Prediction of movement difficulties at 5 years from parent report at 2 years in children born extremely preterm

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Abstract
Aim: To assess the predictive validity of parent-reported gross motor impairment (GMI) at age 2 years to detect significant movement difficulties at age 5 years in children born extremely preterm.
Method: Data were from 556 children (270 males, 286 females) born at less than 28 weeks' gestation in 2011 to 2012 in 10 European countries. Parent report of moderate/severe GMI was defined as walking unsteadily or unable to walk unassisted at 2 years corrected age. Examiners assessed significant movement difficulties (score ≤5th centile on the Movement Assessment Battery for Children, Second Edition) and diagnoses of cerebral palsy (CP) were collected by parent report at 5 years chronological age.
Results: At 2 years, 66 (11.9%) children had moderate/severe GMI. At 5 years, 212 (38.1%) had significant movement difficulties. Parent reports of GMI at age 2 years accurately classified CP at age 5 years in 91.0% to 93.2% of children. Classification of moderate/severe GMI at age 2 years had high specificity (96.2%; 95% confidence interval 93.6–98.0) and positive predictive value (80.3%; 68.7–89.1) for significant movement difficulties at age 5 years. However, 74.5% of children with significant movement difficulties at 5 years were not identified with moderate/severe GMI at age 2 years, resulting in low sensitivity (25.1%; 19.4–31.5).
Interpretation: This questionnaire may be used to identify children born extremely preterm who at age 2 years have a diagnosis of CP or movement difficulties that are likely to have a significant impact on their functional outcomes at age 5 years.

Abbreviations: GMI, gross motor impairment; ISCED, International Standard Classification of Education; MABC, Movement Assessment Battery for Children.

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[Boxed text on page 2]

What this paper adds

- One in 10 children born extremely preterm had gross motor impairment at 2 years.
- At 5 years, more than one-third of children born extremely preterm had movement difficulties.
- Parent-reported gross motor impairment at age 2 years was highly predictive of movement difficulties at age 5 years.

[Main text]

Motor impairment is common among children born extremely preterm (<28 weeks gestational age), with around 10% having cerebral palsy (CP) and up to 50% having movement difficulties.[1,2] CP is the most severe motor disability in childhood[3] and is conceptualized as 'a group of permanent disorders of the development of movement and posture causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain'.[4] Movement difficulties, which may occur without CP, can manifest in infancy and persist throughout the lifespan, with increased difficulties reported in young adults born preterm.[5,6] Delayed motor development early in life may be predictive of, or may contribute to, later developmental and/or mental health problems[7–9] as well as problems with daily activities, attention, communication, and academic skills.[10,11]

Appropriate and timely assessment is key to identifying children who may benefit from intervention to improve motor outcomes.[12–14] Assessing motor development in early childhood is recommended as one of the key components of routine developmental follow-up for children born preterm.[15–17] However, the early identification of children born extremely preterm at risk of long-term movement difficulties remains a challenge. Even the most widely used standardized tests of early motor function have relatively low predictive ability for identifying later movement difficulties.[18] A recent systematic review showed that only one out of seven standardized assessment tools for use at 2 years of age had good predictive validity for later movement difficulties.[19] As such, studies on the long-term predictive validity of motor assessments are recommended.[19]

The resources required to administer standardized tests often prohibit their use on a large scale. Parent reports provide a cost-efficient alternative to clinical assessments and may be useful tools for population-level screening. However, some parent questionnaires have low sensitivity and low positive predictive value for detecting later movement difficulties.[20–22] Evidence on the predictive validity of parent reports in the early years for future movement difficulties is limited[23] and not exclusively focused on children born extremely preterm (see, for example, Yue et al.[22] and Libertus and Landa[24]). Because the motor development of children born extremely preterm differs from that of term-born children,[25,26] it is important to ascertain the accuracy of parent reports in this population, for both clinical practice and research. Assessing the accuracy of screening tools, such as parental reports, is important to provide cost-effective measures that can be incorporated into developmental surveillance programmes. Maximizing both sensitivity and specificity is important to identify tools that identify children at risk who may need further assessment or intervention while reducing the number of over-referrals. The aim of this study was to assess the predictive validity of a parent report of children's gross motor function at 2 years of age for detecting significant movement

difficulties at 5 years of age in children born extremely preterm. Predicting outcomes at 2 years of age for children born extremely preterm is important because this is recommended as a routine point of assessment in neurodevelopmental follow-up for children born preterm discharged from neonatal care, at which point the need for further surveillance or intervention is determined.[15]

METHOD

Design

Data were from the Effective Perinatal Intensive Care in Europe (EPICE) population-based cohort of children born very preterm (<32 weeks gestational age) and the follow-up study at 5 years of age, Screening to improve Health In very Preterm infantS in Europe (SHIPS). In this cohort, 6792 infants born very preterm (1671 extremely preterm) over a 12-month period in 2011 to 2012 from 19 regions in 11 European countries survived to discharge from neonatal care.[27] A standardized questionnaire was used to collect data from obstetric and neonatal records at baseline. At 2 years corrected age and at 5 years chronological age, parents completed a questionnaire to assess their child's health and neurodevelopment. At the 5-year follow-up, children born extremely preterm were also offered an assessment of motor function using the Movement Assessment Battery for Children, Second Edition (MABC-2),[28] conducted by a clinician or study psychologist at a clinic, school, or home.

Parental consent was obtained at baseline and again at 2 years and 5 years. The European study was approved by the French Advisory Committee on Use of Health Data in Medical Research and the French National Commission for Data Protection and Liberties. Ethical authorizations from local ethics boards were obtained, as required by national legislation.

Sample

Our sample included children born extremely preterm from 10 of the 11 study countries (parent-reported gross motor function at 2 years was not assessed in France) who participated in both the 2- and 5-year follow-up (*n* = 665; Figure S1). We excluded children without parent-reported gross motor function at 2 years (*n* = 2) and without MABC-2 scores at 5 years (*n* = 100), and those whose clinical assessment at 5 years was conducted using the MABC-1 (*n* = 7). We included children with severe neurodevelopmental impairment (deaf/hearing uncorrected with aids; blind/sees light only; IQ ≤ 3 standard deviations [SD] [<55 points]). MABC-2 total scores for children who could not be assessed owing to inability to complete any or some of the sub-tests (*n* = 39; of these 18 had a diagnosis of CP) were imputed using the results of domain-level scores where available, or clinical information, on a case-by-case basis by a group of neurodevelopmental specialists and an epidemiologist (RC, UA, SJ, and JZ). A total of 556 children (270 males, 286 females) were included in the final analysis.

Perinatal data collection

Maternal, pregnancy, and neonatal characteristics are detailed in Table 1 and included maternal age at childbirth, maternal country of birth, parity, multiple birth, premature rupture of membranes, pre-eclampsia/eclampsia/haemolysis, elevated liver enzymes (and low platelets), child sex, birthweight, congenital anomalies, and gestational age defined as the best estimate determined by the obstetric team on the basis of information for last menstrual period and antenatal ultrasounds. Small for gestational age was defined as a

birthweight less than the 10th centile of European references developed for the cohort,[27] bronchopulmonary dysplasia as supplemental oxygen at 36 weeks postmenstrual age, severe neonatal morbidity as a composite measure of cystic periventricular leukomalacia, intraventricular haemorrhage grades III and IV, severe necrotizing enterocolitis that required surgery or peritoneal drainage, or retinopathy of prematurity equal to or greater than stage 3.

Two-year follow-up

Data on parental socio-demographic status and child's gross motor function were collected using a questionnaire completed by the child's main caregiver. Gross motor function was assessed using three forced-choice questions (Table 2). Responses were classified into three categories: (1) moderate/severe gross motor impairment (GMI), 1c or 1d; (2) severe GMI, 1d; (3) any severe GMI, 1d or 2b or 3b.

Five-year follow-up

Data on parental cohabitation status, household unemployment status, and the mothers' highest attained educational level were collected by parent report, coded according to the International Standard Classification of Education (ISCED[30]) into three categories: low (ISCED 0–2); intermediate (ISCED 3–5); and high (ISCED 6–8) education. Children's formal clinical diagnoses of CP were also collected by parental report.

The MABC-2 was used to assess three components of motor function: manual dexterity; aiming and catching; and balance.[28] As wide differences in outcome can result from the use of different test norms,[31] the original UK test norms were used to convert raw scores to age-standardized scaled scores (mean 10; SD 3) and centiles for children in all countries, for the three components and a total MABC-2 score. As specified in the MABC-2 manual, scores greater than the 15th centile were used to classify children as having no movement difficulties, scores greater than the 5th and up to the 15th centiles to classify children at risk of movement difficulties, and scores no more than the 5th centile to classify children with significant movement difficulties.[28]

Statistical analysis

First, we described and compared the socio-demographic and clinical characteristics of the study sample and those excluded, using logistic regressions, modelling country as a fixed effect, owing to differences in follow-up rates. Using χ^2 tests, we compared classifications of GMI at 2 years and movement difficulties at 5 years of age. Means (SD) for MABC-2 scaled scores according to classifications of GMI at 2 years were computed. Predictive values with 95% confidence intervals (CI) for significant movement difficulties at 5 years from parent-reported impairment at 2 years were calculated (n = 556). We additionally assessed the predictive values for CP only (Table S1) and for non-CP significant movement difficulties (n = 533) (excluding 42 children with both significant movement difficulties but with CP at 2 years of age) (Table S2). All analyses were performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA) or Stata 15.0 (StatCorp, College Station, TX, USA) with statistical significance defined as two-sided p-values less than 0.05. The predictive values were calculated using the command 'diagt' in Stata. For instance, the sensitivity is the proportion of children with gross motor difficulties at 5 years of age (based on the MABC-2), identified as having a GMI at 2 years (based on the parental questionnaire).

RESULTS

Participants' mean gestational age was 26 weeks 3 days (SD 8 days); mean birthweight was 877.2g (SD 196.0). Participants were more likely to have older, employed, multiparous, and native-born mothers compared with non-participants (Table 1). Participants were also more likely to be small for gestational age, but less likely to be born at a younger gestational age or to have severe neonatal morbidity than non-participants (Table 1). Participants were less likely to have GMI at 2 years of age than children excluded owing to missing MABC-2 scores at 5 years (*n* = 100) or clinical assessment conducted using the MABC-1 (*n* = 7).

At 2 years, the proportion of children with moderate/severe GMI was 11.9%, severe GMI 7.1%, and any severe GMI 8.1% (Table 3). At 5 years, a higher proportion of children were at risk of movement difficulties (22.9%; *n* = 127; two had a diagnosis of CP) or had significant movement difficulties (38.1%; *n* = 212; 35 had a diagnosis of CP) on the MABC-2. No movement difficulties were detected for 217 children (39.0%; four had a diagnosis of CP).

Overall, 80.3% (53 out of 66) of the children classified with moderate/severe GMI at 2 years had significant movement difficulties at 5 years, and 94.9% (37 out of 39) of those classified with severe GMI at 2 years had significant movement difficulties at age 5 years. Of children without moderate/severe GMI at 2 years, 32.4% (158 out of 487) and 24.4% (119 out of 487) had significant movement difficulties or were at risk of movement difficulties at 5 years respectively. Parent reports at 2 years tended to under-identify children with later movement difficulties, as 74.5% (158 out of 212) with significant movement difficulties at 5 years were not identified with moderate/severe GMI at age 2 years.

MABC-2 scores at the age of 5 years generally decreased with increasing levels of impairment at age 2 years in all domains (Table 4). Children with moderate/severe GMI at age 2 years had lower MABC-2 total and component scores at age 5 years. Mean component scores ranged from 6.6 (SD 3.3) for manual dexterity to 8.3 (SD 3.2) for aiming and catching.

Parent reports of GMI at age 2 years accurately classified movement difficulties at age 5 years in 68.2% to 69.1% of children (Table 5). Specificity was very high (96.2–99.4%) for predicting motor function in the average range at age 5 years from parent reports of no moderate/severe GMI at age 2 years. Positive predictive value was also high: 80.3% to 94.9% of children with severe or moderate/severe GMI at age 2 years had significant movement difficulties at age 5 years. However, sensitivity was relatively low, estimated at 17.5% and 25.1% for severe and moderate/severe GMI at age 2 years respectively. The under-identification of children at age 2 years who had significant movement difficulties at age 5 years was reflected in negative predictive value of 66.2% to 67.6%. Looking at the predictive values for CP, parent reports of motor impairment at age 2 years accurately classified CP at age 5 years in 91.0% to 93.2% of children and sensitivity for the identification of children with CP at the age of 5 years varied from 9.3% to 78.6% (Table S1). After exclusion of children with CP (*n* = 42), parent reports of motor impairment at age 2 years accurately classified non-CP significant movement difficulties at age 5 years in 65.9% to 69.3% of children with a sensitivity ranging from 1.1% to 14.9% (Table S2).

DISCUSSION

This study showed that parent-reported moderate/severe GMI at 2 years of age using the items in our questionnaire was highly predictive of significant movement difficulties and of a diagnosis of CP at 5 years among children born extremely preterm. However, while specificity was very high, sensitivity was lower, especially for children with significant movement difficulties, resulting in a significant proportion of children with significant movement

difficulties at 5 years not being identified as having GMI at 2 years. Substantially fewer children were classified with impairment at age 2 years than at age 5 years. Thus, although children born extremely preterm classified as moderate/severely impaired at age 2 years were highly likely to have significant movement difficulties at age 5 years, more than two-thirds of children classified as having significant movement difficulties at age 5 years were classified as not impaired at age 2 years.

Parent questionnaires may prove useful in routine follow-up as screening tools for GMI. They seem to identify the children with the most severe movement difficulties that are likely to have a significant impact on their functional outcomes at age 5 years. Early identification and timely referral for preventive or therapeutic intervention is important because motor impairment is associated with other developmental and mental health problems[7–9] as well as academic skills.[10,11] The high specificity and positive predictive value (>80%) reported here are indicative that GMI on our parent report at 2 years was highly predictive of significant movement difficulties at 5 years of age in this population. The fact that 94.9% of children with parent-reported severe GMI at the age 2 years had significant movement difficulties at age 5 years is extremely encouraging for accuracy in referral of these children to early intervention or for further diagnostic assessment. Moreover, 89.4% of children with moderate/severe GMI at 2 years of age had movement difficulties or significant movement difficulties at age 5 years; therefore referral of these children for further diagnostic assessment would be beneficial. In the context of the parent report used in this study, this refers to children whose parents indicated that they walked unsteadily or were unable to walk unassisted at 2 years of age.

Parent reports may also be useful for outcome measurement in research, where neurodevelopment at 2 years of age is widely regarded as a core outcome for neonatal care.[17,32,33] Primary outcomes in birth cohort studies and randomized trials of obstetric and neonatal interventions often use composite outcomes including an assessment of motor impairment. The inability to walk without assistance at 2 years of age as reported by parents in this extremely preterm population was highly predictive of long-term motor impairment. However, this classification failed to detect children who were classified as at risk of movement difficulties at age 5 years using the MABC-2. Many children who had significant movement difficulties at age 5 years seemed to be able to accomplish critical gross motor milestones related to walking, sitting, and head control at the age of 2 years according to parent reports. Parent questionnaires at early ages which focus on the achievement of specific milestones in terms of gross motor development, such as ours, may therefore not be sensitive enough to detect the full range of movement difficulties that may be experienced later in life.

Motor skills continue to develop in the early years as a result of an active reorganization of previous motor abilities and neurological maturation; this allows the acquisition of new and more complex action systems that serve to satisfy the child's curiosity and motivation to explore the environment.[34] Fine motor skills are refined to become smooth and coordinated actions throughout childhood, as muscles mature and children are able to coordinate visual information with motor skills.[35] Because of the continuous development of motor skills, prediction of later movement difficulties based on parent reports at the age of 2 years is challenging, because many skills are not expected to have been acquired at that age. Even severe motor conditions such as CP might only be identified after 2 years 6 months.[36] Previous studies show suboptimal trajectories of gross and fine motor skills in children born extremely preterm, because they show significant delays very early in life that increase over

time compared with term-born children.[37] Moreover, declining motor function from 2 years to 5 years is particularly accentuated in children with better scores on clinical assessments at the age of 2 years and is primarily due to a decline in fine motor skills at 5 years of age.[38] Variability in the motor development of children born extremely preterm compared with those born at term presents an additional challenge for prediction.[25,26] Therefore, the administration of routine repeated parental questionnaires over time could improve accuracy, especially if validated for children born preterm and if fine motor abilities are included, because the agreement between parent reports and clinical assessments tends to improve with age.[39]

The strengths of this study include data from a large population-based prospective cohort study of children born extremely preterm in 10 countries in Europe. Limitations include the fact that non-participating children had higher social and clinical risk at birth, which may have compromised the generalization of our results. The parent report was designed to classify GMI and not to assess the full range of motor development at 2 years of age. A parent-report scale that provides a detailed assessment of motor abilities at the age of 2 years and yields standardized scores similar could result in more variability in outcomes and thus better correspondence with later tests of motor function. However, to our knowledge, no such scales currently exist. Finally, we previously showed that differences in the proportion of children with impairment were affected by use of different norms.[31] For that reason, we used the UK norms for all children in this study for comparability in outcomes. Future research could explore the correspondence between our parent report questions and other measures of motor function in middle childhood.

In summary, it is important to identify motor impairment as early as possible, before 2 years; however, if not identified previously, 2 years is an important timing for screening, because infants born extremely preterm are recommended to have follow-up including motor function assessment at this age.[15] Still, early detection of children at risk of gross motor impairment remains challenging owing to the diversity of developmental patterns and rapid evolution of children's motor skills early in life, especially among children born extremely preterm. Advances in our understanding of the most accurate cost-effective tools for early screening are urgent, because on the one hand it is important to provide early intervention for children at risk of movement difficulties and, on the other, misclassification of motor impairment poses unnecessary burden to the health system and distress for families. Parent-completed resources such as the one used in this study could be a good first-line screener because they have high specificity and positive predictive value for later CP and motor impairment, but they may miss children who develop later difficulties. Clinicians and researchers should be aware that children without impairment on parent report, such as the one we used, may still need additional screening for movement difficulties later in life.

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CONFLICT OF INTEREST

The authors have stated that they had no interests that might be perceived as posing a conflict or bias.

DATA AVAILABILITY STATEMENT

Owing to the ethical and privacy authorizations for the SHIPS study, supporting data cannot be made openly available. Further information about the data and conditions for access are available from the authors.

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SUPPORTING INFORMATION

The following additional material may be found online:

Table S1: Predictive value of gross motor function classification at 2 years for CP at 5 years in children born extremely preterm.

Table S2: Predictive value of gross motor function classification at 2 years for significant movement difficulty at 5 years in children without CP born extremely preterm.
Figure S1: Participation flowchart of children in the 10 participating countries.

TABLE 1 Maternal and infant characteristics of participants and non-participants among children born <28 weeks' gestation

		Participants	Non-participants		
		(*n* = 556)	Excluded[a] (*n* = 109)	Not followed up[b] (*n* = 725)	
		n (%)	*n* (%)	*n* (%)	*p*[c]
Maternal education[d]	Low (ISCED 0–2)	101 (18.2)	14 (13.0)	—	0.773
	Intermediate (ISCED 3–5)	226 (40.8)	59 (54.6)	—	
	High (ISCED 6–8)	227 (41.0)	35 (32.4)	—	
	Missing	2 (0.4)	1 (0.9)	—	
Household unemployment	At least one parent unemployed	59 (11.1)	22 (21.4)	—	0.004
	Employed or other situations[e]	471 (88.9)	81 (78.6)	—	
	Missing	26 (4.7)	6 (5.5)	—	
Parental cohabiting status	Single/other situation	63 (11.9)	14 (13.3)	—	0.328
	Married/couple/cohabiting	468 (88.1)	91 (86.7)	—	
	Missing	25 (4.5)	4 (3.7)	—	
Maternal age at childbirth (years)	≤24	43 (7.7)	10 (9.4)	162 (22.6)	<0.001
	25–34	328 (59.0)	77 (72.0)	408 (56.8)	
	≥35	185 (33.3)	20 (18.7)	148 (20.6)	
	Missing	0 (0.0)	2 (1.8)	7 (1.0)	
Maternal country of birth	Native-born	456 (82.0)	87 (79.8)	460 (67.8)	<0.001
	Other European country	42 (7.6)	5 (4.6)	62 (9.1)	
	Non-European country	58 (10.4)	17 (15.6)	157 (23.1)	
	Missing	0 (0.0)	0 (0.0)	46 (6.3)	
Parity	Nulliparous	345 (62.4)	73 (68.2)	381 (53.2)	0.005
	Multiparous	208 (37.6)	34 (31.8)	335 (46.8)	
	Missing	3 (0.5)	2 (1.8)	9 (1.2)	
Multiple birth	Singleton	401 (72.1)	89 (81.7)	535 (73.8)	0.060
	Multiple	155 (27.9)	20 (18.4)	190 (26.2)	
	Missing	0 (0.0)	0 (0.0)	0 (0.0)	
Premature rupture of membranes	No	421 (76.8)	80 (74.1)	504 (72.5)	0.078
	Yes	127 (23.2)	28 (25.9)	191 (27.5)	
	Missing	8 (1.4)	1 (0.9)	30 (4.1)	
Eclampsia/pre-eclampsia/HELLP	No	493 (89.2)	90 (82.6)	648 (92.4)	0.255
	Yes	60 (10.9)	19 (17.4)	53 (7.6)	
	Missing	3 (0.5)	0 (0.0)	24 (3.3)	
Sex	Male	270 (48.6)	64 (58.7)	398 (54.9)	0.059
	Female	286 (51.4)	45 (41.3)	327 (45.1)	
	Missing	0 (0.0)	0 (0.0)	0 (0.0)	
Gestational age (completed weeks)	≤24	69 (12.4)	20 (18.4)	134 (18.5)	0.011
	25	94 (16.9)	28 (25.7)	130 (17.9)	
	26	162 (29.1)	26 (23.9)	198 (27.3)	
	27	231 (41.6)	35 (32.1)	263 (36.3)	
	Missing	0 (0.0)	0 (0.0)	0 (0.0)	
SGA[f] (EURO-Peristat)	<10th centile	139 (25.0)	20 (18.4)	142 (19.6)	0.011
	≥10th centile	417 (75.0)	89 (81.7)	583 (80.4)	
	Missing	0 (0.0)	0 (0.0)	0 (0.0)	
Congenital anomalies	No	511 (91.9)	98 (89.9)	674 (93.0)	0.328
	Yes	45 (8.1)	11 (10.1)	51 (7.0)	
	Missing	0 (0.0)	0 (0.0)	0 (0.0)	
Bronchopulmonary dysplasia[g]	No	356 (64.7)	72 (66.7)	413 (58.7)	0.582
	Yes	194 (35.3)	36 (33.3)	291 (41.3)	
	Missing	6 (1.1)	1 (0.9)	21 (2.9)	
Severe neonatal morbidity[h]	No	408 (74.6)	70 (64.8)	486 (69.7)	0.022
	Yes	139 (25.4)	38 (35.2)	211 (30.3)	
	Missing	9 (1.6)	1 (0.9)	28 (3.9)	
Country	Belgium (Flanders)	25 (4.5)	12 (11.0)	90 (12.4)	
	Denmark (eastern region)	30 (5.4)	9 (8.3)	48 (6.6)	
	Estonia (entire country)	35 (6.3)	3 (2.8)	0 (0.0)	
	France (Burgundy, Ile-de-France, northern region)	51 (9.2)	16 (14.7)	118 (16.3)	
	Germany (Hesse, Saarland)	117 (21.0)	29 (26.6)	77 (10.6)	
	Italy (Emilia-Romagna, Lazio)	58 (10.4)	2 (1.8)	28 (3.9)	
	The Netherlands (central eastern)	35 (6.3)	11 (10.1)	20 (2.8)	
	Poland (Wielkopolska)	82 (14.8)	12 (11.0)	62 (8.6)	
	Portugal (Lisbon, northern region)	24 (4.3)	12 (11.0)	27 (3.7)	
	UK (East Midlands, northern, Yorkshire, and the Humber)	99 (17.8)	3 (2.8)	255 (35.2)	
	Missing	0 (0.0)	0 (0.0)	0 (0.0)	
Severe GMI	No	514 (92.9)	87 (81.3)	—	<0.001

	Yes	39 (7.1)	20 (18.7)	—	
	Missing[i]	0 (0.0)	2 (1.8)	—	
Moderate to severe GMI	No	487 (88.1)	82 (76.6)	—	0.002
	Yes	86 (11.9)	25 (23.4)	—	
	Missing[i]	0 (0.0)	2 (1.8)	—	
Any severe GMI	No	511 (91.9)	86 (80.4)	—	<0.001
	Yes	45 (8.1)	21 (19.6)	—	
	Missing[i]	0 (0.0)	2 (1.8)	—	

[a]Children without parent-reported gross motor function at 2 years (*n* = 2) and without MABC-2 scores at 5 years (*n* = 100), and those whose clinical assessment at 5 years was conducted using the MABC-1 (*n* = 7).
[b]Eligible at 5 years but not followed at 2 or at 5 years.
[c]*p*-values from Wald test of logistic regressions (participants vs non-participants) adjusted on country. For maternal education, household unemployment, and parental cohabiting status, *p*-values are from Wald test of logistic regressions comparing participants vs excluded (not considering children not followed up at 2 or 5 years) adjusted on country.
[d]Coded according to the ISCED (United Nations Educational, Scientific and Cultural Organization, 2012) into three categories: low (ISCED 0–2); intermediate (ISCED 3–5); and high (ISCED 6–8) education.
[e]Other situations included student, parental leave, home parent, and other.
[f]SGA, small for gestational age, was defined as a birthweight less than the 10th centile of European references.[29]
[g]Defined as supplemental oxygen at 36 weeks postmenstrual age.
[h]Defined as a composite measure of cystic periventricular leukomalacia, intraventricular haemorrhage grades III and IV, necrotizing enterocolitis that required surgery or peritoneal drainage, or retinopathy of prematurity equal to or greater than stage 3.
[i]Children without parent-reported gross motor function at 2 years (*n* = 2) are missing in this analysis.
Abbreviations: GMI, gross motor impairment; HELLP, haemolysis, elevated liver enzymes, and low platelets syndrome; ISCED, International Standard Classification of Education; MABC-1, -2, Movement Assessment Battery for Children, First or Second Edition.

TABLE 2 Parent report questions to assess gross motor function at 2 years corrected age

Instructions	
'Please read carefully each section below and tick the statement that best describes the ability of your child. All children are different, therefore your child may have passed the stage of development described a long time ago, others may not. Tick one box only for each question.'	
Question	Response options
1	(1a) walks well
	(1b) walks well, but in an unusual way, for example: limps or foot turns out
	(1c) walks unsteadily
	(1d) unable to walk without assistance or aids
2	(2a) sits safely on the floor alone
	(2b) unable to sit without support
3	(3a) holds own head up normally (on his/her own)
	(3b) unable to hold head up without support

TABLE 3 Parent reports of gross motor function at 2 years and classification of motor difficulties using MABC-2 total score at 5 years in children born extremely preterm

	Participants, *n* (%)	MABC-2 total score, *n* (%)		
Parental report Gross motor function at 2 years	**Total (*n* = 556)**	**Normal (>15th centile) (*n* = 217)**	**At risk of movement difficulties (>5th–15th centile) (*n* = 127)**	**Significant movement difficulties (≤5th centile) (*n* = 212)**
Walking				
1. Walks well	449 (81.2)	201 (92.6)	113 (90.4)	135 (64.0)
2. Walks well, but in an unusual way	38 (6.9)	9 (4.1)	6 (4.8)	23 (10.9)
3. Walks unsteadily	27 (4.9)	6 (2.8)	5 (4.0)	16 (7.6)
4. Unable to walk without assistance (severe GMI)	39 (7.1)	1 (0.5)	1 (0.8)	37 (17.5)
Missing	3 (0.5)	0 (0.0)	2 (1.6)	1 (0.5)
Moderate to severe GMI	66 (11.9)	7 (3.2)	6 (4.8)	53 (25.1)
Sitting				
1. Sits safely on the floor alone	533 (96.0)	216 (99.5)	127 (100.0)	190 (90.0)
2. Unable to sit without support	22 (4.0)	1 (0.5)	0 (0.0)	21 (10.0)
Missing	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.5)
Head control				
1. Holds own head up normally	548 (98.9)	216 (99.5)	126 (100.0)	206 (97.6)
2. Unable to hold head up without support	6 (1.1)	1 (0.5)	0 (0.0)	5 (2.4)
Missing	2 (0.4)	0 (0.0)	1 (0.8)	1 (0.5)
Any severe GMI				
No	511 (91.9)	215 (99.1)	126 (99.2)	170 (80.2)
Yes	45 (8.1)	2 (0.9)	1 (0.8)	42 (19.8)
Missing	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Severe GMI: unable to walk without assistance.

Moderate to severe GMI: walks unsteadily or unable to walk without assistance.

Any severe GMI: unable to walk without assistance or unable to sit without support or unable to hold head up without support.

Abbreviations: GMI, gross motor impairment; MABC-2, Movement Assessment Battery, Second Edition.

TABLE 4 MABC-2 standard scores at 5 years by parent reports of gross motor function at 2 years

	MABC-2 standard scores, mean (SD)			
Parental report of gross motor function at 2 years	**Total Mean (SD) *n***	**Balance Mean (SD) *n***	**Aiming and catching Mean (SD) *n***	**Manual dexterity Mean (SD) *n***
Walking				
1. Walks well	7.2 (3.1) 449	8.5 (3.4) 449	8.6 (3.1) 449	6.9 (3.2) 448
2. Walks well, but in an unusual way	5.0 (3.3) 38	6.6 (3.5) 36	7.4 (3.3) 36	4.9 (3.1) 36
3. Walks unsteadily	5.1 (3.1) 27	6.2 (3.0) 27	7.4 (2.9) 27	5.2 (3.1) 27
4. Unable to walk without assistance (severe GMI)	1.8 (1.7) 39 66	2.7 (2.3) 21 48	4.8 (3.9) 21 48	3.8 (2.3) 17 44
Missing, *n* (%)	3 (0.5)	23 (4.1)	23 (4.1)	28 (5.0)
Moderate to severe GMI	3.1 (2.8)	4.6 (3.2)	6.3 (3.6)	4.7 (2.9)
Sitting				
1. Sits safely on the floor alone	6.8 (3.3) 533	8.1 (3.6) 526	8.3 (3.2) 527	6.6 (3.3) 522
2. Unable to sit without support	2.1 (1.9) 22	4.6 (3.5) 9	6.9 (3.1) 8	3.8 (2.0) 8
Missing, *n* (%)	1 (0.2)	21 (3.8)	21 (3.8)	26 (4.7)
Holding head				
1. Holds own head up normally	6.7 (3.4) 548	8.0 (3.6) 532	8.3(3.2) 532	6.6 (3.3) 527
2. Unable to hold head up without support	2.3 (2.8) 6	8.0 (4.2) 2	5.0(0.0) 2	4.5 (3.5) 2
Missing, *n* (%)	2 (0.4)	22 (4.3)	24(4.3)	26 (4.7)
Any severe GMI				
No	7.0 (3.2) 511	8.3 (3.5) 510	8.5 (3.1) 510	6.7 (3.3) 509
Yes	2.1 (2.0) 45	3.4 (2.8) 26	5.0 (3.8) 26	3.9 (2.2) 22
Missing, *n* (%)	0 (0.0)	20 (4.0)	20 (4.0)	21 (3.8)
Total	6.6 (3.4)	8.0 (3.6)	8.3 (3.2)	6.6 (3.3)

Severe GMI: unable to walk without assistance.

Moderate to severe GMI: walks unsteadily or unable to walk without assistance.

Any severe GMI: unable to walk without assistance or unable to sit without support or unable to hold head up without support.

Abbreviations: GMI, gross motor impairment; MABC-2, Movement Assessment Battery for Children, Second Edition.

TABLE 5 Predictive value of gross motor function classification at 2 years for significant movement difficulty at 5 years in children born extremely preterm (*n* = 556)

	Significant movement difficulties at 5 years using MABC-2 total score (≤5th centile)								
Parental report of gross motor function at 2 years	**Sensitivity**		**Specificity**		**Positive predictive value**		**Negative predictive value**		**Accurately classified**
	%	**(95% CI)**	**%**	**(95% CI)**	**%**	**(95% CI)**	**%**	**(95% CI)**	**%**
Unable to sit without support	10.0	(6.3–14.8)	99.7	(98.4–100.0)	95.5	(77.2–99.9)	64.4	(60.1–68.4)	65.6 (21 + 343)/555
Unable to hold head up without support	2.4	(0.8–5.4)	99.7	(98.4–100.0)	83.3	(35.9–99.6)	62.4	(58.2–66.5)	62.6 (5 + 342)/554
Severe GMI	17.5	(12.7–23.4)	99.4	(97.9–99.9)	94.9	(82.7–99.4)	66.2	(61.9–70.2)	68.2 (37 + 340)/553
Moderate to severe GMI	25.1	(19.4–31.5)	96.2	(93.6–98.0)	80.3	(68.7–89.1)	67.6	(63.2–71.7)	69.1 (53 + 329)/553
Any severe GMI	19.8	(14.7–25.8)	99.1	(97.5–99.8)	93.3	(81.7–98.6)	66.7	(62.5–70.8)	68.9 (42 + 341)/556

Severe GMI: unable to walk without assistance.

Moderate to severe GMI: walks unsteadily or unable to walk without assistance.

Any severe GMI: unable to walk without assistance or unable to sit without support or unable to hold head up without support.

Abbreviations: CI, confidence interval; GMI, gross motor impairment; MABC-2, Movement Assessment Battery, Second Edition.