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Parental Five-to-Fifteen questionnaire in identifying motor difficulties at 5 years in children with later motor impairment: A longitudinal follow-up study of very preterm infants

Eeva Mäkilä [a,b,*], Mikael O. Ekblad [c], Päivi Rautava [d], Anna Nyman [e], Annika Lind [f,g,h], Helena Lapinleimu [i], Leena Haataja [j], Sirkku Setänen [k], on behalf of the PIPARI Study Group

[a] Department of Pediatric Neurology, University of Turku, 20014 Turku, Finland
[b] Salo Health Centre, The Wellbeing Services County of Southwest Finland, 24240 Salo, Finland
[c] Department of General Practice, Institute of Clinical Medicine, University of Turku and The Wellbeing Services County of Southwest Finland, Turku, Finland
[d] Turku University Hospital, Clinical Research Centre and University of Turku, Public Health, Turku, Finland
[e] Department of Psychology, University of Turku, Turku, Finland
[f] Terveystalo, Turku, Finland
[g] Department of Psychology, Åbo Akademi University, Turku, Finland
[h] Department of Pediatric Neurology, Turku University Hospital, The Wellbeing Services County of Southwest Finland, Turku, Finland
[i] Department of Pediatrics, Turku University Hospital, The Wellbeing Services County of Southwest Finland, University of Turku, 20014 Turku, Finland
[j] Department of Pediatric Neurology, Children's Hospital, Helsinki University Hospital HUS and University of Helsinki, Helsinki, Finland
[k] Department of Pediatric Neurology, Turku University Hospital, The Wellbeing Services County of Southwest Finland, University of Turku, 20014 Turku, Finland

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ABSTRACT

Children born very preterm have an increased risk for motor impairments. We aimed to evaluate motor performance at 5 years in children born very preterm with and without motor impairment using the parental questionnaire Five-to-Fifteen (FTF).

This prospective follow-up study included 132 children born very preterm (gestational age < 32 weeks and/or birth weight ≤ 1500 g) without neurodevelopmental impairment at 2 years. Parents filled out the FTF regarding the neurodevelopment of their 5-year-old children. Higher scores indicated more difficulties. The Movement Assessment Battery for Children — Second Edition (MABC-2) was performed to evaluate the motor outcome at 11 years. Total test scores ≤15th percentile denoted motor impairment.

There were 23 (17.4 %) children with motor impairment. A 1-point increase in the FTF motor skills mean scores increased the risk of motor impairment to 19-fold (OR 19.1, 95 % CI 3.5–104.5, $p = 0.001$). Children with motor impairment had higher mean scores in the FTF motor skills compared to children without motor impairment (mean 0.56 vs. 0.26, $p < 0.001$), but also in Executive functions (0.63 vs. 0.40, $p = 0.001$), Perception (0.35 vs. 0.18, $p < 0.001$), Memory (0.51 vs. 0.31 $p = 0.01$) and Language (0.45 vs. 0.25, $p = 0.02$), respectively.

Motor impairment was almost 20 times more likely when motor difficulties increased by 1 point in the FTF questionnaire. Moreover, children with motor impairment had more difficulties in all other developmental domains of the FTF. Based on these findings, the FTF parental questionnaire might be a useful tool in children's preventive health care to early identify motor impairment and its negative associations.

1. Introduction

During the past few decades, the survival rate of children born very preterm (gestational age < 32 weeks and/or birth weight ≤ 1500 g) has increased, and the incidence of cerebral palsy (CP) has decreased [1,2]. Despite this improvement, the prevalence of motor impairments, such as developmental coordination disorder (DCD), in children born very preterm is still 4–6 times higher than in controls born full term [3–5],

* Corresponding author at: Läntinen terveysasema, Vilhonkatu 25, 24240 Salo, Finland.
E-mail address: eaahos@utu.fi (E. Mäkilä).

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whose prevalence of DCD in literature is 5–6 % [6]. In children born very preterm or with very low birth weight, motor impairments are known to have many comorbidities, such as behavioral, attentional, and social problems, different levels of cognitive impairment and problems in academic performance, as well as lower quality of life compared to those without motor impairments [3,7–10]. Therefore, early identification of children born very preterm with an increased risk of later motor impairments is crucial in order to provide timely support. However, motor impairments are suggested to be underdiagnosed and, therefore, the opportunity for intervention is missed.

The Five-to-Fifteen (FTF) parental questionnaire is a standardized and validated instrument for the assessment of developmental difficulties originally in 5–15-year-old children, and in 5–17-year-olds in the revised version (5–15R) [11–13]. We have previously shown that children born very preterm received higher scores (had more difficulties) in the whole developmental profile of the FTF at 5 and 8 years of age compared to the full-term controls [14]. Prior literature has focused more on concurrent or later negative comorbidities of motor impairments in children born very or extremely preterm [3,7–9]. There are, to our knowledge, no previous studies of clinically significant early motor difficulties in children with later motor impairment.

The importance of long-term follow-up of children born very preterm is internationally recognized, and several recommendations for follow-up practices have been published [15–17]. However, the different follow-up programs vary, for example, regarding the inclusion criteria, assessment methods used, and duration of the follow-up time. In Finland, there is no national follow-up program for children born very preterm. In the study catchment area, all very preterm infants (gestational age < 32 weeks and/or birth weight ≤ 1500 g) are systematically followed up to 2 years of corrected age. By that age, major neurodevelopmental impairments (NDIs) such as CP and/or severe cognitive impairment can be identified and referred for further rehabilitation and care. Thereafter, the follow-up of children without NDI continues in child welfare clinics at least once a year until 6 years of age, similarly to all children under school age in Finland.

We aimed to study if the parental FTF questionnaire could identify clinically significant motor difficulties at 5 years in children born very preterm with motor impairment diagnosed at 11 years. We also compared the rate of other developmental difficulties between children with and without motor impairment. The hypothesis was that parents would identify clinically significant motor difficulties already at 5 years of age in children with later motor impairment.

2. Methods

2.1. Study design

This prospective follow-up study is part of the multidisciplinary PIPARI Study (The Development and Functioning of Very Low Birth Weight Infants from Infancy to School Age) including very preterm infants born to Finnish or Swedish-speaking families at the Turku University Hospital, Finland, between 2001 and 2006, and followed up to 17 years of age [18]. The original version of the FTF questionnaire [19] was completed by a parent when the children were 5 years of age. The motor outcome was assessed at 11 years. The Ethics Review Committee of the Hospital District of Southwest Finland approved the study protocol in 2000 and again in 2012. A written informed consent for this follow-up study was provided by the parents for the entire follow-up and by both parents and children for the 11-year follow-up.

2.2. Participants

All children born very preterm (gestational age < 32 weeks and/or birth weight ≤ 1500 g) with a completed FTF questionnaire at 5 years and a motor assessment at 11 years of age were included ($n = 132$). The exclusion criteria of the PIPARI study included severe congenital anomalies or a diagnosed syndrome affecting development. In the present study, children with NDI at the age of 2 years (full-scale intelligence quotient, IQ < 70, CP, visual and/or hearing impairment) were excluded ($n = 21$) as they were followed up in special heath care. Prenatal background characteristics were collected from the mothers' medical records and by using parental questionnaires. Information about neonatal care and assessments were collected using the international Vermont-Oxford Network database. The flow chart of the participants is shown in Fig. 1.

2.2.1. Parental Five-to-Fifteen questionnaire at 5 years of age

The FTF questionnaire is a standardized and validated assessment method which was developed by a group of researchers from Sweden, Denmark, Norway, and Finland in 2004 [11–13]. A revised version of the questionnaire 5–15R was upgraded in 2016 [20]. The FTF questionnaire includes 181 statements about a child's development divided into 8 domains (and subdomains): motor skills (gross motor skills and fine motor skills), executive functions (attention and concentration, overactivity and impulsivity, passivity and inactivity, and planning and organizing), perception (perception of space and directions, concepts of time, perception of own body, and perception of visual forms and figures), memory, language (comprehension of spoken language, expressive language, and verbal communication), learning (reading and writing, arithmetics, general learning, and coping with learning), social skills, and emotional/behavioral difficulties (internalization, acting out, and obsessive actions or thoughts). In this study, the FTF was completed at the age of 5 years, when the domain of learning and the subdomain of concepts of time were omitted from the analyses as recommended in the manual [20]. There are three alternative answers for each statement: not true/never (0 points), somewhat true/sometimes (1 point), and very true/often (2 points), mean value range 0–2. More points indicate more difficulties: >98th percentile cut-off scores indicate remarkable developmental problems, 90–97th percentile developmental problems, and 75–89th percentile some developmental problems, as described in the manual of the FTF [19].

2.2.2. Motor assessment at 11 years of age

The motor performance was evaluated at the age 11 by a physician using the Movement Assessment Battery for Children — Second Edition (MABC-2) [21]. This assessment was developed for 3–16-year-old children and includes three domains: manual dexterity (3 items), aiming and catching (2 items), and balance (3 items). Raw scores were summed up and converted to standard scores equating to percentiles of each domain and the total test score. The age band 3 (from 11 to 16 years) and the manual norms for 11-year-old children were used, as in Finland there is no country specific norms for MABC-2. A total test score $\leq$ 15th percentile denoted motor impairment, as suggested according to the European Academy of Childhood Disability's (EACD) recommendation [6]. In addition, we decided to use the cut-off of $\leq$15th percentile thinking of referral and support purposes.

2.3. Statistics

Descriptive values were reported as mean (standard deviation, SD), min, and max values or a number (%). The distribution of continuous variables was studied both graphically and using the Shapiro-Wilk test. Differences in the continuous background characteristics between the study children and those who withdrew, as well as between children with and without motor impairment, were studied using the independent sample *t*-test. For the categorical background characteristics, Pearson's Chi-square test or Fisher's exact test was used, as appropriate.

Binomial logistic regression analyses were used to study the effect of one unit increase in the mean scores of every FTF domain/subdomain on the risk of motor impairment. The results of these associations were provided in odds ratios (OR) with 95 % confidence intervals (CI) and *p*-values. First, the analyses were adjusted for the male sex, full-scale IQ at

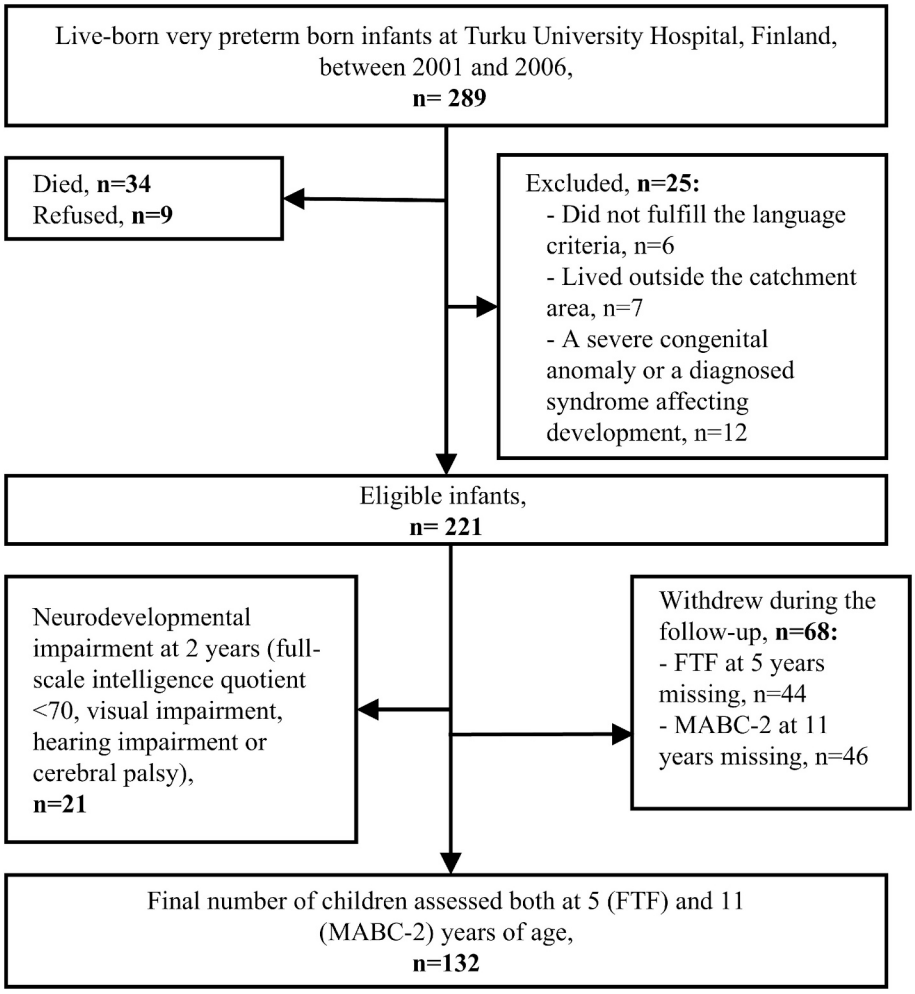

Fig. 1. Flow chart of the participants.

Table 1
Perinatal background characteristics in children born very preterm categorized according to motor outcome at 11 years of age. A total test score ≤ 15th percentile based on the MABC-2 assessment denoted motor impairment. Statistically significant results are italicized. *p*-value describes the difference between the children with and without motor impairment.

Background characteristics	All study children, n = 132	With motor impairment, n = 23	Without motor impairment, n = 109	*p*-Value
Gestational age, mean (SD), weeks	29.1 (2.8)	28.4 (2.9)	29.2 (2.7)	0.2
Birth weight, mean (SD), grams	1104.8 (305.7)	998.2 (335.6)	1127.3 (295.8)	0.07
Birth weight z-score[a], mean (SD)	−1.6 (1.5)	−1.8 (1.8)	−1.5 (1.4)	0.4
Small for gestational age (<−2 SD), n (%)	50 (37.9)	11 (47.8)	39 (35.8)	0.3
Prenatal corticosteroids, n (%)	126 (95.5)	22 (95.7)	104 (95.4)	1.0
Multiple birth, n (%)	44 (33.3)	6 (26.1)	38 (34.9)	0.4
Cesarean delivery, n (%)	84 (63.6)	14 (60.9)	70 (64.2)	0.8
Male, n (%)	71 (53.8)	*20 (87.0)*	*51 (46.8)*	*<0.001*
Patent ductus arteriosus (operated), n (%)	14 (10.6)	3 (13.0)	11 (10.1)	0.7
Bronchopulmonary dysplasia, n (%)	17 (12.9)	3 (13.0)	14 (12.8)	1.0
Necrotizing enterocolitis (operated), n (%)	4/131 (3.1)	1 (4.3)	3/108 (2.8)	0.5
Sepsis, n (%)	24 (18.2)	6 (26.1)	18 (16.5)	0.4
Laser-treated retinopathy of prematurity, n (%)	4/123 (3.3)	2 (8.7)	2/100 (2.0)	0.2
Major brain injury in MRI[b] at term, n (%)	23/128 (18.0)	*10/22 (45.5)*	*13/106 (12.3)*	*0.001*
Full-scale IQ at 11 years, mean (SD)[c]	91.1 (15.5)	*80.9 (17.4)*	*93.2 (14.2)*	*<0.001*
Mother's education >12 years, n (%)	56/126 (44.4)	7/22 (31.8)	49/104 (47.1)	0.2
Father's education >12 years, n (%)	31/126 (24.6)	3/22 (13.6)	28/104 (26.9)	0.2
The percentiles for total test scores in the MABC-2, mean (SD), min, max	37.6 (22.6), 0.5, 84.0	*5.7 (3.3), 0.5, 9.0*	*44.3 (18.8), 16.0, 84.0*	*<0.001*

[a] Birth weight in relation to gestational age.
[b] The specific MRI protocol and details about the classification of the findings were previously described by Setänen et al. [44].
[c] Evaluated by a psychologist using the WISC-IV, Finnish translation [45].

11 years (evaluated by a psychologist using the Wechsler Intelligence Scale for Children — Fourth Edition, WISC-IV, Finnish translation [18]), and major brain injury in brain magnetic resonance imaging (MRI) at term (the specific MRI protocol and details about the classification of the findings were previously described by Setänen et al. [44]), based on statistically significant differences between the groups according to the motor outcome (Table 1). The final analyses were only adjusted for the male sex as this model had the lowest Akaike information criterion (AIC) value described in the smaller-is-better form. Also, the male sex has previously been shown to affect many domains of the FTF [12]. *p*-Value of <0.01 was used when choosing covariates for adjusted analyses to consider multiple comparisons.

The number of children with and without clinically significant problems (using cut-off of 90th percentile) in different FTF domains at 5 years of age and the proportions of these children with and without motor impairment were calculated. Differences between the groups were analyzed using Pearson's Chi-square test or Fisher's exact test. As for the mean scores in the FTF domains and subdomains, the differences between the groups according to the motor outcome were studied using the independent sample *t*-test. If more than 40 % of the answers in any of the FTF domains were missing, the child concerned was not included in the analyses of that domain, as described in our previous study [14].

The statistical analyses were performed using SPSS version 28.0 (IBM SPSS Statistics, IBM Corporation, Armonk, NY, USA). Two-tailed *p*-values of <0.05 were considered statistically significant.

3. Results

A total of 132 children born very preterm were assessed both at 5 and 11 years of age. The included study children had a lower birth weight compared to those who withdrew (n = 68) (1104.8 g vs. 1208.6 g, $p = 0.03$), they were more often born small for gestational age (37.9 % vs. 20.6 %, $p = 0.01$), and had a higher full-scale IQ at 11 years (91.1 vs. 82.5, $p = 0.008$). There was no statistically significant difference in parents' educational level between the study children and those who withdrew.

There were 23 children (17.4 %) with motor impairment (total test score ≤ 15th percentile in the MABC-2). The mean percentiles for total test scores in the MABC-2 were 5.7 (SD 3.3), min 0.5, and max 9.0. The corresponding values in children without motor impairment were 44.3 percentiles (SD 18.8), min 16.0, and max 84.0. Children with motor impairment had lowest percentiles for total test scores in the MABC-2 domain Balance 11.0 (SD 11.9), min 0.5, and max 37.0, whereas children without motor impairment had lowest percentiles for total test scores in MABC-2 domain Aiming and Catching 39.3 (SD 27.0), min 1.0, and max 95.0. The perinatal background characteristics of children with and without motor impairment are shown in Table 1. Children with motor impairment were more often male (87.0 % vs. 46.8 %, $p < 0.001$), had more often major brain injury in MRI at term (45.5 % vs. 12.3 %, $p = 0.001$), and had a lower full-scale IQ at 11 years (80.9 vs. 93.2, $p < 0.001$) compared to children without motor impairment. None of the study children had a clinical diagnosis of DCD according to the medical records.

Higher mean scores (more difficulties) in all FTF domains and subdomains increased the risk for motor impairment, although some of these associations were not statistically significant (Table 2). An increase of 1 point in the 5-year motor skills mean score increased the risk of motor impairment to 19-fold (OR 19.1, 95 % CI 3.5–104.5, $p = 0.001$, adjusted for the male sex). The result remained statistically significant when also adjusted for full-scale IQ and major brain injury in MRI at term. Table 3 shows that 52.6 % of children with clinically significant (≥90th percentile) difficulties in motor skills in the FTF also had motor impairment according to the MABC-2 assessment. Conversely, 89.3 % of children without these difficulties had age-appropriate later motor development.

Children with motor impairment had higher mean scores (more difficulties) at 5 years of age in the FTF domains motor skills (mean 0.56 vs. 0.26, $p < 0.001$), executive functions (0.63 vs. 0.40, $p = 0.001$), perception (0.35 vs. 0.18, $p < 0.001$), memory (0.51 vs. 0.31 $p = 0.01$), and language (0.45 vs. 0.25, $p = 0.02$) compared to children without motor impairment (Table 4). The mean scores of all the FTF domains categorized according to the motor outcome are shown in Fig. 2.

Table 2
The ORs describes how many times higher the risk for motor impairment is when the mean scores of the certain FTF domain/subdomain at 5 years of age increase by one point. More points indicated more difficulties. The analyses were adjusted for the male sex. A total test score ≤ 15th percentile based on the MABC-2 assessment denoted motor impairment. Statistically significant results are italicized.

FTF domain/subdomain at 5 years n = 132	Adjusted OR for motor impairment at 11 years	95 % CI	*p*-Value
*Motor skills**	*19.1*	*3.5–104.5*	*0.001*
Gross motor skills*	*8.3*	*2.3–29.4*	*0.001*
Fine motor skills	*10.9*	*2.2–55.3*	*0.004*
Executive functions	*5.3*	*1.2–23.3*	*0.03*
Attention and concentration*	*5.4*	*1.4–20.1*	*0.01*
Overactivity and impulsivity	2.3	0.8–6.6	0.1
Passivity and inactivity	2.2	0.5–10.4	0.3
Planning and organizing**	*3.0*	*1.1–7.8*	*0.03*
*Perception**	*12.1*	*1.6–89.3*	*0.02*
Perception of space and directions	3.9	0.8.–20.4	0.1
Perception of own body*	*13.2*	*2.2–79.8*	*0.005*
Perception of visual forms and figures*	2.7	0.7–9.5	0.1
*Memory**	3.6	1.0–13.3	0.06
Language	*5.9*	*1.2–28.5*	*0.03*
Comprehension of spoken language*	2.6	0.6–11.3	0.2
Expressive language	*4.6*	*1.1–18.4*	*0.03*
Verbal communication	*3.1*	*1.1–9.2*	*0.04*
Social skills	3.9	0.5–29.0	0.1
Emotional/behavioral difficulties	6.1	0.6–65.6	0.1
Internalization	4.9	0.3–84.0	0.3
Acting out	2.4	0.6–9.7	0.2
Obsessive actions or thoughts	7.2	0.5–97.0	0.1

* Data missing for one child.
** Data missing for two children.

4. Discussion

This study of a regional follow-up cohort of very preterm infants demonstrated that parents may identify motor difficulties in their 5-year-old children with later motor impairment. In addition to motor difficulties, parents reported a wide spectrum of other developmental difficulties in these children compared to those without motor impairment. This novel finding was in line with our hypothesis and suggests that parental FTF questionnaire might be a useful assessment method in children's preventive health care to early identify motor impairment and its comorbidities in this high-risk population.

We discovered an almost 20-fold risk of motor impairment when early motor difficulties increased by 1 point according to parental questionnaire. Interestingly, the difficulties in fine motor skills had stronger connection to later motor impairment than gross motor skills. Less extensive (5–12-fold) risk was seen between increased difficulties in perception, executive functions and language skills and later motor impairment. As for increased emotional or behavioral difficulties, a similar association was seen, although not statistically significant. More than half of the children with clinically significant motor difficulties (≥90th percentile in the FTF) had motor impairment based on a structured and validated motor assessment (the MABC-2) performed at 11

Table 3
The FTF results in 132 children born very preterm according to motor outcome (children with motor impairment, n = 23, and children without motor impairment, n = 109), assessed using the MABC-2. The proportions are presented in numbers, n (%). Statistically significant results are italicized.

FTF domain at 5 years of age	*MABC-2 at 11 years of age*		*p*-Value
-Children with clinically significant difficulties (≥90th percentile), n (%) -Children without clinically significant difficulties (<90th percentile), n (%)	Children with motor impairment (≤15th percentile), n (%)	Children without motor impairment (>15th percentile), n (%)	
Motor skills*			*<0.001*
19 (14.5)	*10 (52.6)*	*9 (47.4)*	
112 (85.5)	*12 (10.7)*	*100 (89.3)*	
Executive functions			*0.002*
30 (22.7)	*11 (36.7)*	*19 (63.3)*	
102 (77.3)	*12 (11.8)*	*90 (88.2)*	
Perception*			0.1
7 (5.3)	3 (42.9)	4 (57.1)	
124 (94.7)	20 (16.1)	104 (83.9)	
Memory*			*0.02*
36 (27.5)	*11 (30.6)*	*25 (69.4)*	
95 (72.5)	*12 (12.6)*	*83 (87.4)*	
Language			0.09
18 (13.6)	6 (33.3)	12 (66.7)	
114 (86.4)	17 (14.9)	97 (85.1)	
Social skills			*0.04*
30 (22.7)	*9 (30.0)*	*21 (70.0)*	
102 (77.3)	*14 (13.7)*	*88 (86.3)*	
Emotional/behavioral difficulties			0.06
7 (33.3)	14 (66.7)		
21 (15.9)	16 (14.4)	95 (85.6)	
111 (84.1)			

* Data missing for one child.

years according to the PIPARI Study protocol. It is notable that none of the study children had clinical diagnosis of motor impairment by that age. This is supported by previous literature about motor impairments being underdiagnosed [22]. The vast majority (nearly 90 %) of the study children who did not have clinically significant motor difficulties (<90th percentile in the FTF) according to their parents had age-appropriate motor development assessed using the MABC-2. Based on these findings, we suggest that the FTF might serve as an additional tool for identifying the children with an increased risk of motor impairment.

In the present study, children with motor impairment had more difficulties not only in their motor skills at 5 years of age, but also in executive functions, perception, memory, and language skills, compared to children without motor impairment. In line with these findings, several previous studies including children born very preterm as well as full term have reported association between motor impairment and an increased risk of difficulties with concentration, executive functions, and perception [7,10,23,24]. Previous studies have also reported increased difficulties in social, emotional, and behavioral skills associated with motor impairment in children born preterm and full term in pre-school and school age [7,8,24–26]. Our results support these previous findings, as the children with motor impairment had more difficulties in social skills. Moreover, these children had more emotional/behavioral difficulties than the children without motor impairment. However, the differences were not statistically significant, possibly because of the low number of children with motor impairment in our study sample.

The children with motor impairment at 11 years of age were more often male and had more often major brain injury in MRI at term compared to the children without motor impairment; this was even though the children with NDI were excluded. Both the male sex and neonatal brain MRI abnormalities are commonly known risk factors for

Table 4
The 5-year FTF scores of children born very preterm according to motor outcome. More points indicate more difficulties. Percentiles for total test scores ≤15th in the MABC-2 performed at 11 years denoted motor impairment. Statistically significant results are italicized.

FTF domain/ subdomain	Children with motor impairment (n = 23)	Children without motor impairment (n = 109)	*p*-Value
Motor skills mean (SD)	*0.56 (0.32)**	*0.26 (0.25)*	*<0.001*
Gross motor skills mean (SD)	*0.53 (0.49)**	*0.22 (0.31)*	*0.01*
Fine motor skills mean (SD)	*0.58 (0.33)*	*0.29 (0.27)*	*<0.001*
Executive functions mean (SD)	*0.63 (0.38)*	*0.40 (0.30)*	*0.001*
Attention and concentration mean (SD)	*0.65 (0.43)*	*0.37 (0.34)**	*0.001*
Overactivity and impulsivity mean (SD)	*0.75 (0.50)*	*0.51 (0.41)*	*0.02*
Passivity and inactivity mean (SD)	0.27 (0.27)	0.19 (0.30)	0.2
Planning and organizing mean (SD)	*0.70 (0.46)*	*0.37 (0.45)***	*0.002*
Perception mean (SD)	*0.35 (0.26)*	*0.18 (0.20)**	*<0.001*
Perception of space and directions mean (SD)	0.30 (0.34)	0.18 (0.24)	0.05
Perception of own body mean (SD)	*0.35 (0.25)*	*0.16 (0.24)**	*<0.001*
Perception of visual forms and figures mean (SD)	*0.41 (0.38)*	*0.21 (0.31)**	*0.007*
Memory mean (SD)	*0.51 (0.38)*	*0.31 (0.32)**	*0.01*
Language mean (SD)	*0.45 (0.36)*	*0.25 (0.24)*	*0.02*
Comprehension of spoken language mean (SD)	0.41 (0.30)	0.29 (0.31)*	0.1
Expressive language mean (SD)	*0.45 (0.41)*	*0.23 (0.26)*	*0.02*
Verbal communication mean (SD)	0.52 (0.55)	0.28 (0.36)	0.05
Social skills mean (SD)	0.29 (0.29)	0.18 (0.19)	0.09
Emotional/behavioral difficulties mean (SD)	0.25 (0.23)	0.16 (0.16)	0.08
Internalization mean (SD)	0.16 (0.19)	0.13 (0.15)	0.4
Acting out mean (SD)	*0.40 (0.37)*	*0.25 (0.28)*	*0.03*
Obsessive actions and thoughts mean (SD)	0.16 (0.20)	0.07 (0.14)	0.07

* Data missing for one child.
** Data missing for two children.

motor and cognitive impairments [27]. The present study showed that children with motor impairment had more than 12 points lower full-scale IQ at 11 years compared to children without motor impairment. This is in line with previous literature as well as our own report of the same PIPARI Study cohort [9,10]. Accordingly, these risk factors probably have an influence on other developmental difficulties in children with motor impairment also shown in the present study.

The prevalence of motor impairment among children born very preterm or with very low birth weight has been shown to vary between 12 and 71 % in previous studies using the 15th percentile as cut-off in standardized motor assessments [4]. In Finland, 0.9 % (n = 419) of all infants were born very preterm (gestational age < 32 weeks and/or birth

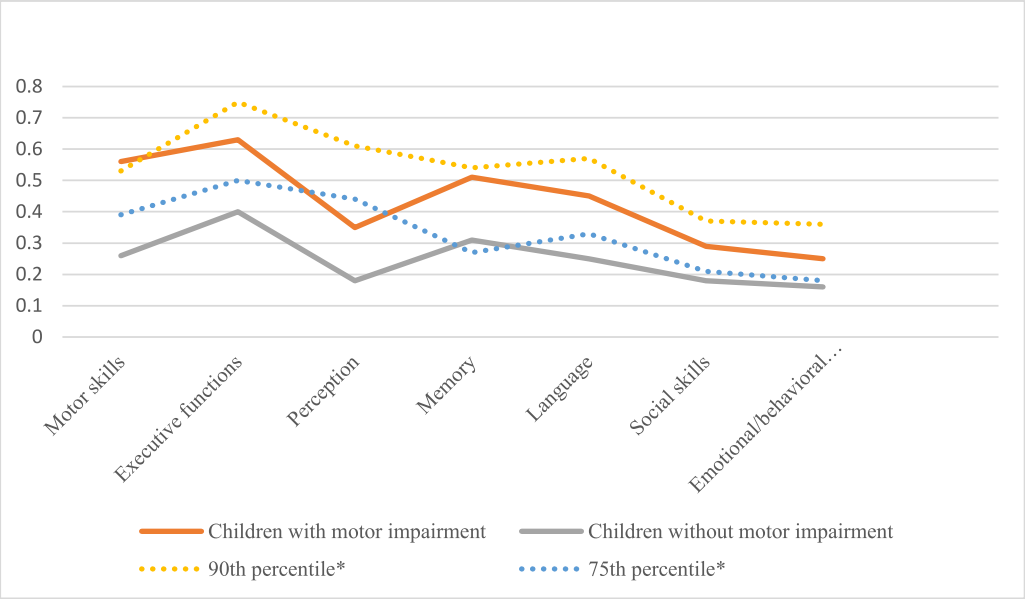

Fig. 2. The mean scores of the Five-to-fifteen (FTF) domains (higher scores indicate more difficulties) in 5-year-old children according to motor outcome. The results were related to 90th and 75th percentiles based on a Finnish normal population sample [19].
*based on a Finnish normal population sample [19].

weight ≤ 1500 g) in 2022 [28]. In the Finnish health care system, all children are followed up in the child welfare clinics from 0 to 6 years of age to regularly assess their growth and development as well as to provide vaccinations according to the Finnish vaccination program [29]. Children without NDI or other major disabilities requiring specialized medical care continue attending the child welfare clinic controls like all their full-term peers when the developmental follow-up for very preterm infants ends at 2 years of corrected age. Due to the increased risk of motor impairment and other co-occurring developmental difficulties in, for example, behavior, language skills, cognitive and executive functions, perception as well as social and emotional skills associated with very preterm birth [3,4,7,10,26,30–38], it would be important to identify the high-risk children born very preterm from the vast mass of age-appropriately developing children at child welfare clinics. This would allow them to be referred to further diagnostic evaluations and support services. Based on the findings of the present study, the FTF might provide a practical tool for children's preventive health care to promote the identification of children with motor impairment. Early identification and support might prevent long-term social and educational problems.

Parental questionnaires can provide a simple, reliable, and low-cost tool for the recognition of developmental difficulties in preterm children. Besides the FTF, there are other parental questionnaires validated for developmental screening of children born very preterm, including the Ages and Stages Questionnaires (ASQ) for 0–6-year-olds and the Parent Report of Children's Abilities — Revised (PARCA-R) for 2-year-olds [39–41]. In general, when using a parental questionnaire, difficulties in one developmental domain can affect the parental perception of another, and it is often impossible to know if these difficulties are comorbid or secondary to each other. In previous studies regarding children born extremely preterm, parents have been suggested to underestimate the motor and cognitive difficulties of their children [7,42]. We have previously demonstrated that 41–60 % of children born very preterm performing below normal variation (standard score < 8) in psychological assessment NEPSY II had developmental difficulties according to the FTF at 5 years of age [43]. In contrast, 17–40 % of children classified within normal variation were reported to have difficulties according to the FTF. Obviously, the parental questionnaire is only one part of a comprehensive developmental assessment including, for example, valuable perceptions of the daycare or school staff.

The revised version of the FTF questionnaire (5–15R) includes a questionnaire for teachers, an extension of the age range up to 17 years, and impact questions for each domain of the questionnaire [20]. In contrast to the original version of the questionnaire used in this study [19], the upgraded version has separate norms for boys and girls. The questions themselves are principally the same, except for some differences in phrasing and examples that are given. In this study, the original version of the FTF questionnaire was used, as the revised version was not available at the time of the study. In future, the revised questionnaire might give even more accurate information about developmental difficulties. The 5–15R also provides a very useful and illustrative online version of the questionnaire supporting its further implementation in clinical practice [20].

The major strength of this study was the prospective study design and the use of standardized and validated clinical assessment methods at both age points. The follow-up rate was acceptable (near to 70 %). The children who withdrew were born heavier, were less often born small for gestational age, and had a lower full-scale IQ at 11 years of age compared to the study children. This should be considered regarding the generalizability of the results. There was no statistically significant difference in parents' educational level between the study children and those who withdrew. We excluded children with NDI at 2 years of age because we aimed to focus on children whose follow-up in special medical care ends at 2 years of age. It is notable that none of the children in our study had received a clinical diagnosis of motor impairment by 11 years of age. Accordingly, identification of motor impairment in preventive health care needs to be improved.

A possible limitation of the study was the relatively small number of children with motor impairment, despite our decision to define motor impairment by using the 15th percentiles as the cut-off for the total scores of the MABC-2; this was suggested by the latest recommendation from the EACD [6]. Using the stricter cut-off of the 5th percentile might have made the differences between the groups even more evident. In addition, we aimed to find children with developmental difficulties associated with possible later motor impairment, which further supported the less strict cut-off for further referral and support purposes. Unfortunately, in Finland there is no country specific norms for MABC-2. Another limitation is the lack of full-term controls, which in future

studies might provide some new information. However, we have recently reported that children born very preterm had higher scores (more difficulties) in the whole developmental profile of the FTF at 5 and 8 years of age compared to full-term controls [14]. Therefore, the developmental difficulties of children born very preterm are not restricted to certain developmental domains. Furthermore, because the FTF questionnaire was originally designed to assess ADHD and its comorbidities, understanding the prevalence of ADHD or other neurodevelopmental conditions in this cohort would have been valuable additional information.

5. Conclusions

Motor impairment was almost 20 times more likely in children born very preterm when motor difficulties increased by 1 point in the parental FTF questionnaire at 5 years of age. Moreover, children with motor impairment had more difficulties in all other developmental domains of the FTF compared to children with age-appropriate motor development at 11 years. Based on these novel findings, the FTF parental questionnaire might be a useful tool in children's preventive health care to early identify motor impairment and its comorbidities in this high-risk population of children born very preterm.

Abbreviations

ASQ	The Ages and Stages Questionnaires
AIC	Akaike information criterion
CP	cerebral palsy
CI	confidence interval
DCD	developmental coordination disorder
EACD	The European Academy of Childhood Disability
FTF	The Five-to-Fifteen
5–15R	The Five-to-Fifteen-Revised
IQ	intelligence quotient
MRI	magnetic resonance imaging
MABC-2	The Movement Assessment Battery for Children — Second Edition
NDI	neurodevelopmental impairment
OR	odds ratio
PARCA-R	The Parent Report of Children's Abilities — Revised
SD	standard deviation
WISC-IV	The Wechsler Intelligence Scale for Children — Fourth Edition

Consent to participate and to publish

A written informed consent for this follow-up study was provided by the parents for the entire follow-up and by both parents and children for the 11-year follow-up.

CRediT authorship contribution statement

Eeva Mäkilä: Writing – original draft, Formal analysis, Data curation. **Mikael O. Ekblad:** Writing – review & editing. **Päivi Rautava:** Writing – review & editing. **Anna Nyman:** Writing – review & editing. **Annika Lind:** Writing – review & editing. **Helena Lapinleimu:** Writing – review & editing. **Leena Haataja:** Writing – review & editing. **Sirkku Setänen:** Writing – review & editing, Formal analysis, Data curation.

Ethics approval

The PIPARI study was conducted in accordance with the Declaration of Helsinki. The Ethics Review Committee of the Hospital District of Southwest Finland approved the study protocol in 2000 and again in 2012.

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Declaration of competing interest

The authors have no competing interests to declare that are relevant to the content of this article.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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