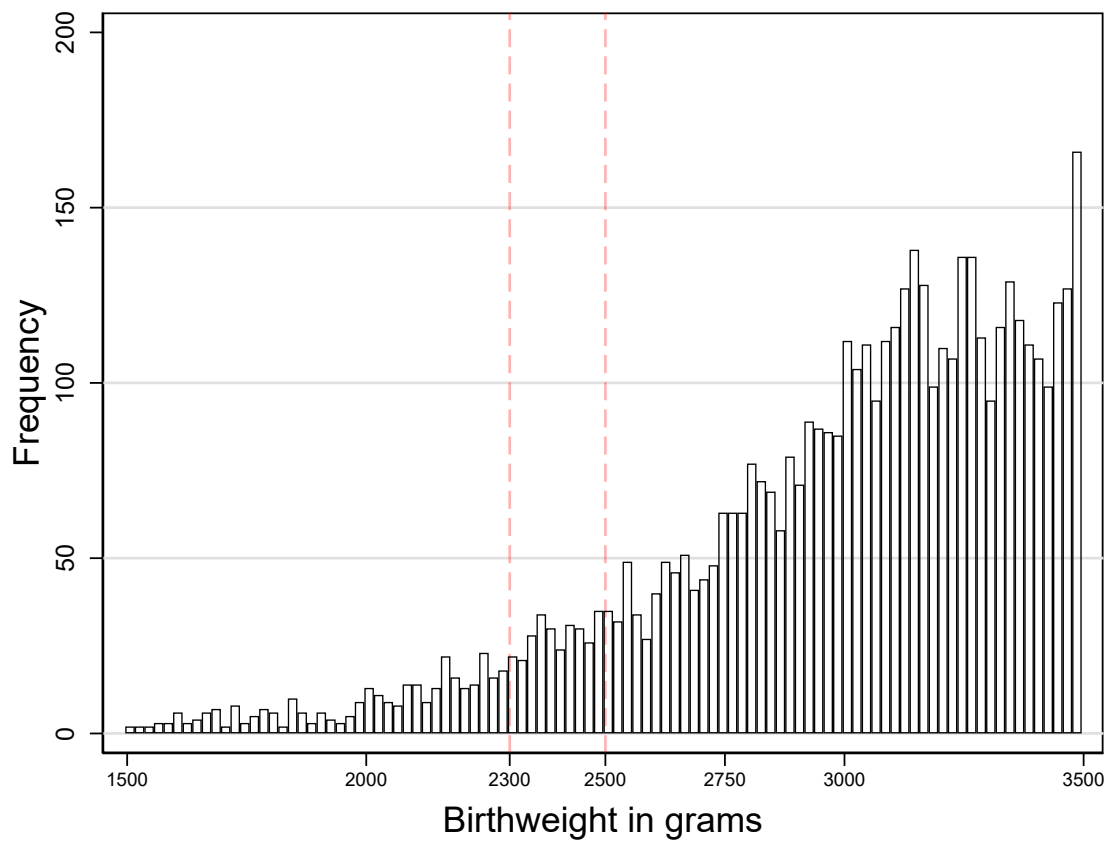
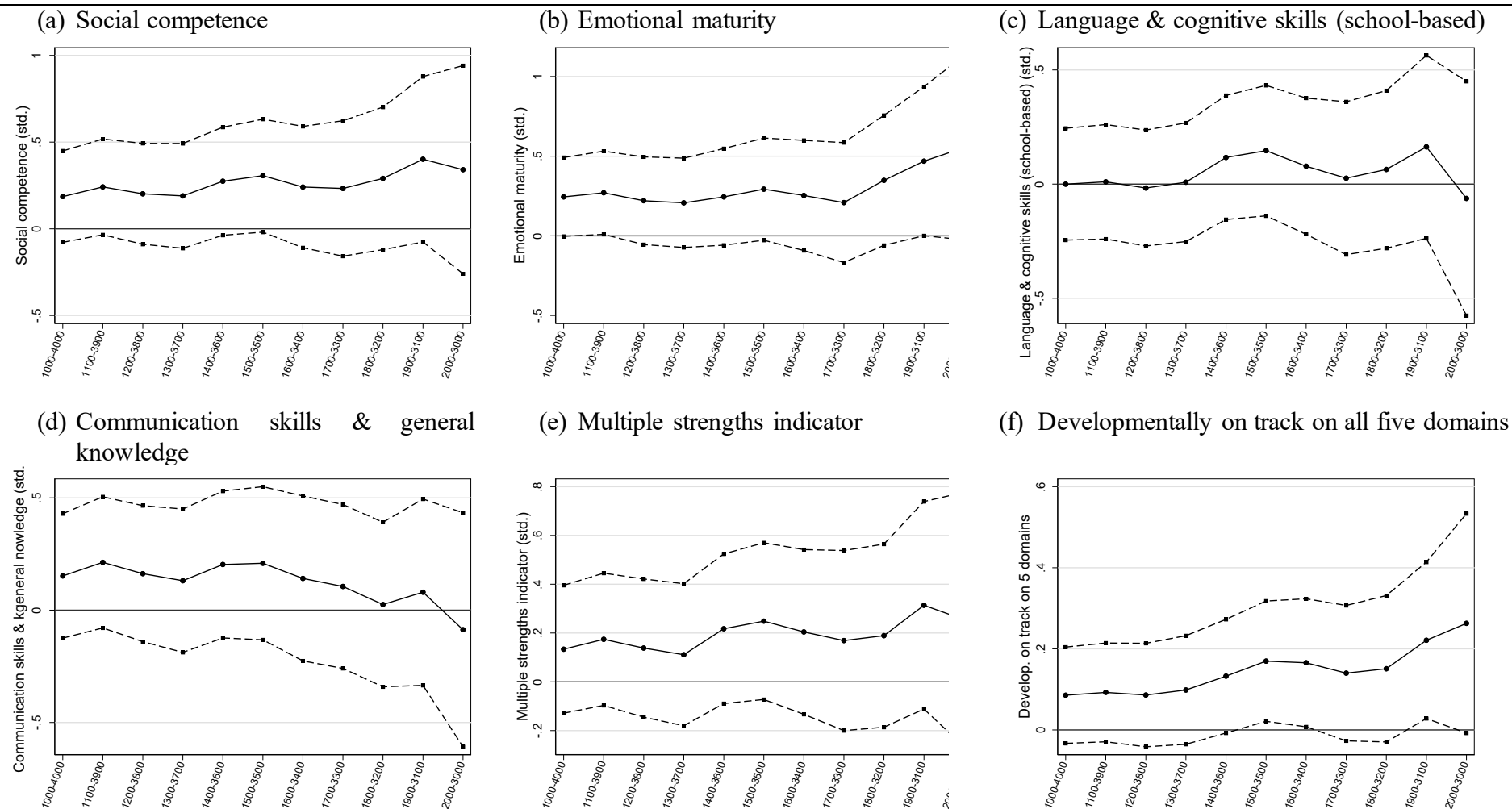


Figure A 2 Birthweight distribution for the estimation sample (N=4,931) in 20g bins



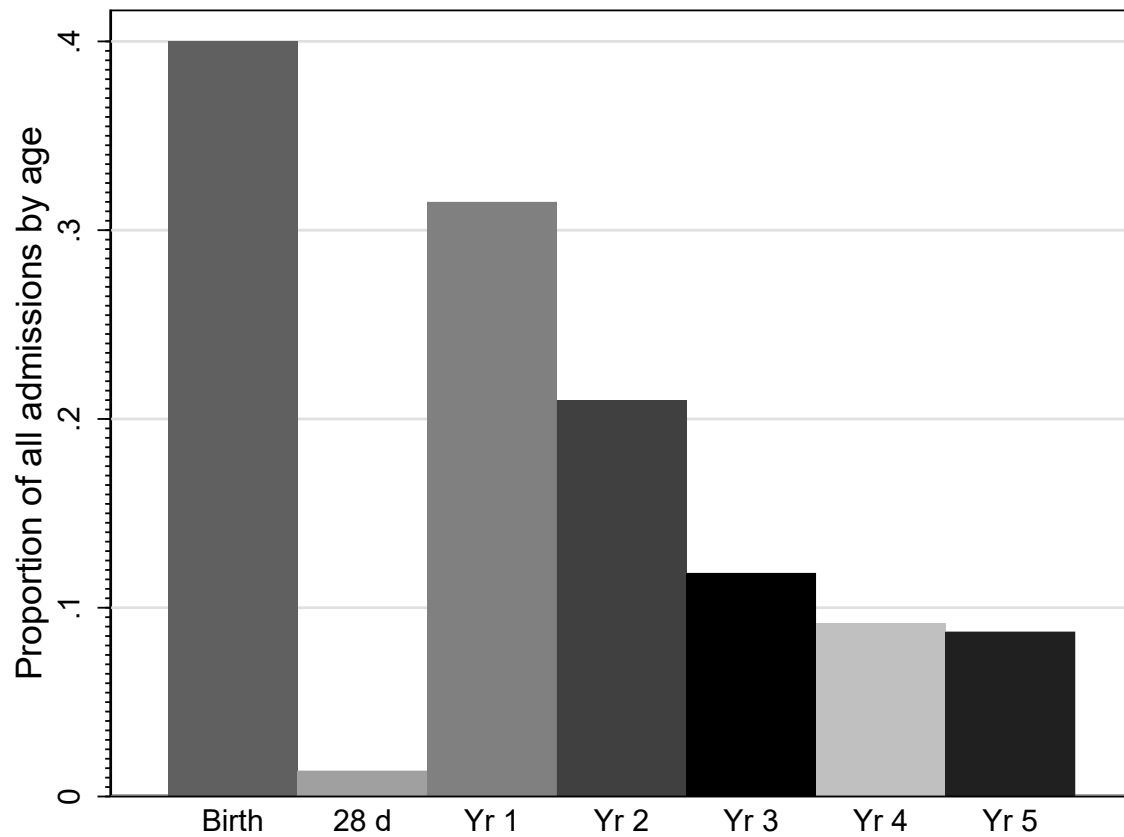
Note: Figure reports distribution of birthweight for estimation sample (N=4,931 individuals) born between 2002 and 2014 in the Northern Territory. Each bin represents 20g of birthweight. See also Figure 4.

Figure A 3 Sensitivity of estimation results with respect to birthweight range (1000g-4000g) for other AEDC outcomes



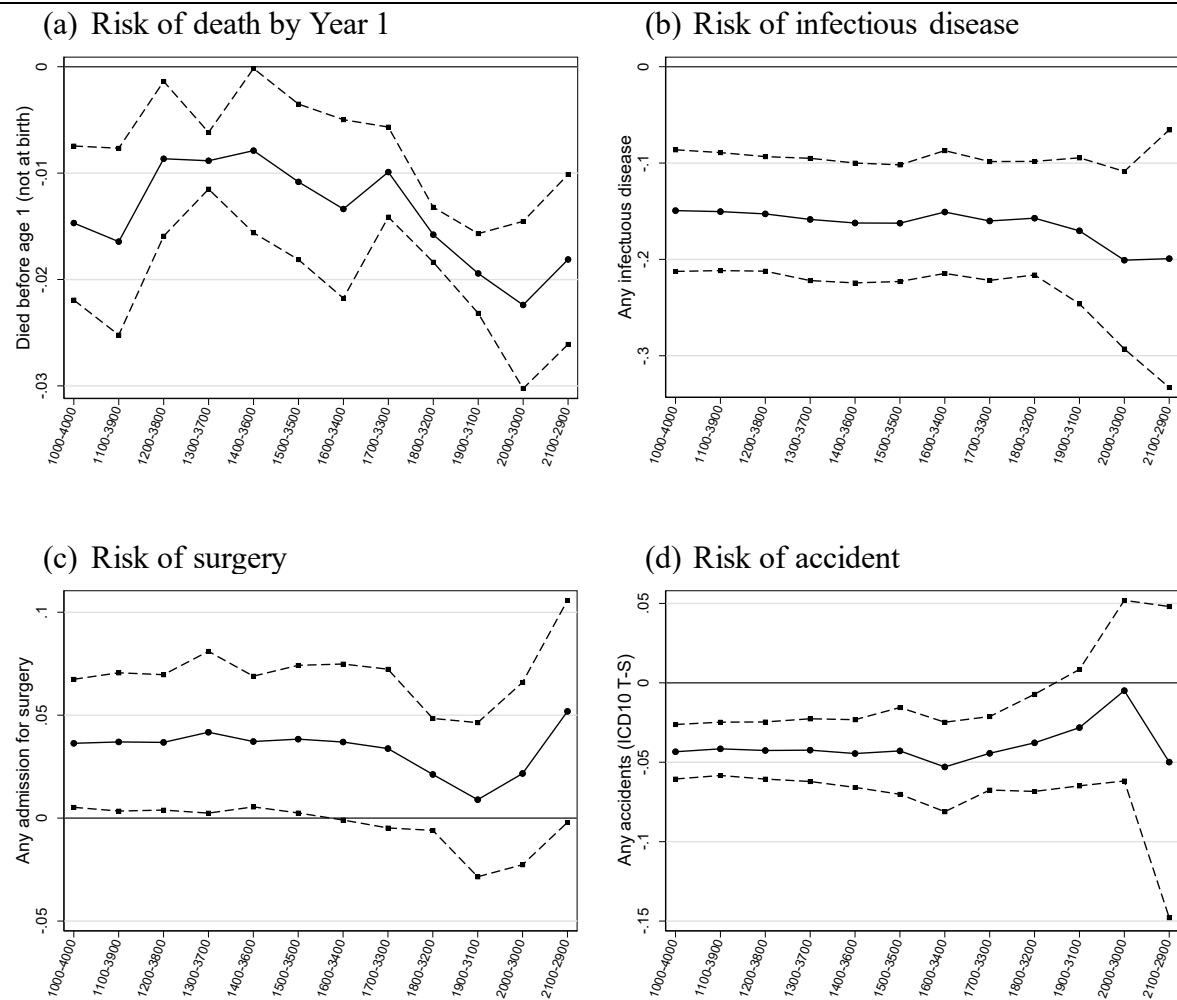
Note: Reported are robustness checks for baseline estimates from Table 2, column (5) (Panel A and Panel B) for alternative ranges of birthweight sample restrictions (1,000g and 4,000g). The baseline model restricted birthweight between 1,500g-3,500g. Bullet points and solid line represent 2SLS estimates, squares and dashed lines represent 95% confidence intervals. Robustness checks for the outcomes 'Not vulnerable on any domain' and 'physical health & wellbeing' are reported in Figure 7.

Figure A 4 Admission to hospital by age



Note: Figure reports the proportion of babies admitted to hospital in hospitalisation data (including emergency and inpatient admissions) between birth and month 60. Forty percent of all admissions occur at birth. Less than 3% occur within month 1 and 12 after birth. Thirty two percent were admitted between month 1 and 12 (first year of life excluding first month of birth).

Figure A 5 Sensitivity of estimation results with respect to birthweight range (1,000g-4,000g) for key health care system outcomes



Note: Reported are robustness checks for baseline estimates from Table 6 column (5) for alternative ranges of birthweight sample restrictions (1,000g-4,000g). The baseline model restricted birthweight between 1500g and 3,500g. Bullet points and solid line represent 2SLS estimates, squares and dashed lines represent 95% confidence intervals. Risk of death is constructed from death registry information (death by exact date). Risk of respiratory disease and risk of infection are constructed from information on primary diagnosis in hospital admission data using ICD-10 codes.

Table A 1 Comparison of co-variables between samples not matched and matched with AEDC

Variable	Perinatal data but no AEDC data	Perinatal data was matched with AEDC	p-value test (1)=(2)	Combined observations (1)+(2)
	(1)	(2)	(3)	(4)
Female	0.485	0.489	0.486	61595
Aboriginal	0.384	0.447	0.000	61595
Non-Aboriginal	0.548	0.458	0.000	61595
Aboriginal status missing	0.068	0.095	0.000	61595
Number of siblings	2.280	2.690	0.000	61595
Birth order	1.777	1.884	0.000	61595
SCN	0.178	0.183	0.183	60996
Length of stay	5.0	5.1	0.524	61092
Birthweight	3255.2	3271.6	0.013	61585
Birthweight (<2,300g)	0.065	0.054	0.000	61595
Birthweight (2,300g-2,500g)	0.033	0.039	0.003	61595
Gestation age	38.494	38.710	0.000	61590
Premature	0.108	0.100	0.012	61595
APGAR 1 minute	8.296	8.390	0.031	61595
APGAR 5 minutes	8.985	9.119	0.000	61595
DOB year	2010	2008	0.000	61595
DOB month	6.4	6.4	0.522	61595
Hospital A	0.457	0.429	0.000	61595
Hospital B	0.174	0.181	0.107	61595
Hospital C	0.044	0.044	0.767	61595
Hospital D	0.072	0.091	0.000	61595
Hospital E	0.003	0.004	0.173	61595
Hospital F	0.204	0.211	0.101	61595
Any Labour Complications	0.453	0.433	0.000	61595
Mother has medical condition	0.479	0.479	0.924	61595
Mother age	27.952	27.551	0.000	61594
Mother Aboriginal	0.352	0.411	0.000	61595
Mother non-Aboriginal	0.647	0.589	0.000	61595
Aboriginal status unknown	0.000	0.000	0.353	61595
Number of pregnancies	2.636	2.746	0.000	61195
Week of first antenatal visit	12.1	12.8	0.000	60396

Note: Table reports means/proportions of outcomes recorded in the perinatal files for children born in the Northern Territory, but comparing children who do not have a record for the AEDC (1) and children who do (2). The AEDC was collected in years 2009, 2012, 2015 and 2018. p-value refers to a t-test statistic for testing the hypothesis that the means/proportions between columns (1) and (2) are the same. Sample sizes differ across variables, but matched sample refers to 10,364 children with AEDC records and perinatal records. Almost 3.1% of birth were delivered outside the hospital sector (numbers suppressed).

Table A 2 Comparison of AEDC outcomes between those not born and those born in the NT

	Not born in NT (1)	Born in NT (2)	p-value (1)=(2) (3)	Nr. obs. (4)
Sat AEDC in another state	0.405	0.079	0.000	17001
AED age 4.1-5.0	0.146	0.170	0.000	17005
AECD age 5.1-5.3	0.206	0.231	0.000	17005
AECD age 5.4-5.6	0.233	0.230	0.629	17005
AECD age 5.7-5.9	0.235	0.219	0.013	17005
AECD 5.10-6.0	0.112	0.096	0.001	17005
AECD age 6.1-6.3+	0.068	0.054	0.000	17005
Major city	0.201	0.033	0.000	17001
Inner regional	0.086	0.015	0.000	17001
Outer regional	0.432	0.483	0.000	17001
Remote	0.143	0.205	0.000	17001
Very Remote	0.138	0.263	0.000	17001
SEIFA most disadvantaged	0.219	0.334	0.000	16803
SEIFA least disadvantaged	0.223	0.133	0.000	16803
Attended pre-school	0.085	0.078	0.079	17005
No preschool	0.786	0.851	0.000	17005
Pre-school info missing	0.128	0.071	0.000	17005
English as a second language	0.237	0.380	0.000	17005
<i>Has valid AEDC outcomes</i>				
Physical health & wellbeing	0.953	0.949	0.191	17005
Emotional maturity	0.952	0.947	0.154	17005
Social competence	0.948	0.940	0.032	17005
Language & cognitive skills (school-based)	0.950	0.942	0.023	17005
Communication skills & general knowledge	0.954	0.949	0.165	17005
Multiple strength indicator valid	0.952	0.945	0.067	17005
<i>AEDC outcomes</i>				
Not developmentally vulnerable on any domain	0.277	0.412	0.000	16071
Developmentally on track on all 5 domains	0.474	0.366	0.000	16189
Physical health & wellbeing	8.844	8.433	0.000	16978
Emotional maturity	8.029	7.609	0.000	16854
Social competence	8.177	7.664	0.000	16957
Language & cognitive skills (school-based)	8.185	7.282	0.000	16891
Communication skills & general knowledge	7.845	7.120	0.000	16983
Multiple strengths indicator	62.984	54.416	0.000	17005

Note: Table reports means and proportions of outcomes recorded in the AEDC files for children born in the Northern Territory and children not born but residing in the Northern Territory. p-value refers to a t-test statistic for testing the hypothesis that the means/proportions between columns (1) and (2) are the same.

Table A 3 First stage estimation results for different samples (outcome: SCN assignment)

	Four instruments using two birthweight thresholds				Two instruments using one birthweight threshold			
	No controls	OLS Basic Peri controls	OLS Full controls	OLS Full controls + main est. sample	1500-1499g Full sample	2300-3500g Full sample	1500-2499g Main est. sample	2300-3500g Main est. sample
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Log birth weight	-0.588*** (0.100)	-0.183*** (0.057)	-0.182*** (0.057)	-0.181** (0.082)	-3.854*** (0.224)	-0.144** (0.052)	-3.945*** (1.091)	-0.146* (0.075)
Low BW threshold	-3.415*** (1.026)	-4.770*** (1.015)	-4.822*** (1.016)	-3.802*** (1.213)	-31.002*** (1.184)		-31.647*** (7.822)	
Birthweight 2300g-2500g	32.154*** (1.077)	27.374*** (1.072)	27.440*** (1.018)	32.048*** (7.743)		25.444*** (1.122)		30.021*** (8.148)
Low BW Log BW	0.521*** (0.131)	0.675*** (0.129)	0.681*** (0.129)	0.555*** (0.153)	4.012*** (0.154)		4.091*** (1.003)	
2300-2500g $\times$ Log BW	-4.082*** (0.136)	-3.482*** (0.137)	-3.490*** (0.130)	-4.074*** (0.991)		-3.237*** (0.144)		-3.816*** (1.043)
Birth year 2000	0.000 (.)	0.000 (.)	0.000 (.)		0.000 (.)	0.000 (.)		
Birth year 2001	0.000 (0.010)	-0.005 (0.007)	-0.013* (0.007)		-0.045** (0.019)	-0.012* (0.006)		
Birth year 2002	0.003 (0.009)	-0.005 (0.008)	-0.011 (0.008)	0.000 (.)	-0.004 (0.020)	-0.013 (0.008)	0.000 (.)	0.000 (.)
Birth year 2003	-0.007 (0.010)	-0.005 (0.011)	-0.012 (0.011)	0.010 (0.125)	-0.023 (0.015)	-0.012 (0.012)	-0.098 (0.155)	0.010 (0.135)
Birth year 2004	-0.028* (0.015)	-0.032** (0.012)	-0.041*** (0.012)	-0.037 (0.130)	-0.089** (0.033)	-0.042*** (0.012)	-0.211 (0.219)	-0.042 (0.140)
Birth year 2005	-0.032** (0.012)	-0.027** (0.010)	-0.036*** (0.009)	-0.001 (0.143)	-0.074** (0.027)	-0.039*** (0.010)	-0.219 (0.200)	-0.007 (0.154)
Birth year 2006	-0.065*** (0.009)	-0.060*** (0.011)	-0.069*** (0.011)	-0.069 (0.122)	-0.097* (0.047)	-0.071*** (0.012)	-0.198 (0.187)	-0.071 (0.132)

Birth year 2007	-0.062*** (0.016)	-0.059*** (0.013)	-0.068*** (0.013)	-0.078 (0.131)	-0.145*** (0.042)	-0.065*** (0.013)	-0.363 (0.225)	-0.080 (0.140)
Birth year 2008	-0.044*** (0.013)	-0.048*** (0.013)	-0.057*** (0.013)	0.054 (0.162)	-0.116** (0.049)	-0.060*** (0.014)	0.140 (0.166)	0.046 (0.174)
Birth year 2009	-0.044*** (0.009)	-0.047*** (0.009)	-0.057*** (0.009)	-0.066 (0.131)	-0.090* (0.049)	-0.059*** (0.010)	-0.174 (0.200)	-0.064 (0.141)
Birth year 2010	-0.022** (0.009)	-0.031*** (0.010)	-0.041*** (0.010)	-0.049 (0.121)	-0.053 (0.035)	-0.040*** (0.011)	-0.298 (0.241)	-0.047 (0.130)
Birth year 2011	-0.039*** (0.013)	-0.044*** (0.013)	0.010 (0.013)	-0.324** (0.117)	0.004 (0.022)	0.011 (0.013)	0.403* (0.196)	-0.294** (0.122)
Birth year 2012	-0.066*** (0.017)	-0.074*** (0.016)	-0.021* (0.010)	-0.403*** (0.059)	-0.056 (0.043)	-0.022* (0.010)	0.163 (0.095)	-0.356*** (0.053)
Birth year 2013	-0.066*** (0.015)	-0.071*** (0.013)	-0.018** (0.008)	-0.424*** (0.066)	-0.014 (0.021)	-0.020** (0.008)	0.000 (.)	-0.373*** (0.061)
Birth year 2014	-0.046*** (0.014)	-0.048*** (0.013)	0.005 (0.009)	0.000 (.)	-0.001 (0.016)	0.005 (0.009)		0.000 (.)
Birth year 2015	-0.050*** (0.008)	-0.054*** (0.009)	-0.001 (0.008)		0.039 (0.023)	-0.003 (0.007)		
Birth year 2016	-0.036** (0.014)	-0.040*** (0.014)	0.011 (0.008)		-0.004 (0.021)	0.008 (0.008)		
Birth year 2017	-0.040*** (0.012)	-0.050*** (0.011)	0.000 (.)		0.000 (.)	0.000 (.)		
Female		-0.022*** (0.005)	-0.022*** (0.005)	-0.027** (0.011)	-0.029*** (0.009)	-0.020*** (0.005)	-0.027 (0.033)	-0.026** (0.011)
Indigenous		0.024*** (0.004)	0.018** (0.008)	0.001 (0.023)	-0.002 (0.007)	0.016* (0.009)	0.014 (0.116)	-0.003 (0.024)
Non-Indigenous		0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)
Unknown		-0.069*** (0.011)	-0.066*** (0.012)	-0.026 (0.023)	-0.074 (0.046)	-0.070*** (0.013)	0.040 (0.084)	-0.027 (0.025)
DOB January		-0.002 (0.005)	-0.002 (0.006)	0.028 (0.018)	-0.036** (0.015)	0.002 (0.006)	0.018 (0.043)	0.036* (0.018)

DOB February	-0.002 (0.010)	-0.003 (0.010)	0.005 (0.014)	-0.020 (0.020)	-0.002 (0.010)	0.000 (0.049)	0.013 (0.012)
DOB March	-0.004 (0.011)	-0.005 (0.011)	0.033 (0.025)	-0.053* (0.025)	-0.004 (0.011)	0.045 (0.062)	0.038 (0.025)
DOB April	0.005 (0.008)	0.004 (0.008)	0.042* (0.021)	-0.013 (0.011)	0.004 (0.009)	0.083 (0.062)	0.047* (0.022)
DOB May	-0.005 (0.009)	-0.006 (0.009)	0.026 (0.025)	-0.037* (0.018)	-0.010 (0.010)	0.059 (0.064)	0.030 (0.026)
DOB June	-0.001 (0.007)	-0.002 (0.007)	0.015 (0.017)	0.007 (0.018)	-0.004 (0.008)	0.110** (0.046)	0.017 (0.017)
DOB July	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)
DOB August	-0.010 (0.009)	-0.011 (0.009)	0.018 (0.026)	-0.058** (0.025)	-0.008 (0.010)	-0.099 (0.072)	0.023 (0.028)
DOB September	0.000 (0.007)	-0.000 (0.007)	0.015 (0.025)	-0.032 (0.019)	0.001 (0.008)	-0.095* (0.047)	0.019 (0.026)
DOB October	-0.005 (0.008)	-0.005 (0.008)	-0.022 (0.014)	-0.029 (0.024)	-0.008 (0.009)	-0.103* (0.055)	-0.017 (0.015)
DOB November	-0.002 (0.008)	-0.003 (0.008)	-0.009 (0.013)	-0.053*** (0.015)	-0.000 (0.009)	-0.091*** (0.029)	-0.003 (0.012)
DOB July	0.004 (0.008)	0.004 (0.008)	-0.003 (0.021)	-0.044** (0.015)	0.004 (0.008)	-0.130*** (0.039)	0.006 (0.020)
Hospital A (base)							
Hospital B	0.055*** (0.014)	0.056*** (0.014)	0.036 (0.023)	0.055 (0.038)	0.062*** (0.015)	0.034 (0.030)	0.039 (0.025)
Hospital C	-0.014** (0.006)	-0.018*** (0.006)	-0.018* (0.009)	0.037 (0.024)	-0.017** (0.007)	0.036** (0.013)	-0.019* (0.010)
Gestation age 34 wks	0.418*** (0.056)	0.418*** (0.055)	0.407*** (0.068)	0.239*** (0.058)	0.555*** (0.061)	0.263*** (0.077)	0.552*** (0.075)
Gestation age 35 wks	0.555*** (0.056)	0.552*** (0.055)	0.485*** (0.059)	0.285*** (0.070)	0.639*** (0.034)	0.308** (0.099)	0.557*** (0.044)

Gestation age 36 wks	0.364*** (0.019)	0.362*** (0.019)	0.362*** (0.033)	0.188*** (0.044)	0.365*** (0.016)	0.288*** (0.088)	0.374*** (0.033)
Gestation age 37 wks	0.085*** (0.007)	0.082*** (0.008)	0.076** (0.029)	0.033 (0.025)	0.073*** (0.007)	0.017 (0.074)	0.065* (0.030)
Gestation age 38 wks	0.028*** (0.006)	0.025*** (0.006)	0.039*** (0.010)	-0.013 (0.072)	0.026*** (0.006)	0.034 (0.064)	0.040*** (0.011)
Gestation age 39 wks	0.003 (0.004)	0.002 (0.004)	0.040*** (0.007)	-0.042 (0.041)	0.005 (0.004)	0.027 (0.075)	0.041*** (0.007)
Gestation age 40 wks	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)
Gestation age 41 wks	0.005 (0.010)	0.004 (0.010)	0.004 (0.018)	-0.027 (0.038)	0.001 (0.009)	-0.010 (0.047)	0.002 (0.018)
APGAR 1 minute	-0.049*** (0.002)	-0.048*** (0.002)	-0.041*** (0.004)	-0.026*** (0.006)	-0.050*** (0.002)	-0.022 (0.015)	-0.047*** (0.004)
APGAR 5 minute	-0.007 (0.015)	-0.007 (0.015)	-0.071*** (0.009)	0.075*** (0.006)	-0.040*** (0.010)	0.002 (0.010)	-0.081*** (0.008)
Any labor complications	0.066*** (0.004)	0.064*** (0.004)	0.058*** (0.010)	0.052** (0.022)	0.063*** (0.005)	0.055 (0.034)	0.061*** (0.011)
Mother is Aboriginal		0.022*** (0.008)	0.052** (0.019)	0.036*** (0.009)	0.020** (0.008)	0.020 (0.112)	0.061** (0.020)
Age of mother		0.004* (0.002)	0.008 (0.005)	-0.006* (0.003)	0.005** (0.002)	0.008 (0.006)	0.008 (0.005)
Age mother square		-0.000 (0.000)	-0.000 (0.000)	0.000** (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Gravidity (total no. of pregnancies)		-0.006*** (0.001)	-0.005* (0.003)	-0.004** (0.001)	-0.005*** (0.001)	0.009* (0.005)	-0.006* (0.003)
Gravidity missing		-0.013 (0.024)	-0.116 (0.078)	0.010 (0.037)	-0.008 (0.026)	0.325* (0.155)	-0.122 (0.082)
Age at first antenatal visit		0.000 (0.000)	-0.000 (0.001)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.002)	-0.000 (0.001)
Anten. visit info missing		0.008	-0.015	-0.016	0.010	0.004	-0.024

			(0.013)	(0.028)	(0.015)	(0.014)	(0.052)	(0.034)
Smoking no			0.005	0.036**	-0.020	0.006	0.009	0.040**
			(0.006)	(0.016)	(0.012)	(0.007)	(0.026)	(0.017)
Smoking yes			0.000	0.000	0.000	0.000	0.000	0.000
			(.)	(.)	(.)	(.)	(.)	(.)
Smoking missing data			-0.061***	0.365**	-0.123**	-0.065***	-0.336	0.315**
			(0.013)	(0.132)	(0.051)	(0.015)	(0.256)	(0.140)
Any medical conditions			0.027***	0.022**	0.012	0.027***	0.020	0.022*
			(0.004)	(0.010)	(0.007)	(0.004)	(0.023)	(0.011)
Constant	4.910***	2.057***	1.954***	2.355***	30.292***	1.932***	31.466***	2.191***
	(0.813)	(0.413)	(0.411)	(0.659)	(1.702)	(0.369)	(8.539)	(0.616)
Observations	34,900	34,900	34,900	4,932	4,331	32,376	606	4,604
F-test statistic	1,641.26	513.24	516.75	118.52	358.19	336.22	36.36	33.63
p-value IV=0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Any controls	✓	✓	✓	✓	✓	✓	✓	✓
Basic perinatal controls	×	✓	✓	✓	✓	✓	✓	✓
Extended perinatal controls	×	×	✓	✓	✓	✓	✓	✓

Note: The outcome is a binary indicator of whether the baby was admitted to a SCN after birth. Each regression model controls for birth year fixed effects and month of birth fixed effects. Coefficients suppressed. Column (4) presents estimation results of first stage for final estimation sample, babies born between 2003 and 2013 (one baby in 2014) for whom we could link AEDC data to perinatal records. AEDC was recorded in 2009, 2012, 2015, and 2018. The minimum birthweight is 1,500g and the maximum is 3,500. Columns (5)-(8) report first-stage results for one birthweight threshold only (interacted with log birthweight). Standard errors are clustered at the 100g birthweight bins. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A 4 McCrary Density testing for manipulation around the low birthweight thresholds

	Birthweight threshold	
	2,300 grams	2,500 grams
Panel A: Model 1		
Restrictions	BW >2,050 & BW <2,450	BW > 2,350 & BW<2,750
Sample size	3069	6261
Number observations	1514, 1555	1643, 4618
Effective number	634, 851	870, 1663
Order estimated polynomial	2, 2	2, 2
Kernel	Triangular	Triangular
VCE method	Jackknife	Jackknife
Birthweight estimate (h)	93.7, 82.3	79.3, 100.7
Robust T statistics	0.7877	0.9370
p-value	0.4309	0.3488
Panel B: Model 2		
Restrictions	BW>2,100 & BW<2,500	BW>2,300 & BW<2,700
Sample size	3416	5559
Number observations	1244, 2172	2097, 3462
Effective number	542, 735	
Order estimated polynomial	2, 2	2, 2
Kernel	Triangular	Triangular
VCE method	Jackknife	Jackknife
Birthweight estimate (h)	78.4, 72.3	70.0, 63.3
Robust T statistics	0.5778	1.410
p-value	0.5634	0.1583

Note: This table presents tests for manipulation using STATA's `rddensity` command. It is an unrestricted, computing data-driven bandwidth selectors, RD Manipulation Test using local polynomial density estimation.

Table A 5 Testing for discontinuities in baseline characteristics

	Estimation Sample Born 2002-2014
<i>Outcome:</i>	
Female	-0.034 (0.082)
Aboriginal baby	0.065 (0.087)
Firstborn child	-0.040 (0.104)
Mother Aboriginal	0.087 (0.079)
Age mother	-1.225 (1.157)
Week first Antenatal visit	1.167 (1.247)
Number of previous live births	0.408 (0.296)
Number of previous pregnancies	0.456 (0.332)
Evidence of smoking	0.009 (0.084)
Rural area	-0.021 (0.076)
Socioeconomic disadvantage (AECD)	0.328 (0.247)
Observations	4,931

Note: Each row presents a separate regression model, using birthweight thresholds as instrumental variables. All models are estimated with Two-Stage Least Squares. Control variables include outcomes that were strictly observable by the hospital staff at birth and should have been considered for the decision to admit a baby into a SCN. Baby perinatal controls (log birthweight, months of birth, categories of gestation age, and labour complications, APGAR score at 1 minute and 5 minute); Mother perinatal controls: Any medical health condition. Standard errors clustered by birthweight categories in 100g bins. The estimation sample is the same as in Table 2. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A 6 Full estimation results on impact of special care nursery admission on AEDC on probability of not being developmentally vulnerable on any AEDC domain

	OLS Only AEDC controls (1)	OLS + Basic perinatal (2)	OLS Full set of controls (3)	2SLS AEDC + Basic Perin. (4)	2SLS Full set of controls (5)
Special care nursery	-0.043** (0.017)	-0.004 (0.019)	-0.007 (0.018)	0.175** (0.085)	0.191** (0.083)
<i>Child AECD controls</i>					
<i>AECD assessment year (Base: 2009)</i>					
2012	0.017 (0.026)	0.031 (0.026)	0.026 (0.024)	0.040 (0.025)	0.036 (0.024)
2015	-0.021 (0.027)	-0.010 (0.027)	-0.018 (0.027)	-0.004 (0.026)	-0.010 (0.025)
2018	0.016 (0.028)	0.022 (0.027)	0.032 (0.029)	0.030 (0.027)	0.038 (0.029)
<i>Age AECD (Base: 5y 4m - 5y 6m)</i>					
4y 10m - 5y	-0.026 (0.020)	-0.015 (0.040)	-0.015 (0.039)	-0.016 (0.038)	-0.015 (0.037)
5y 1m - 5y 3m	-0.069*** (0.021)	-0.100*** (0.036)	-0.098*** (0.036)	-0.096*** (0.034)	-0.093*** (0.033)
5y 7m - 5y 9m	0.034* (0.019)	-0.011 (0.035)	-0.008 (0.034)	-0.015 (0.033)	-0.013 (0.033)
5y 10m - 6y	-0.016 (0.026)	-0.032 (0.043)	-0.027 (0.042)	-0.032 (0.041)	-0.027 (0.041)
6y 1m - 6y 3m	-0.085** (0.039)	-0.073* (0.041)	-0.061 (0.040)	-0.077* (0.039)	-0.066* (0.039)
English 2 nd language	-0.133*** (0.029)	-0.106*** (0.024)	-0.099*** (0.023)	-0.108*** (0.022)	-0.100*** (0.021)
Attended pre-school	0.104*** (0.022)	0.083*** (0.020)	0.080*** (0.020)	0.083*** (0.019)	0.080*** (0.019)
Sat AEDC outside NT	0.440*** (0.040)	0.381*** (0.079)	0.408*** (0.044)	0.386*** (0.083)	0.415*** (0.048)
Birth order	-0.031*** (0.008)	-0.022*** (0.007)	-0.012 (0.009)	-0.021*** (0.007)	-0.009 (0.009)
<i>Baby perinatal controls</i>					
Log birthweight		0.157** (0.064)	0.130** (0.063)	0.291*** (0.078)	0.280*** (0.077)
Female		0.137*** (0.013)	0.136*** (0.013)	0.141*** (0.012)	0.141*** (0.013)
<i>Non-Aboriginal baby (Base)</i>					
Aboriginal		-0.184*** (0.024)	-0.024 (0.036)	-0.188*** (0.023)	-0.022 (0.036)
Unknown		0.017 (0.039)	0.014 (0.039)	0.023 (0.038)	0.020 (0.038)

Month of birth (Base: July)

January	-0.052 (0.040)	-0.052 (0.039)	-0.059 (0.038)	-0.060 (0.037)
February	-0.053 (0.048)	-0.050 (0.048)	-0.056 (0.046)	-0.053 (0.045)
March	-0.045 (0.043)	-0.045 (0.044)	-0.055 (0.041)	-0.055 (0.042)
April	-0.145*** (0.042)	-0.145*** (0.042)	-0.153*** (0.041)	-0.153*** (0.041)
May	-0.139*** (0.038)	-0.138*** (0.039)	-0.144*** (0.038)	-0.143*** (0.037)
June	-0.083** (0.041)	-0.086** (0.041)	-0.088** (0.038)	-0.090** (0.039)
August	-0.056 (0.037)	-0.058 (0.036)	-0.058* (0.035)	-0.061* (0.034)
September	-0.066** (0.032)	-0.068** (0.031)	-0.068** (0.031)	-0.069** (0.030)
October	-0.102*** (0.033)	-0.105*** (0.032)	-0.100*** (0.032)	-0.103*** (0.031)
November	-0.086* (0.045)	-0.089** (0.045)	-0.088** (0.042)	-0.090** (0.042)
December	-0.127** (0.056)	-0.126** (0.058)	-0.130*** (0.058*)	-0.129*** (0.061*)

Birth hospital (Base: Hospital A)

Hospital B	0.035 (0.024)	0.014 (0.023)	0.028 (0.023)	0.007 (0.022)
Hospital C	-0.069 (0.049)	-0.075 (0.048)	-0.059 (0.047)	-0.064 (0.046)

Gestation age (Base: 40 weeks)

34 or less weeks	0.017 (0.045)	0.016 (0.044)	-0.075 (0.064)	-0.086 (0.061)
35 weeks	0.044 (0.043)	0.045 (0.044)	-0.056 (0.056)	-0.064 (0.054)
36 weeks	0.002 (0.032)	0.002 (0.032)	-0.064 (0.043)	-0.071* (0.043)
37 weeks	-0.024 (0.026)	-0.026 (0.025)	-0.040 (0.026)	-0.043* (0.026)
38 weeks	0.011 (0.020)	0.009 (0.019)	0.004 (0.019)	0.002 (0.019)
39 weeks	0.001 (0.022)	0.000 (0.022)	-0.007 (0.021)	-0.008 (0.021)
41+ weeks	0.005 (0.027)	0.005 (0.026)	0.001 (0.025)	0.001 (0.024)
APGAR 1 minute	0.013** (0.006)	0.012* (0.006)	0.020*** (0.008)	0.020*** (0.007)
APGAR 5 minute	-0.021* (0.021)	-0.023** (0.021)	-0.009 (0.021)	-0.010 (0.021)

Any labor complications		(0.011) 0.007	(0.011) 0.004	(0.012) -0.005	(0.012) -0.008
<i>Mother perinatal controls</i>		(0.012)	(0.012)	(0.012)	(0.012)
Mother is Aboriginal			-0.159*** (0.047)		-0.173*** (0.046)
Age of mother			0.018** (0.008)		0.016** (0.008)
Age of mother squared			-0.000 (0.000)		-0.000 (0.000)
Total no. of pregnancies			-0.016***		-0.016***
Pregnancies info miss.			(0.005) -0.234* (0.133)		(0.005) -0.212* (0.122)
Gest. age at 1 st ant. visit			-0.002* (0.001)		-0.002* (0.001)
1 st antenatal visit miss.			-0.006 (0.060)		-0.008 (0.056)
Smoking in pregnancy (Base: yes at 1 st)					
No indication smoking			0.034* (0.018)		0.027 (0.017)
Any medical conditions			-0.009 (0.013)		-0.014 (0.012)
Constant	0.556*** (0.049)	-0.475 (0.497)	-0.580 (0.496)	-1.697** (0.686)	-1.900*** (0.667)
N individuals	4,931	4,931	4,931	4,931	4,931
First stage F-stat. ^a				67.65	68.86
<i>Control variables</i>					
Child AEDC ^b	✓	✓	✓	✓	✓
Baby perin. ^c	✗	✓	✓	✓	✓
Mother perin. ^d	✗	✗	✓	✗	✓

Note: This table reports the estimated treatment effects of special nursery admission on human capital development at age 5, here proxied by the probability of not being developmentally vulnerable on any domain of the AEDC (0,1). Each column reports the estimated coefficient obtained from a separate regression model. 2SLS results use four instruments as outlined in Eq. (2). ^aFirst stage F-statistics of hypothesis that four instruments (<2,300g, between 2,300 and 2,500 g, both interacted with log birthweight) have zero influence on the probability of admission to the SCN. Control variables include: ^bChild AEDC data (year and age of assessment, English as second language, attended pre-school, was assessed in another state, school fixed effects); ^c baby perinatal controls (log birthweight, gender, Aboriginal baby, birth order, months of birth, birth hospital, categories of gestation age, APGAR score at 1 minute and 5 minutes, and labour complications); ^dMother perinatal controls (Aboriginal mother, age mother (and squared), number of pregnancies, week of first antenatal visits, any indication of smoking at first antenatal visit, any health condition). Standard errors clustered by school identifier are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A 7 Additional heterogeneity and robustness checks

Outcome:	Benchmark model	Aboriginal	Non- Aboriginal	Public Hospital A	Public Hospital B	Use lower threshold only as IV: 2,300g	Use upper threshold only as IV: 2,500g
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Panel A Binary indicator = 1 if score > 10th (not vulnerable) or 25th (on track) percentile</i>							
Not vulnerable on any domain	0.191** (0.083)	0.161 (0.101)	0.237 (0.158)	0.283** (0.117)	0.138 (0.113)	0.463** (0.236)	0.165 (0.103)
Developmentally on track on all 5 domains	0.168** (0.076)	0.097 (0.080)	0.298** (0.139)	0.231** (0.110)	0.080 (0.088)	0.502** (0.244)	0.231** (0.097)
<i>Panel B: Score of individual AEDC domain</i>							
Physical health & wellbeing	0.357** (0.176)	0.342 (0.236)	0.363 (0.271)	0.620** (0.270)	0.099 (0.253)	1.123** (0.481)	0.322 (0.219)
Social competence	0.315* (0.164)	0.394* (0.234)	0.381 (0.271)	0.534** (0.257)	0.314 (0.226)	0.648 (0.443)	0.283 (0.214)
Emotional maturity	0.288* (0.163)	0.160 (0.218)	0.631** (0.276)	0.480* (0.252)	0.299 (0.240)	0.778 (0.515)	0.265 (0.207)
Language & cognitive skills (school-based)	0.139 (0.145)	0.271 (0.197)	-0.168 (0.245)	0.257 (0.220)	0.053 (0.215)	0.304 (0.429)	0.160 (0.175)
Communication skills & general knowledge	0.223 (0.176)	0.315 (0.219)	0.228 (0.251)	0.411* (0.235)	0.066 (0.248)	0.519 (0.470)	0.174 (0.213)
Multiple strengths indicator	0.248 (0.164)	0.299 (0.218)	0.331 (0.260)	0.440* (0.246)	0.220 (0.218)	0.688 (0.473)	0.240 (0.203)

N	4,931	2,158	2,282	2,661	1,291	606	4,603
F-stat	68.86	41.68	17.64	39.18	33.80	16.99	77.46

Note: Reported are estimated effects of special nursery admission on human capital development when the child starts full-time schooling. Panel A: linear probability models where the outcome variable is binary: Not vulnerable on any domain (score>10th percentile, mean of control group: 0.611) and developmentally on track on five domains (score>25th percentile, mean for control group:403). Panel B reports the results for the score measures of the five AEDC domains and the multiple strengths indicator. Each row and column report the estimated coefficient obtained from a separate regression model. Outcomes in Panel B were standardised to mean zero and standard deviation one. 2SLS results use four instruments as outlined in Eq. (2). This Table reports robustness checks to the benchmark model (column (1)), see Table 2 (column (5)). Models in (6) and (7) only use two instrumental variables (either the lower bound threshold, interacted with log birthweight, or the higher bound threshold). These models restrict the sample to 1,500g-2,499g ((6)) and 2,300g-3,500g ((7)). Standard errors clustered by school identifier are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A 8 Full estimation results on total number of hospital admissions

	OLS No controls	OLS + Basic perinatal	OLS Full set of controls	2SLS AEDC + Basic Perin.	2SLS Full set of controls
	(1)	(2)	(3)	(4)	(5)
SCN admission	0.238*** (0.040)	0.091*** (0.023)	0.092*** (0.023)	0.077 (0.094)	0.076 (0.098)
Log birth weight		-0.350*** (0.074)	-0.316*** (0.073)	-0.359*** (0.103)	-0.327*** (0.099)
Female		-0.085*** (0.010)	-0.083*** (0.010)	-0.085*** (0.011)	-0.083*** (0.011)
Indigenous		0.527*** (0.106)	0.073** (0.035)	0.528*** (0.107)	0.073** (0.035)
Non-Indigenous (base)					
Unknown		0.007 (0.014)	-0.001 (0.021)	0.007 (0.015)	-0.002 (0.021)
DOB January		-0.008 (0.030)	-0.012 (0.031)	-0.008 (0.029)	-0.012 (0.031)
DOB February		0.015 (0.032)	0.012 (0.032)	0.015 (0.032)	0.012 (0.032)
DOB March		-0.014 (0.029)	-0.018 (0.029)	-0.014 (0.029)	-0.018 (0.029)
DOB April		-0.017 (0.027)	-0.020 (0.026)	-0.017 (0.027)	-0.020 (0.026)
DOB May		-0.011 (0.023)	-0.015 (0.022)	-0.011 (0.023)	-0.015 (0.022)
DOB June		0.010 (0.023)	0.010 (0.022)	0.010 (0.023)	0.010 (0.022)
DOB July (base)		0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)
DOB August		0.001 (0.024)	0.000 (0.023)	0.001 (0.024)	0.000 (0.023)
DOB September		-0.014 (0.020)	-0.010 (0.020)	-0.014 (0.020)	-0.010 (0.019)
DOB October		-0.046* (0.024)	-0.047** (0.023)	-0.046* (0.024)	-0.047** (0.023)
DOB November		-0.029 (0.031)	-0.023 (0.030)	-0.029 (0.031)	-0.023 (0.030)
DOB December		-0.017 (0.026)	-0.019 (0.025)	-0.017 (0.026)	-0.019 (0.025)
Hospital A (base)		0.000 (.)	0.000 (.)	0.000 (.)	0.000 (.)
Hospital B		0.027 (0.048)	0.069 (0.053)	0.027 (0.050)	0.070 (0.056)
Hospital C		0.494*** (0.113)	0.473*** (0.094)	0.494*** (0.114)	0.473*** (0.095)
Gestation age 34 wks		0.067 (0.065)	0.071 (0.063)	0.074 (0.051)	0.079 (0.050)

Gestation age 35 wks		0.044 (0.040)	0.036 (0.037)	0.052 (0.051)	0.045 (0.053)
Gestation age 36 wks		0.050 (0.040)	0.045 (0.039)	0.055 (0.047)	0.051 (0.048)
Gestation age 37 wks		0.030 (0.019)	0.032 (0.019)	0.031 (0.021)	0.033 (0.022)
Gestation age 38 wks		0.038** (0.018)	0.038* (0.020)	0.038** (0.018)	0.038* (0.020)
Gestation age 39 wks		0.024 (0.020)	0.026 (0.022)	0.024 (0.020)	0.026 (0.021)
Gestation age 40 wks (base)					
Gestation age 41		-0.031* (0.018)	-0.026 (0.018)	-0.031* (0.018)	-0.026 (0.018)
APGAR 1 minute		-0.013*** (0.005)	-0.013*** (0.005)	-0.013* (0.008)	-0.014* (0.008)
APGAR 5 minute		0.013 (0.008)	0.016** (0.008)	0.013 (0.008)	0.016** (0.008)
Any labor complications		0.010 (0.007)	0.008 (0.007)	0.010 (0.011)	0.009 (0.010)
Mother is Aboriginal			0.423*** (0.078)		0.424*** (0.080)
Age of mother			-0.045*** (0.013)		-0.045*** (0.013)
agemum2			0.001*** (0.000)		0.001*** (0.000)
Total no. of pregnancies			0.010*** (0.004)		0.010*** (0.004)
Gravida missing			-0.030 (0.060)		-0.033 (0.054)
Age at first antenatal visit			0.004** (0.002)		0.004** (0.002)
Antenatal visit age missing			0.102** (0.044)		0.103** (0.045)
Smoking no			0.003 (0.014)		0.003 (0.014)
Smoking yes (base)			0.000 (.)		0.000 (.)
Smoking Missing data			0.009 (0.033)		0.009 (0.032)
Any medical conditions			0.035* (0.021)		0.036 (0.023)
Constant	-0.056 (0.098)	2.440*** (0.550)	2.801*** (0.501)	2.520*** (0.844)	2.895*** (0.804)

N individuals	22,601	22,601	22,601	22,601	22,601
First stage F-stat. ^a				67.65	127.81
<i>Control variables</i>					
Baby perin. ^c	×	✓	✓	✓	✓
Mother perin. ^d	×	×	✓	×	✓

Note: This table reports the estimated treatment effects of special nursery admission on total number of hospital admissions by age five (standardised to mean 0 and standard deviation 1. Each column reports the estimated coefficient obtained from a separate regression model. 2SLS results use four instruments as outlined in Eq. (2).

^aFirst stage F-statistics of hypothesis that four instruments (<2,300g, between 2,300 and 2,500 g, both interacted with log birthweight) have zero influence on the probability of admission to the SCN. Control variables include:

^b Child AEDC data (year and age of assessment, English as second language, attended pre-school, was assessed in another state, school fixed effects); ^c baby perinatal controls (log birthweight, gender, Aboriginal baby, birth order, months of birth, birth hospital, categories of gestation age, APGAR score at 1 minute and 5 minutes, and labour complications); ^d Mother perinatal controls (Aboriginal mother, age mother (and squared), number of pregnancies, week of first antenatal visits, any indication of smoking at first antenatal visit, any health condition). Standard errors clustered by post codes (135 separate units) are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A 9 Impact of SCN admission on baby length of stay in hospital post birth

	Benchmark model			Drop ‘unhealthy’ babies (gestation age < 35 weeks)		
	Pooled (1)	Boys (2)	Girls (3)	Pooled (4)	Boys (5)	Girls (6)
Special care nursery	6.904* (4.170)	5.996 (4.180)	8.370** (4.175)	11.627*** (2.287)	13.124*** (2.191)	10.602*** (2.828)
Log birthweight	-9.126* (4.843)	-12.613** (5.009)	-5.127 (4.993)	0.272 (2.065)	-1.376 (1.427)	1.752 (3.244)
Gestation age < 34	11.066*** (2.511)	11.501*** (2.380)	9.828*** (3.091)			
Gestation age 35	1.320 (2.378)	1.411 (2.215)	0.846 (2.670)	-0.079 (1.440)	-0.982 (1.476)	0.740 (1.840)
Gestation age 36	0.185 (1.771)	-0.746 (1.736)	0.885 (1.904)	-0.735 (1.102)	-2.525*** (0.948)	0.925 (1.477)
Gestation age 37	0.395 (0.805)	-0.312 (0.388)	0.959 (1.452)	0.572 (0.821)	-0.013 (0.438)	1.286 (1.437)
Gestation age 38	0.054 (0.251)	0.035 (0.230)	0.052 (0.294)	0.083 (0.184)	-0.057 (0.176)	0.175 (0.239)
Gestation age 39	-0.068 (0.203)	-0.018 (0.177)	-0.156 (0.249)	-0.176 (0.142)	-0.083 (0.180)	-0.193 (0.197)
Gestation age 40 (Base)						
Gestation age 41+	0.416 (0.366)	0.423** (0.213)	0.394 (0.632)	0.233 (0.377)	0.290 (0.311)	0.252 (0.646)
APGAR 1 minute	-0.184 (0.232)	-0.271 (0.306)	-0.073 (0.170)	0.300*** (0.113)	0.371** (0.148)	0.189 (0.136)
APGAR 5 minute	0.359** (0.183)	0.598** (0.233)	0.079 (0.149)	-0.092 (0.206)	1.098*** (0.282)	-0.128 (0.173)
Labor complications	-0.033 (0.427)	0.019 (0.525)	-0.025 (0.422)	-0.350 (0.275)	-0.449 (0.302)	-0.104 (0.328)
Medical conditions	-0.471** (0.231)	-0.427* (0.233)	-0.455 (0.310)	-0.439** (0.202)	-0.453** (0.226)	-0.389 (0.307)
Constant	70.555 (43.197)	100.028** (44.273)	43.806 (40.671)	-10.087 (19.429)	-3.441 (13.433)	-11.680 (26.695)
Observations	4,932	2,278	2,654	4,694	2,139	2,555

Note: Each column presents a separate regression model, using birthweight thresholds as instrumental variables. All models are estimated with Two-Stage Least Squares. Each model controls for birth year and birth month, and hospital fixed effects (suppressed). Standard errors clustered by school identifier are reported in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.