Gestational age at birth and child special educational needs: a UK representative birth cohort study

Neora Alterman ,[1] Samantha Johnson,[2] Claire Carson,[1] Stavros Petrou,[3] Oliver Rivero-Arias ,[1] Jennifer J Kurinczuk,[1] Alison Macfarlane,[4] Elaine Boyle ,[2] Maria A Quigley[1]

[1]National Perinatal Epidemiology Unit (NPEU), Nuffield Department of Population Health, University of Oxford, Oxford, UK
[2]Department of Health Sciences, University of Leicester, Leicester, UK
[3]Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK
[4]Department of Health Sciences, City University, London, UK

Correspondence to
Dr Neora Alterman, National Perinatal Epidemiology Unit (NPEU), Nuffield Department of Population Health, University of Oxford, Oxford OX1 2JD, UK; neora.alterman@gmail.com

Received 9 July 2020
Revised 9 November 2020
Accepted 9 December 2020

To cite: Alterman N, Johnson S, Carson C, *et al*. *Arch Dis Child* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/archdischild-2020-320213

ABSTRACT

Objective To examine the association between gestational age at birth across the entire gestational age spectrum and special educational needs (SENs) in UK children at 11 years of age.

Methods The Millennium Cohort Study is a nationally representative longitudinal sample of children born in the UK during 2000–2002. Information about the child's birth, health and sociodemographic factors was collected when children were 9 months old. Information about presence and reasons for SEN was collected from parents at age 11. Adjusted relative risks (aRRs) were estimated using modified Poisson regression, accounting for confounders.

Results The sample included 12 081 children with data at both time points. The overall prevalence of SEN was 11.2%, and it was inversely associated with gestational age. Among children born <32 weeks of gestation, the prevalence of SEN was 27.4%, three times higher than among those born at 40 weeks (aRR=2.89; 95% CI 2.02 to 4.13). Children born early term (37–38 weeks) were also at increased risk for SEN (aRR=1.33; 95% CI 1.11 to 1.59); this was the same when the analysis was restricted to births after labour with spontaneous onset. Birth before full term was more strongly associated with having a formal statement of SEN or SEN for multiple reasons.

Conclusion Children born at earlier gestational ages are more likely to experience SEN, have more complex SEN and require support in multiple facets of learning. This association was observed even among children born early-term and when labour began spontaneously.

What is already known on this topic?

- Preterm birth, especially extremely preterm birth, is a risk factor for neurodevelopmental sequelae and poor attainment in school.
- Special educational needs are more prevalent in children born at earlier gestational ages, even in children born at 37–38 weeks compared with 40 weeks.

What this study adds?

- Children born at 37–38 weeks of gestation are at moderately elevated risk of special educational needs even if labour began spontaneously.
- The risk of special educational needs following birth at earlier gestational ages is not only greater, but children's needs tend to be more complex.
- Preterm birth is associated most strongly with special educational needs due to attention-deficit/hyperactivity disorder or health/physical difficulties.

INTRODUCTION

Children born preterm (<37 weeks' gestation) are at elevated risk of long-term health problems,[1] neurodevelopmental disorders[2] and poorer school performance.[3 4] The risk is highest in children born very preterm (<32 weeks). These adversities culminate in a higher prevalence of special educational needs (SEN) among children born preterm[5] which may arise from a range of cognitive, learning, physical or behavioural difficulties. Children born extremely preterm (<28 weeks) are more likely to have complex SEN because of impairments in multiple developmental domains.[6 7]

Most prior studies have focused solely on children born extremely preterm or have aggregated all preterm births.[8 9] Some studies have, however, identified a gradient of higher risk for any gestation shorter than 40 weeks.[10 11] The onset of birth is often not spontaneous, but planned through labour induction or pre-labour caesarean section. By 2018–2019, planned births accounted for half of all births in England.[12] It is uncertain whether a relatively shorter pregnancy within term gestations is a risk factor for SEN when labour begins spontaneously.

We aimed to investigate the association between gestational age at birth and SEN at age 11 (final year of primary school) across the full spectrum of gestation and specifically within births at term that began spontaneously. We further aimed to investigate the reasons for SEN in children born preterm compared with those born at term.

METHODS

Millennium Cohort Study

The Millennium Cohort Study (MCS) is a nationally representative longitudinal study of 18 818 children born in the UK between September 2000 and January 2002. The sample was drawn from the universal Child Benefit register at the age of 9–10 months. The sample does not include babies who died prior to the age at sampling, but these constituted 5.5 in 1000 births.[13] A cluster-stratified sampling design was employed where electoral wards were sampled as clusters and wards with a high proportion of disadvantaged families or ethnic minorities were over-sampled to allow for adequate representation.[14] The smaller UK countries were also over-sampled. Initial interviews with the main carer, usually the mother, were conducted when the child was aged 9–10 months and subsequently every 2–4 years, collecting a wide range of information about demographics, health and development. The current study uses data collected at the 9-month survey and the age-11 survey. The latter was conducted when 95.5% of children were in their final year of primary school.

Gestational age at birth

Gestational age in weeks was ascertained from the mother's report of estimated date of delivery and actual date of birth. This information has been shown to have high agreement with linked routine hospital records, except for births post term (≥42 weeks).[15] Completed gestational weeks were categorised as 23–32 weeks (very preterm), 32–33 weeks (moderately preterm), 34–36 weeks (late preterm), 37–38 weeks (early term),

Table 1 Characteristics of Millennium Cohort Study children included in this study by gestational age

	Very preterm <32* N (%†)	Moderately preterm 32–33 n (%)	Late preterm 34–36 n (%)	Early term 37–38 n (%)	Full term 39 n (%)	Full term 40 n (%)	Late term 41 n (%)	Total N (%)	P value‡
	143 (1.2)	135 (1.1)	732 (6.6)	2460 (20.6)	2613 (21.3)	3438 (28.6)	2560 (20.6)	12 081 (100.0)	
Sociodemographic characteristics									
Mean†† maternal age (SD)	27.6 (5.9)	30.0 (6.2)	28.3 (6.2)	28.4 (5.9)	28.4 (6.0)	27.8 (6.0)	28.1 (5.9)	28.2 (6.0)	0.020
White child ethnicity	114 (81.2)	115 (90.7)	616 (86.1)	2017 (83.2)	2163 (84.5)	2866 (84.6)	2.266 (89.3)	10 157 (85.4)	<0.001
Partnership status									0.132
Married	91 (55.5)	90 (67.4)	420 (50.7)	1575 (58.4)	1627 (56.9)	2125 (56.0)	1562 (56.0)	7490 (56.5)	
Cohabiting	31 (28.9)	30 (22.6)	183 (28.2)	528 (24.9)	623 (26.2)	801 (26.6)	651 (28.6)	2847 (26.7)	
Single mother	21 (15.6)	15 (10.0)	129 (21.0)	357 (16.8)	363 (16.9)	512 (17.4)	347 (15.5)	1744 (16.9)	
Maternal education									0.006
Higher (University)	43 (26.8)	44 (32.4)	224 (25.4)	749 (26.0)	861 (28.9)	1111 (28.2)	908 (31.8)	3940 (28.5)	
Medium (A-level)	16 (11.3)	14 (11.6)	83 (11.3)	373 (14.3)	359 (13.0)	516 (14.3)	401 (15.0)	1762 (13.9)	
Lower (GCSE)	50 (37.5)	62 (46.5)	308 (43.2)	903 (40.6)	947 (39.3)	1232 (39.2)	930 (39.1)	4432 (39.8)	
None or other	34 (24.5)	15 (9.5)	117 (20.2)	435 (19.1)	446 (18.9)	579 (18.3)	321 (14.1)	1947 (17.8)	
Household socioeconomic class									0.013§
Managerial/professional	49 (30.7)	53 (44.0)	308 (38.4)	1034 (39.2)	1130 (39.9)	1454 (39.8)	1204 (44.4)	5232 (40.5)	
Intermediate	35 (24.3)	32 (25.3)	129 (17.1)	474 (19.3)	505 (19.4)	680 (19.8)	497 (19.2)	2352 (19.4)	
Routine/manual	55 (39.8)	40 (24.0)	258 (38.5)	840 (36.6)	841 (34.6)	1098 (33.7)	763 (32.6)	3895 (34.6)	
Never/long-term	4 (5.2)	10 (6.8)	37 (6.0)	112 (5.0)	137 (6.1)	206 (6.7)	96 (3.8)	602 (5.6)	
Pregnancy and postnatal characteristics									
Male	68 (50.2)	75 (63.7)	381 (52.5)	1271 (52.2)	1286 (51.0)	1706 (49.6)	1276 (51.5)	6063 (51.2)	0.184
Mean† birth weight, kg (SD)	1.27 (0.38)	2.00 (0.44)	2.62 (0.50)	3.14 (0.49)	3.35 (0.45)	3.48 (0.45)	3.65 (0.45)	3.32 (0.60)	<0.001
Multiple birth	38 (26.1)	30 (24.5)	108 (14.6)	123 (5.5)	26 (1.1)	6 (0.2)	0 (0.0)	331 (3.0)	<0.001
Firstborn child	76 (52.7)	64 (49.1)	328 (42.3)	905 (38.3)	995 (37.4)	1465 (42.3)	1197 (47.3)	5030 (41.7)	<0.001
Maternal smoking									0.003
Never	86 (63.0)	80 (58.5)	446 (57.9)	1671 (63.9)	1749 (63.8)	2335 (64.1)	1772 (65.7)	8139 (63.8)	
Gave up in pregnancy	19 (10.4)	21 (15.0)	99 (13.8)	264 (11.9)	260 (9.7)	406 (12.9)	315 (13.6)	1384 (12.2)	
Smoked during pregnancy	38 (26.5)	34 (26.5)	186 (28.3)	525 (24.3)	602 (26.5)	696 (23.1)	471 (20.7)	2552 (24.0)	
Alcohol during pregnancy	10 (7.0)	11 (7.7)	54 (8.0)	161 (6.9)	189 (7.3)	230 (7.2)	210 (8.6)	865 (7.5)	0.683
Labour induced	16 (8.6)	28 (16.6)	196 (26.2)	717 (28.7)	566 (21.4)	798 (22.0)	1215 (46.4)	3536 (28.3)	<0.001
Mode of birth									<0.001
Vaginal delivery	58 (41.3)	57 (39.9)	461 (64.5)	1628 (67.2)	2083 (81.7)	2937 (87.1)	2146 (85.2)	9370 (78.9)	
Planned caesarean	13 (8.4)	20 (15.2)	73 (9.2)	568 (22.5)	299 (10.2)	133 (3.4)	61 (2.1)	1167 (9.1)	
Emergency caesarean	71 (50.4)	58 (44.9)	198 (26.3)	262 (10.3)	226 (8.1)	362 (9.5)	351 (12.7)	1528 (12.0)	
Neonatal intensive care	125 (91.7)	133 (85.0)	296 (39.9)	222 (8.8)	124 (4.3)	159 (4.1)	110 (4.7)	1149 (9.6)	<0.001
Month of birth									0.170
September–December	48 (24.2)	47 (28.9)	264 (34.1)	916 (36.1)	918 (33.1)	1224 (34.7)	896 (34.7)	4313 (34.4)	
January–April	45 (30.6)	42 (31.1)	246 (32.7)	798 (32.6)	828 (31.4)	1081 (31.2)	793 (29.9)	3833 (31.4)	
May–August	50 (45.2)	46 (40.0)	222 (33.1)	746 (31.3)	867 (35.5)	1133 (34.0)	871 (35.4)	3935 (34.2)	

*The median gestational age in the group of <32 weeks was 29.5 weeks, with 0.3% born ≤27 weeks (extremely preterm).
†Percentages and means are weighted to account for study design, non-response and loss to follow-up at age 11.
‡χ^2 tests for categorical variables and F tests for continuous variables.
§Based on small numbers.
GCSE, General Certificate of Secondary Education.

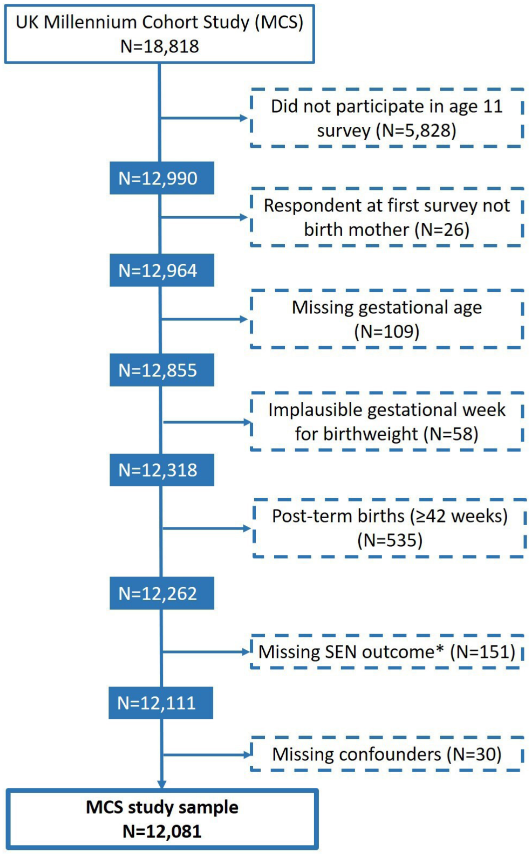

Figure 1 MCS children included in study sample. *Missing outcome includes 23 missing observations due to not attending school and 30 missing observations due to reason for special educational needs being a gifted or talented child (see Methods section).

39 weeks, 40 weeks (both defined full term) and 41 weeks (late term) (table 1).[16]

Special educational needs

At the age-11 survey, parents were asked whether the school or local education authority had ever told them their child has SEN. Further information was collected on whether the child had a statement of SEN. This is a legal document that may be issued by the local authority following a statutory assessment and indicates the child has higher intensity of need (replaced in 2014 by an Education, Health and Care Plan). Those in process of assessment (48 children) were classified as without a statement. In addition, information about the reason(s) for the child's SEN, that is, the diagnosis or difficulty, was gathered using predefined and open-text responses. For the current study, we categorised the reported reasons for SEN into learning difficulty, autism spectrum disorder (ASD), speech/language/communication difficulties, attention-deficit/hyperactivity disorder (ADHD), health/physical problem and behavioural/emotional/social difficulties (online supplemental table S1). We further generated a variable designating whether the child had multiple SENs (more than a single category of reason for SEN). In several cases, the reason given for the child's SEN was being gifted or talented. If no additional evidence of SEN existed, these cases were classified as missing the outcome, as they might be due to misclassification.

Exclusions and missing data

Of the 18 818 children recruited to the MCS, 12 990 (69%) participated in the age-11 survey (figure 1). Children were excluded if the mother was not the main respondent at the initial survey or if gestational age was missing or implausible given the reported birth weight.[15 17] Post-term births were excluded due to lower data quality.[15] Children with missing data on SEN or confounders were also excluded. The final study sample had a similar distribution of gestational age to the cohort of children originally recruited but was somewhat less socially advantaged (online supplemental table S2).

Statistical analyses

Relative risks for the association between gestational age at birth and each of the outcomes were estimated using modified Poisson regression with gestational week 40 used as referent.[18] All potential confounders were collected at the 9-month survey. A priori adjustments were made for mother's education level, multiple birth, child sex and month of birth (age within the school year).[3 4] Additional potential confounders were mother's age, partnership status, smoking during pregnancy, alcohol consumption during pregnancy (none/light vs moderate/heavy),[19] household's socioeconomic class (based on last known occupation of the mother or her partner, if higher), ethnicity (white or non-white) and whether firstborn. Additional confounders associated with the exposure and SEN outcome at p value <0.1 were assessed in separate sociodemographic and perinatal models. The effect of each variable removal was examined individually, both within a block (retaining if $p<0.10$) and when the variables from both blocks were combined, until only those independently associated with the outcome at p value <0.05 were retained. Models of additional outcomes were adjusted for the same covariates to aid comparability. For analyses of reasons for SEN, we compared preterm births (<37 weeks) with births at term (37–41 weeks). All analyses were conducted in Stata V.15. Analyses accounted for the clustered, stratified design using the survey commands, while also allowing for within-family clustering for multiples. Weights were applied to allow for non-response at the initial survey and loss to follow-up at age 11.[20] Ethics approval for the MCS was granted from the Multicentre Research Ethics Committee. No further approvals were required for this study.

Sensitivity analysis

We restricted the analysis of multiple SENs to predefined reasons, not including those coded from open-text answers where reliability may be lower (online supplemental table S1).

Subgroup analyses

We explored the associations of gestational age with SEN outcomes within the group of term-born children and where labour onset was spontaneous, that is, excluding planned birth through induction of labour or planned caesarean section.

RESULTS

Descriptive characteristics

The analysis sample included 12 081 children. Gestational age at birth was associated with birth weight and singleton birth in a 'dose-response' pattern. In addition, it was associated with the following characteristics ($p<0.05$): maternal age, education, smoking, child ethnicity, being firstborn and household socioeconomic class (table 1).

Table 2 Association between gestational age and any SEN, statement of SEN and multiple SENs at age 11 in the MCS children—all births and spontaneous-onset births at term only

	Total	Very preterm <32 weeks	Moderately preterm 32–33 weeks	Late preterm 34–36 weeks	Early term 37–38 weeks	Full term 39 weeks	Full term 40 weeks	Late term 41 weeks
Any SEN								
Total sample								
N	12 081	143	135	732	2460	2613	3438	2560
n (%)*	1243 (11.2)	33 (27.4)	15 (10.6)	108 (17.1)	283 (12.7)	250 (10.3)	315 (9.5)	239 (10.0)
RR (95% CI)		2.88 (2.02 to 4.11)	1.11 (0.62 to 2.01)	1.80 (1.40 to 2.31)	1.34 (1.11 to 1.61)	1.08 (0.90 to 1.30)	1.00	1.05 (0.88 to 1.26)
Adjusted† RR (95% CI)		2.89 (2.02 to 4.13)	1.09 (0.58 to 2.04)	1.78 (1.41 to 2.25)	1.33 (1.11 to 1.59)	1.07 (0.90 to 1.28)	1.00	1.05 (0.88 to 1.25)
Spontaneous-onset term births								
N	6854	–	–	–	1246	1783	2526	1299
n (%)	651 (9.9)				143 (12.8)	162 (9.4)	226 (9.0)	120 (9.6)
Adjusted RR (95% CI)		–	–	–	1.36 (1.06 to 1.74)	1.04 (0.83 to 1.30)	1.00	1.07 (0.84 to 1.36)
Statement of SEN								
Total sample								
N	12 075	143	135	732	2460	2609	3438	2558
n (%)	561 (4.9)	18 (15.3)	8 (6.7)	53 (7.3)	127 (5.4)	106 (4.6)	134 (3.8)	115 (4.5)
RR (95% CI)		4.02 (2.29 to 7.07)	1.76 (0.77 to 4.04)	1.91 (1.33 to 2.75)	1.41 (1.03 to 1.94)	1.21 (0.90 to 1.63)	1.00	1.18 (0.88 to 1.58)
Adjusted RR (95% CI)		3.98 (2.24 to 7.06)	1.84 (0.78 to 4.38)	1.88 (1.30 to 2.72)	1.38 (1.01 to 1.88)	1.20 (0.89 to 1.62)	1.00	1.22 (0.91 to 1.63)
Spontaneous-onset term births								
N	6850	–	–	–	1246	1780	2526	1298
n (%)	275 (4.1)				64 (5.2)	56 (3.6)	96 (3.6)	59 (4.5)
Adjusted RR (95% CI)		–	–	–	1.31 (0.88 to 1.96)	1.00 (0.68 to 1.48)	1.00	1.29 (0.88 to 1.89)
Multiple SENs								
Total sample								
N	12 053	141	135	730	2455	2611	3429	2552
n (%)	287 (2.8)	11 (8.5)	3 (2.5)	28 (6.0)	68 (3.1)	68 (2.9)	70 (2.1)	39 (2.0)
RR (95% CI)		4.01 (2.08 to 7.72)	1.19 (0.35 to 4.11)	2.84 (1.55 to 5.22)	1.46 (0.99 to 2.15)	1.36 (0.92 to 2.01)	1.00	0.94 (0.60 to 1.49)
Adjusted RR (95% CI)		3.32 (1.61 to 6.84)	1.09 (0.30 to 3.93)	2.54 (1.41 to 4.60)	1.40 (0.95 to 2.05)	1.32 (0.90 to 1.94)	1.00	0.97 (0.62 to 1.53)
Spontaneous-onset term births								
N	6841	–	–	–	1244	1782	2521	1294
n (%)	152 (2.4)				39 (3.7)	44 (2.7)	49 (1.9)	20 (1.8)
Adjusted RR (95% CI)		–	–	–	1.75 (1.03 to 2.95)	1.41 (0.86 to 2.29)	1.00	1.00 (0.57 to 1.73)

*Percentages are weighted to account for sampling design, non-response to the MCS, and loss to follow-up.
†Adjusted for white ethnicity, maternal education, household socioeconomic class, child sex, month of birth, multiple birth.
MCS, Millennium Cohort Study; RR, relative risk; SEN, special educational need.

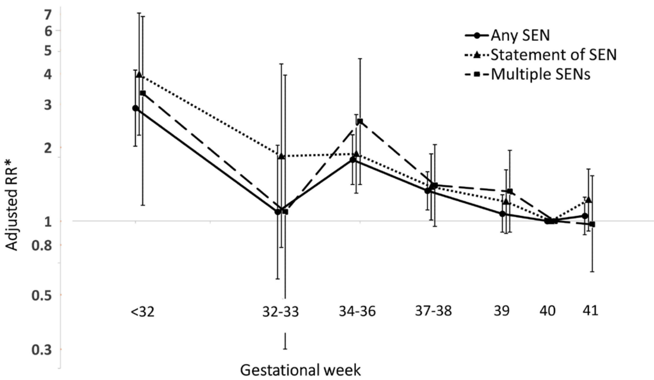

Figure 2 Any special educational need (SEN), statement of SEN and multiple SENs in the Millenium Cohort Study children at age 11 by gestational age. *Adjusted for ethnicity, maternal education, household socioeconomic class, child sex, month of birth, multiple birth. RR, relative risk.

Association between gestational age and SEN

The proportion of children with any SEN was 11.2%. This ranged from 9.5% in children born at 40 weeks to 27.4% in those born at <32 weeks (table 2). There was an inverse association between gestational age and SEN, both before and after adjustment for confounders. The relative risk (RR) reached 2.89 (95% CI 2.02 to 4.13) among children born very preterm compared with those born at 40 weeks. A statistically significant increase in risk (RR=1.33; 95% CI 1.11 to 1.59) was found even among children born at early term gestation. An exception to this trend were children born moderately preterm, who were not at higher risk than those born at 40 weeks. Children born at 41 weeks did not have a different risk compared with the reference group.

The proportion of children with a statement of SEN was 4.9%. This ranged from 3.8% in children born at 40 weeks to 15.3% in children born very preterm (table 2). The proportion of children with multiple SENs was 2.8%, ranging from 2.0% for children born late term to 8.5% in very preterm. Of the children with multiple SENs, 38.3% did not have a statement, and of the children that had a statement, 63.9% did not have multiple SENs. A 'dose-response' of increased risk with lower gestational age was observed for having a statement and multiple SENs, reaching adjusted relative risk (aRR)=3.98 (95% CI 2.24 to 7.06) and aRR=3.32 (95% CI 1.61 to 6.84) respectively for those born very preterm. The aRR observed for statement and multiple SENs was generally higher than for any SEN (figure 2). The result of a sensitivity analysis using only predefined reasons to measure multiple SENs was not materially different from the main result (online supplemental table S3).

We further examined these associations within a subgroup of births at term with spontaneous onset, excluding 38% of births where delivery was planned. The RR for SEN in births with spontaneous onset at early term was similar to that found for all births at early term (aRR=1.36 vs aRR=1.33, respectively), as was the RR of a statement of SEN (aRR=1.31 vs aRR=1.38) (table 2). The RR for multiple SENs within spontaneous-onset births was slightly higher than that of all births at early term (aRR=1.75 vs. aRR=1.40).

Reasons for SEN in children born preterm and at term

Learning difficulty was the most frequent reason for SEN, reported for 6.8% of the sample and comprising 61.9% of those with SEN. ASD was reported as the reason for SEN in 19.5% of

Table 3 Reasons for SEN at age 11 in the Millennium Cohort Study children born preterm compared with term gestation

		Any SEN		Learning difficulty		Autism spectrum disorder		Speech/communication difficulties		Attention deficit hyperactivity disorder		Health/physical		Behavioural/emotional/social difficulties	
	N*	N (%)†	Adjusted RR‡ (95% CI)	N (%)	Adjusted RR (95% CI)	N (%)	Adjusted RR (95% CI)	N (%)	Adjusted RR (95% CI)	N (%)	Adjusted RR (95% CI)	N (%)	Adjusted RR (95% CI)	N (%)	Adjusted RR (95% CI)
Total	12 053	1215 (11.0)		772 (6.8)		235 (2.1)		175 (1.7)		149 (1.6)		162 (1.4)		114 (1.2)	
37–41 weeks	11 047	1063 (10.3)	1.00	678 (6.5)	1.00	209 (2.0)	1.00	155 (1.6)	1.00	128 (1.4)	1.00	129 (1.2)	1.00	99 (1.1)	1.00
<37 weeks	1006	152 (17.4)	1.66 (1.38 to 2.01)	94 (9.6)	1.40 (1.08 to 1.83)	26 (3.4)	1.68 (1.02 to 2.77)	20 (2.3)	1.46 (0.83 to 2.55)	21 (3.5)	2.22 (1.11 to 4.47)	33 (3.5)	2.86 (1.80 to 4.54)	15 (2.8)	2.16 (0.88 to 5.29)

*28 observations missing reason for SEN not included.
†Weighted percentages from all children per gestational age group.
‡Adjusted for white ethnicity, maternal education, household socioeconomic class, child sex, month of birth, multiple birth.
RR, relative risk; SEN, special educational need.

children with SEN, followed by speech/language/communication difficulties (15.2%), ADHD (14.3%), health/physical problem (13.1%) and behavioural/emotional/social difficulties (11.1%). Table 3 presents the aRR for each reason for SEN in children born preterm compared with term. Preterm-born children were at increased risk for all SEN reasons examined, although the aRRs for SEN because of speech/language/communication and behavioural/emotional/social problems were not statistically significant. There was evidence of a stronger effect of preterm birth on SEN in relation to ADHD (aRR=2.22; 95% CI 1.11 to 4.47) and health/physical needs (aRR=2.86; 95% CI 1.80 to 4.54) compared with the effect on any SEN overall.

DISCUSSION

We have shown that the risk of SEN among 11-year-old children in the UK increases with lower gestational age at birth. We have further shown that children born preterm are more likely to have complex SEN or SEN for multiple reasons than children born at term. Children born very preterm had an almost threefold higher risk of any SEN and fourfold higher risk for a statement of SEN or multiple reasons for SEN compared with children born at 40 weeks of gestation. Our findings are comparable with a Scottish study where children born at 28–32 weeks were 2.7 times more likely to have SEN at any point during their school career.[11] A prior national UK study found RRs of SEN substantially higher than those described here, but included only extremely preterm children born <26 weeks of gestation.[8] Furthermore, our results regarding multiple SENs are in line with prior studies examining children born very and extremely preterm that found a threefold increased risk of having impairments in multiple domains affecting learning.[6 21]

Our study explored the full gestation spectrum and we observed a gradient of risk for children born preterm and for birth at any gestational week lower than 40. Effects were statistically significant starting at early term (37–38 weeks) where 12.7% of the children had SEN compared with 9.5% of the children in week 40. This modest additional risk may potentially have a large population effect since almost one in four births occur at these gestational weeks because of a high rate of planned early births.[12 22] A prior study found that a planned early birth was associated with an elevated risk for being developmentally vulnerable at age 5, which was higher than the excess risk associated with the lower gestational age.[23] However, another study did not identify an interaction between SEN and type of birth onset,[11] and our study did not find a weaker effect of birth at early term when including only those with spontaneous labour onset. This might imply that gestation is the main driver leading to SEN in children born at early term gestations, rather than a fetal or maternal reason leading to iatrogenic early birth.

The moderately preterm group diverged from the ‘dose-response’ pattern of increasing risk with decreasing gestational age, but the reasons for this are unclear. In the MCS, it has previously been shown that this group is socioeconomically more advantaged and ethnically less diverse than the adjacent groups[4 24]; however, these factors were adjusted for in the models. This divergence in the dose response was not identified in other populations[11] and may therefore be due to unmeasured confounders or to chance, given the low numbers with reported SEN in this group.

Regarding parent-reported reasons for SEN, preterm birth was most strongly associated with health/physical needs including sensory impairments. Of the children born at term, 1.2% were reported to have SEN for this reason compared with 3.5% of the children born preterm. A previous study using routine educational records similarly observed the strongest associations with SEN due to physical/motor disability and sensory impairments, along with intellectual disability.[25] Preterm birth was also associated more strongly with SEN for ADHD compared with SEN for any reason. This finding is consistent with previous research reporting higher risks of ADHD in preterm populations.[26]

The main strength of our study is use of a nationally representative sample large enough to explore the association of SEN with the complete gestation spectrum while adjusting for detailed potential confounders. A further strength is the examination of complex SEN and exploration of reasons for SEN, allowing a better understanding of the special needs characteristic of preterm-born children.

The main study limitation was reliance on parents’ reporting about SEN, which may be prone to bias. However, during the relevant time frame, the Department of Education register in England may not have been the gold standard for SEN either, since one in four children in England were recorded as having SEN at age 11.[27] These are composed of different levels including 13.3% with ‘School Action’ code, 11.3% with ‘School Action Plus’ code where advice or support from external agencies is sought in consultation with parents, and 3.3% with a statement of SEN.[27 28] A commissioned national review concluded that many children, especially with ‘School Action’ code, were inaccurately identified as having SEN when their need was for better teaching and pastoral care.[29] The prevalence of SEN in our study was 11.2% overall (similarly to ‘School Action Plus’) and implies parents may have been better informed about SEN when it was genuine. The prevalence of SEN statement found in our study (4.9%) was also comparable with that in England at the relevant time[27] and increases confidence in our findings.

Children with SEN have lower aspirations for their future education and employment[30] and substantially fewer of them progress to higher education, particularly those with a statement of SEN.[28] There is a need for broader screening and consideration of additional support for children born before full term, including among those born just a few weeks early. Our findings also suggest that the possible long-term implications of birth at early term gestations should be considered in decision-making regarding planned births in pregnancies with no immediate detriment to mother or baby. Results are generalisable to settings with similar neonatal care and school support.

Conclusion

UK children born at earlier gestational ages are more likely to have SEN at age 11 compared with those born in week 40, reaching a peak of 27.4% in children born very preterm. An increased risk of SEN exists even for children born at early term gestations and even when the birth was of spontaneous onset. SEN in children born preterm is more common and also more complex.

Acknowledgements We are grateful to the families of the Millennium Cohort Study and to the Medical Research Council (MRC) for funding this project (MR/M01228X/1). We would like to acknowledge the TIGAR Patient and Public Involvement (PPI) group and National Childbirth Trust (NCT) representatives for their input on the study objectives and the TIGAR Advisory Group for their input on the study design.

Contributors MAQ, NA, CC and SJ designed the study with input from EB, JJK, AM, SP and OR-A. Statistical analysis was performed by NA, while MAQ, CC, SJ, EB, JJK, AM, SP, OR-A and NA were all involved in the interpretation of the findings. NA wrote the initial draft of the manuscript and all authors contributed to draft of the manuscript and reviewed the final version.

Funding The TIGAR study was funded by a research grant from the Medical Research Council (MR/M01228X/1).

Competing interests None declared.

Patient consent for publication Not required.

Data availability statement Data from the Millennium Cohort Study surveys are available from the Centre for Longitudinal Studies and can be accessed through the UK Data Service (https://ukdataservice.ac.uk/).

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

ORCID iDs
Neora Alterman http://orcid.org/0000-0001-8027-4164
Oliver Rivero-Arias http://orcid.org/0000-0003-2233-6544
Elaine Boyle http://orcid.org/0000-0002-5038-3148

REFERENCES

1 Miller JE, Hammond GC, Strunk T, *et al*. Association of gestational age and growth measures at birth with infection-related admissions to hospital throughout childhood: a population-based, data-linkage study from Western Australia. *Lancet Infect Dis* 2016;16:952–61.
2 Woythaler M. Neurodevelopmental outcomes of the late preterm infant. *Semin Fetal Neonatal Med* 2019;24:54–9.
3 Chan E, Quigley MA. School performance at age 7 years in late preterm and early term birth: a cohort study. *Arch Dis Child Fetal Neonatal Ed* 2014;99:F451–7.
4 Quigley MA, Poulsen G, Boyle E, *et al*. Early term and late preterm birth are associated with poorer school performance at age 5 years: a cohort study. *Arch Dis Child Fetal Neonatal Ed* 2012;97:F167–73.
5 Twilhaar ES, de Kieviet JF, Aarnoudse-Moens CS, *et al*. Academic performance of children born preterm: a meta-analysis and meta-regression. *Arch Dis Child Fetal Neonatal Ed* 2018;103:F322–30.
6 Johnson S, Strauss V, Gilmore C, *et al*. Learning disabilities among extremely preterm children without neurosensory impairment: comorbidity, neuropsychological profiles and scholastic outcomes. *Early Hum Dev* 2016;103:69–75.
7 Hutchinson EA, De Luca CR, Doyle LW, *et al*. School-age outcomes of extremely preterm or extremely low birth weight children. *Pediatrics* 2013;131:e1053–61.
8 Johnson S, Hennessy E, Smith R, *et al*. Academic attainment and special educational needs in extremely preterm children at 11 years of age: the EPICure study. *Arch Dis Child Fetal Neonatal Ed* 2009;94:F283–9.
9 Odd D, Evans D, Emond A. Preterm birth, age at school entry and educational performance. *PLoS One* 2013;8:e76615.
10 Paranjothy S, Dunstan F, Watkins WJ, *et al*. Gestational age, birth weight, and risk of respiratory hospital admission in childhood. *Pediatrics* 2013;132:e1562–9.
11 MacKay DF, Smith GCS, Dobbie R, *et al*. Gestational age at delivery and special educational need: retrospective cohort study of 407,503 schoolchildren. *PLoS Med* 2010;7:e1000289.
12 NHS Digital. *NHS maternity statistics 2018-19*, 2019.
13 Cullis A. *A technical report infant mortality in the Millennium Cohort Study (MCS) sample areas*. Centre for Longitudinal Studies, 2007.
14 Plewis I, Calderwood L, Hawkes D, *et al*. *The Millennium Cohort Study: technical report on sampling*. Centre for Longitudinal Studies, 2007.
15 Poulsen G, Kurinczuk JJ, Wolke D, *et al*. Accurate reporting of expected delivery date by mothers 9 months after birth. *J Clin Epidemiol* 2011;64:1444–50.
16 American College of Obstetricians and Gyneocologists (ACOG), Society for Maternal-Fetal Medicine. Definition of term pregnancy committee opinion 2013:579.
17 Bonellie S, Chalmers J, Gray R, *et al*. Centile charts for birthweight for gestational age for Scottish singleton births. *BMC Pregnancy Childbirth* 2008;8:5.
18 Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702–6.
19 Kelly Y, Iacovou M, Quigley MA, *et al*. Light drinking versus abstinence in pregnancy – behavioural and cognitive outcomes in 7-year-old children: a longitudinal cohort study. *BJOG* 2013;120:1340–7.
20 Hansen K, Johnson J, Calderwood L, *et al*. *Millennium Cohort Study: a guide to the datasets (first, second, third, fourth and fifth surveys)*. London: Centre for Longitudinal Studies, 2014.
21 Woodward LJ, Moor S, Hood KM, *et al*. Very preterm children show impairments across multiple neurodevelopmental domains by age 4 years. *Arch Dis Child Fetal Neonatal Ed* 2009;94:339–44.
22 Office for National Statistics. Births by gestational age at birth, England and Wales, 2018. Available: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/adhocs/10766birthsbygestationalageatbirthenglandandwales2018 [Accessed 11 May 2020].
23 Bentley JP, Roberts CL, Bowen JR, *et al*. Planned birth before 39 weeks and child development: a population-based study. *Pediatrics* 2016;138. doi:10.1542/peds.2016-2002
24 Fitzpatrick A, Carter J, Quigley MA. Association of gestational age with verbal ability and spatial working memory at age 11. *Pediatrics* 2016;138:e20160578.
25 Mackay DF, Smith GCS, Dobbie R, *et al*. Obstetric factors and different causes of special educational need: retrospective cohort study of 407,503 schoolchildren. *BJOG* 2013;120:297–308.
26 Franz AP, Bolat GU, Bolat H, *et al*. Attention-deficit/hyperactivity disorder and very preterm/very low birth weight: a meta-analysis. *Pediatrics* 2018;141. doi:10.1542/peds.2017-1645
27 Department of Education. *Special educational needs in England*. London, 2012.
28 Department for Education. Special educational needs: an analysis and summary of data sources 2019.
29 OFSTED. *The special educational needs and disability review*, 2010.
30 Institute of Education. *SEN, school life and future aspirations – Millennium Cohort Study*, 2017.