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ORIGINAL ARTICLE

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One-third of children had clinical signs of developmental coordination disorder 6 months after their international adoption

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Abstract

Aim: Our aim was to fill a gap in the research about the prevalence of developmental coordination disorder (DCD) among internationally adopted children. We explored the prevalence of signs of DCD and the associations between those and behavioural problems six and 18 months after adoption.

Methods: The data came from the ongoing Finnish Adoption Study 2 and this research focused on the international adoptions of children under 7 years of age between 2012 and 2016. Their motor development was tested with the Movement Assessment Battery for Children, Second Edition to identify DCD symptoms. Behavioural symptoms were measured using the Child Behavior Checklist (CBCL). Only children aged 3 years plus were tested.

Results: The 95 children (70% boys) arrived in Finland at a mean age of 3.3 years. Six months later, 35% of the 49 children who were tested had clinical DCD symptoms and this has fallen to 13% of 67 at 18 months. Symptoms at 6 months were associated with higher internalising CBCL scores at 18 months.

Conclusion: DCD symptoms in internationally adopted children were double the rate in the general child population 18 months after adoption. Early motor problems 6 months after adoption were associated with later behavioural symptoms.

KEYWORDS
behavioural symptoms, developmental coordination disorder, internationally adopted children, motor difficulties

1 | INTRODUCTION

International adoptions have decreased worldwide, but the number of children with special needs has simultaneously increased.[1,2] Developmental and growth delays are common among internationally adopted children when they arrive in their new country.[1,3–6] Early-life institutional care has been shown to have lasting effects on the development of a child's motor skills, such as balance and bilateral coordination, even years after they are adopted.[7] However, many studies have shown that post-adoption development often improves quickly.[4,6]

Developmental coordination disorder (DCD) is a neurodevelopmental condition that is characterised by motor difficulties,

Abbreviations: CBCL, Child Behavior Checklist; DCD, developmental coordination disorder; MABC-2, Movement Assessment Battery for Children, Second Edition.

without other neurological conditions or structural defects, visual impairments or intellectual disabilities.[8,9] The estimated prevalence of DCD in the general child population has been quantified as 5%–6%.[8–10] However, the prevalence in preterm children has been reported to be 6–8 times higher.[10,11] DCD is as a common chronic disorder that has as impact on children's everyday lives due to difficulties in psychomotor activities. Children with DCD have problems with their fine and gross motor skills and may also have difficulties in other cognitive domains, such as visuospatial processing, executive functioning and attention. These difficulties may also harm their social and academic functioning.[8,9] Preschool children with DCD have often been shown to have language and communication difficulties.[8,12] Co-occurring psychosocial and behavioural problems are also more common in children with DCD than in normally developing children.[8,10,13] The aetiology of and mechanisms behind DCD are still unknown. However, many neuroimaging studies of children with DCD have shown abnormalities in numerous regions of the brain.[8,9,14,15]

A study of children aged 3–6 years found that language difficulties co-occurred with motor difficulties and those children also had more externalising behaviours, such as increased aggression, than normally developing children.[12] Another study of children aged 4 and 5 years showed that those at risk of DCD had more behaviour and psychological problems than their typically developing peers.[13] Meanwhile a review study of children aged 4–11 years showed that those with DCD had more anxiety and depression symptoms than typically developing children.[16] Another study showed that children aged 6–11 with DCD had deficits in their executive function skills.[17] Motor problems and comorbidities that suggest DCDs also seem to continue through adolescence into adulthood.[8,9] That is why many researchers consider that DCD is a part of a wider neurodevelopmental symptomology.[8,9,13] Some studies have also reported that children with DCD also had a lower quality of life than children without DCD.[18,19] Having a child with DCD in a family could also affect the quality of life of the entire family, including the parents working lives, the families' social lives and the well-being of any siblings.[8,20]

Although many types of developmental delays are common in children who have been internationally adopted, we are unaware of any studies that have examined the prevalence of DCD in this population.

The aim of this prospective study was to evaluate how many internationally adopted children had clinical symptoms of DCD and whether those symptoms of DCD were associated with the children's background factors. We also evaluated the association between DCD symptoms and the children's behaviour. Our hypothesis was that internationally adopted children would have more motor developmental challenges than those seen in studies on unadopted children from the general population.[8,9] We also hypothesised that signs of DCD 6 months after they arrived in their new country would indicate greater difficulties, but they would have decreased by the 18-month follow-up visit. However, we anticipated that they could still be associated with behavioural problems at that point.

Key Notes

- This Finnish study filled a gap in the research about symptoms of developmental coordination disorder (DCD) in internationally adopted children.
- We found that 35% had signs of DCD 6 months after their adoptions and this had fallen to 13% at 18 months, which was still twice the rate in the general child population.
- Earlier motor problems at the 6-month visit were associated with behavioural symptoms at 18 months.

2 | METHODS

2.1 | Study design and sample

The data came from the Finnish Adoption Study 2, which is a prospective follow-up study of the health and well-being of internationally adopted children in Finland. The children in the study were internationally adopted through authorised adoption organisations and came to Finland between October 2012 and December 2016. The children included in this study were all under 7 years of age when they arrived in Finland. This was chosen as the cut-off age for the study because it is the age when Finnish children start school. The characteristics of the study population are presented in Table 1. The original clinical follow-up cohort of internationally adopted children comprised 95 children and the parents who adopted them. Their first assessment was carried out by a paediatrician (AH) approximately 6 months after they arrived in Finland and the second assessment was carried out 1 year later after that. The original aim was to carry out the first study assessment 3 months after the children arrived in Finland, but this was not always possible. Only children who were at least 3 years of age could be tested with the Motor Assessment Battery, Second Edition (MABC-2). This meant that we were able to test 51/95 children (67% boys) during the 6-month follow-up and 69/95 children (69% boys) during the 18-month follow-up. Two children were excluded from the final data analysis because they were diagnosed with mental retardation and the final analysis comprised 49 children at 6 months and 67 at 18 months. Motor development data were available on 70 children (Table 1) and 46 children took part in both the 6-month and 18-month assessments (Figure 1). One child left the study after the first assessment.

The parents provided the background characteristics for the children: their age at adoption, age at assessments, sex, country of adoption and type of any previous pre-adoptive placements (Table 1). The type and number of placements were divided into three categories, foster homes, orphanages or three or more placements before adoption. The child's place of origin was categorised by continent or region.

The children were divided into two health categories. The first category comprised children who did not have a high risk of movement difficulties, based on their background health data. The second

TABLE 1 Characteristics of the study population (n = 70).

Children		
Age at arrival in Finland, years	Mean (SD) Median [min, max]	3.3 (1.4) 3.1 [0.9, 6.9]
Age at first assessment, years	Mean (SD) Median [min, max]	4.3 (1.2) 4.0 [2.9, 7.4]
Age at second evaluation, years	Mean (SD) Median [min, max]	4.7 (1.3) 4.4 [2.9, 8.3]
Sex		
Girl	*n* (%)	21 (30)
Boy	*n* (%)	49 (70)
Health status		
Normal ability to move	*n* (%)	53 (75.7)
Prematurity, structural defect or developmental delay	*n* (%)	17 (24.3)
Continent of birth		
Africa	*n* (%)	15 (21.7)
Asia	*n* (%)	41 (59.4)
Eastern Europe	*n* (%)	7 (10.1)
South America	*n* (%)	6 (8.7)
Pre-adoptive placements		
Foster home	*n* (%)	3 (4.6)
Orphanage	*n* (%)	48 (73.8)
Three or more placements	*n* (%)	14 (21.5)
Adoptive family		
Mothers' highest education		
Primary school	*n* (%)	0 (0)
High or vocational school	*n* (%)	5 (14.3)
University	*n* (%)	30 (85.7)
Mothers' age, years	Mean (SD)	41.7 (5.5)
	Median [Min, Max]	40.9 [28.7, 52.4]
Siblings, number	Mean (SD)	0.53 (0.9)
	Median [Min, Max]	0 [0, 4]

category comprised children who had a high risk of developmental movement difficulties. The reasons for this included premature birth, known prenatal alcohol exposure, known major developmental delay without clinical diagnosis and congenital limb deformities (Table 1). The cohort included seven children who were born preterm at 27–32 weeks of gestation.

The characteristics of the adoptive families are presented in Table 1. The questionnaires on the background characteristics of the child and family were sent to the families after they had registered for the study and they returned them when they arrived for the child's first assessment. They included a 50-item questionnaire about the child's health and background and the Child Behavior Checklist (CBCL).[21] There was also a parental health and background questionnaire, which included questions about marital status, age, education and profession. It also asked how many siblings the child had in their adoptive family. We stated that we hoped that the parents would answer the questions together.

2.2 | Measurements

The children's motor development was evaluated by a paediatrician (AH) who carried out the study assessments, with the Movement Assessment Battery for Children, Second Edition (MABC-2) in Helsinki and Turku.[22,23] This test identifies children with motor function difficulties or motor developmental delays from 3 years of age.[23] It contains eight tasks covering three areas: manual dexterity, aiming and catching and balance. The scores are based on the two attempts in each category. These results provide raw scores, which are calculated to create standard scores and further equated to the percentiles for each of the three domains and the total test scores. A total test score of more than 67, above the 15th percentile, indicates a normal test result with no movement difficulties. Scores of 57–67, between the 5th and 15th percentiles, indicate borderline results that suggest that a child is at risk of movement difficulties. Total test scores of up to 56, below the 5th percentile, indicate significant clinical signs of motor dysfunction. This finding could be used as a diagnostic tool for DCD in children aged 5 years and over, according to the International Classification of Diseases Tenth Revision. However, the signs of DCD can be seen earlier.[8,23] The MABC-2 has been shown to have good test–retest reliability and reasonable construct validity in children of 3–5 years of age.[8,23,24] The paediatrician was trained to assess the test by a child physiotherapist at the Turku University Hospital. The MABC-2 test scores from both assessments were calculated and the total test results were determined after the second assessment.

The children's weight, height and head circumference values had been measured at local health centres after their arrival in Finland and during later check-ups. These were copied from their health records into the study data during their 6-month and 18-month study assessments. Similarly, their pre-adoptive growth data, based on register data from the pre-adoption authorities, were transferred to the study data. Growth measurements were expressed as Z-scores, namely deviations from the mean of the sex-specific and age-specific growth charts of the World Health Organisation.[25] In each category, a Z-score of below −2 standard deviations indicated delayed growth. Catch-up growth during the follow-up period was also analysed.

The Child Behavior Checklist (CBCL) questionnaire was used to measure the children's behavioural and emotional problems.[21] The CBCL provides total scores for these two elements and separates the scores for internalising and externalising behavioural symptoms. Internalising behavioural symptoms can include anxiety, depression, somatic complaints without medical causes and withdrawal from social contacts. Externalising behavioural symptoms can include conflict with others, rule-breaking or aggressive behaviour. Each item is

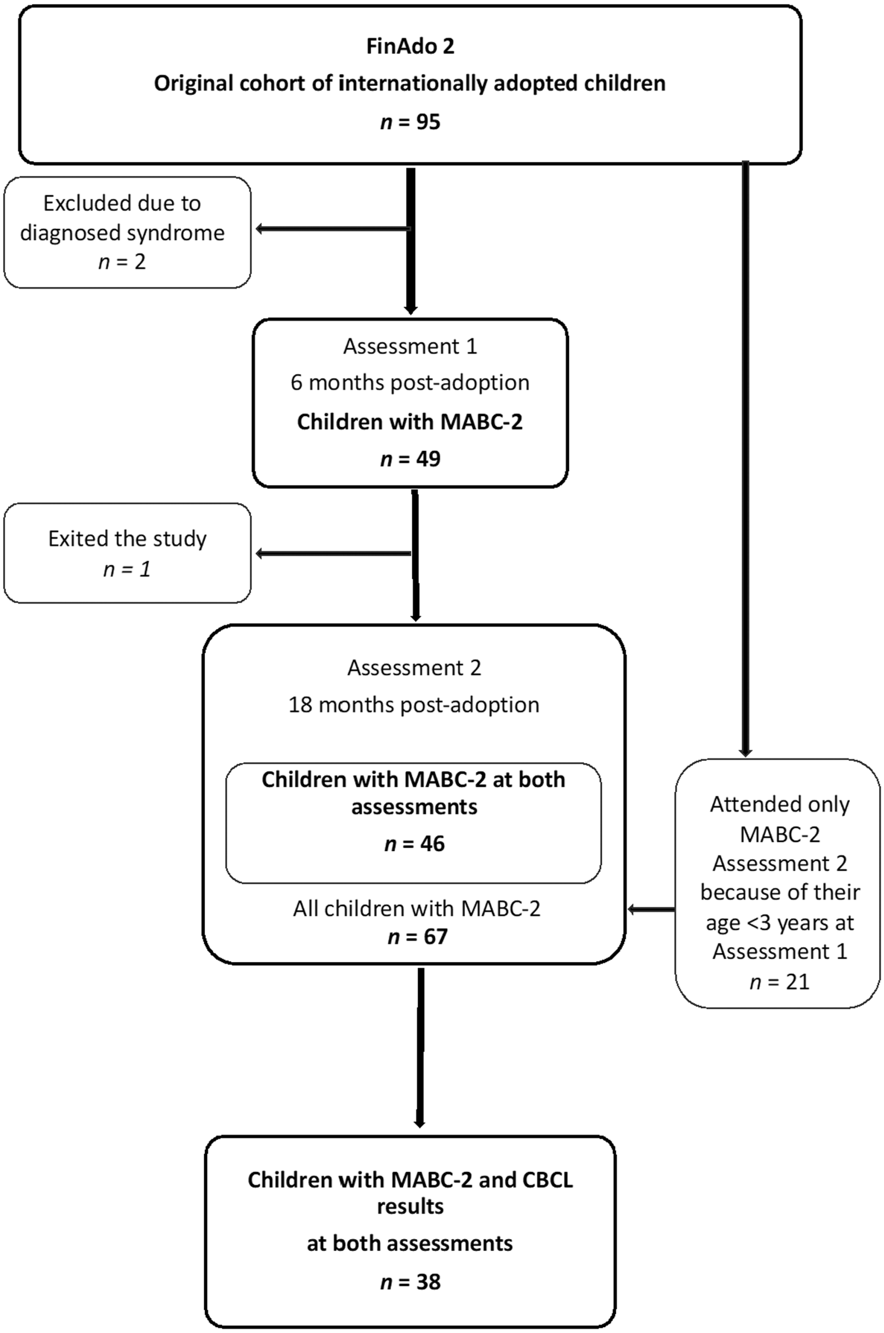

FIGURE 1 Flowchart of the FinAdo study population. (MABC-2, Movement Assessment Battery for Children, Second Edition; CBCL, Child Behavior Checklist).

rated as zero for not true, one for somewhat or sometimes true or two for very true or often true. Higher CBCL scores indicate more frequent child behavioural symptoms. The current study used the CBCL for children aged 18 months to 5 years, which has 100 questions. Children aged 6–18 years were tested with the version with 113 questions. Both questionnaires produced identical age-adjusted dimensions and total scores.[21]

2.3 | Statistical analysis

The data comprised one or two MABC-2 observations from each participant, depending on which study assessments they took part in. The associations between the background, growth and health status characteristics and MABC-2 test results were tested with linear regression analysis. The background and health characteristics were retrieved from the parental questionnaires and the growth values were extracted from children's health cards. We also examined the associations between health background characteristics and scoring below the 5th percentile, namely the DCD-level scoring, or borderline scores between the 5 and 15th percentiles. These indicated the risk for DCD. Cross tables were used to identify children who did not improve their performance or still performed at the DCD level at the second assessment. R version 4.1.1 (R Foundation, Vienna, Austria) was used for all the statistical analyses.

ACTA PÆDIATRICA NURTURING THE CHILD — WILEY

2.4 | Ethics

The Ethics Review Committee of the Hospital District of Southwest Finland approved the study (ETMK102/180/2012) and the parents provided written, informed consent.

3 | RESULTS

A total of 70 children were assessed at 6 and/or 18 months after they arrived in Finland (Table 1). There were 49 children assessed at 6 months and 67 children assessed a year after that. We were able to obtain motor development data for 46 children at both time points (Figure 1).

Just over a third (35%) of the 49 children tested during the first assessment had DCD-level motor performance and 10% had scores that indicated a risk of movement difficulties (Table 2). The performance of six children did not improve during the follow-up visit at 18 months. When it came to manual dexterity, nine children did not show development that reached the normal level. Only two of the seven children who scored abnormal levels in aiming and catching during the first assessment did not improve their performance by the second assessment. Of the other five children, three children did not show remarkable improvements in their balance and the rest reached the normal level. The children's pre-adoptive growth, their growth by their first assessment and their catch-up growth were not associated with their motor performance. A number of factors were not associated with their motor performance at either assessment point. These were their age when they arrived in Finland or their first evaluation, their continent of origin and the types of pre-adoptive placements ($p=0.32$–0.99).

At the first assessment, 21 of the 67 children were under 3 years of age and did not participate in the MABC-2 test until the second assessment. One child who participated in the first assessment did not participate in the second one. We found that 13% of the 67 children had signs of DCD-level motor difficulties. This prevalence was also the same in the children who only participated in the second assessment. We also found that 10% of the 67 children had risk level scores during the second assessment. Almost one-third of the 17 children whose scores were at the DCD level at 6 months after their adoption had not shown catch-up development by the 18-month assessment (Table 2).

Overall, the girls had better manual dexterity skills than the boys during the second assessment ($\beta=0.87\pm0.36$, $p=0.02$), but there was no significant difference in the other domains or total test results between the sexes. Of the 67 children who participated in the second assessment, seven (10%) were preterm and their motor performance was also analysed separately. Two of these preterm children performed at the DCD level, two performed at the risk level and three performed at the normal level during that assessment. The prevalence of DCD-level performance among the children who were not born preterm was 12%. The preterm children had the greatest difficulties with manual dexterity skills.

TABLE 2 The Movement Assessment Battery for Children, Second Edition test results of internationally adopted children at study assessments 1[a] and 2[b].

	Assessment 1, total $n=49$ *n* (%)	Assessment 2, total $n=67$[c] *n* (%)
Manual dexterity		
No movement difficulty (above the 15th percentile)	19 (38.8)	40 (59.7)
Border line, at risk of movement difficulty (between the 5th and 15th percentiles)	9 (18.4)	10 (14.9)
Significant clinical sign of motor dysfunction (below the 5th percentile)	21 (42.9)	17 (25.4)
Aiming and catching		
No movement difficulty (above the 15th percentile)	42 (85.7)	60 (89.6)
Border line, at risk of movement difficulty (between the 5th and 15th percentiles)	4 (8.2)	4 (5.9)
Significant clinical sign of motor dysfunction (below the 5th percentile)	3 (6.1)	3 (4.5)
Balance		
No movement difficulty (above the 15th percentile)	31 (63.3)	57 (85)
Border line, at risk of movement difficulty (between the 5th and 15th percentiles)	9 (18.4)	6 (9)
Significant clinical sign of motor dysfunction (below the 5th percentile)	9 (18.4)	4 (6)
Total test score		
No movement difficulty (above the 15th percentile)	27 (55.1)	51 (76.1)
Border line, at risk of movement difficulty (between the 5th and 15th percentiles)	5 (10.2)	7 (10.4)
Significant clinical sign of motor dysfunction or DCD (below the 5th percentile)	17 (34.7)	9 (13.4)

[a]6 months after arrival in the adoptive family.
[b]18 months after arrival in the adoptive family.
[c]Including 21 children who were under 3 years old at the time of Assessment 1 and DCD signs among them did not differ from the others at Assessment 2.

The children whose total test scores at the first assessment were below the 5th percentile, at the DCD level, had higher internalising CBCL scores at the second assessment than the other adopted children (β=0.29±0.14, p=0.04) (Table 3). The children who had significant difficulties in manual dexterity (<5th percentile) (Table 3) had significantly higher externalising CBCL scores than the children at risk of movement difficulties or normal range groups (β=0.23±0.10, p=0.04).

4 | DISCUSSION

The prevalence of DCD-level motor performance was still 13% when we assessed the children 18 months after they were internationally adopted. Although there were only seven preterm children, we tested whether prematurity would explain such a high prevalence of DCD symptoms. A third of the preterm-born children had a DCD-level motor performance 18 months after their adoption. However, the prevalence of DCD-level scores was still 12% among the other children when the preterm children were omitted from the overall sample. That 12% was double the percentage reported in the general child population.[8–10] None of the background factors we tested was associated with abnormal performance in the MABC-2 at either assessment.

As the MABC-2 is a valid tool for evaluating motor performance from 3 years of age, the results may predict future motor function if no interventions are provided to practise or strengthen the child's skills.[8,24,26] In our study, 13% of the children performed at the DCD level at their 18-month assessment and these children may be the ones who are at risk of having DCD through adolescence and into adulthood.[8,9,11] Our results suggested that internationally adopted children who had motor difficulties more than 1 year after arrival will require more intensive follow-ups than those who do not.

Prematurity has been identified as a risk factor for DCD.[10,11,14] Our results agreed with the numerous studies that showed that non-adopted preterm children had DCD more often than children born at term.[10,11] Studies have reported that the DCD prevalence was up to 48% when children born extremely preterm reached 5 years of age and varied between 8% and 28% at 6.5–13 years of age.[10,11,14] One of those studies reported that the prevalence of DCD also seemed to be more stable between 5 and 7 years of age and 13 years of age when children born extremely preterm were compared to term-born children.[11] During the second assessment in our study, only 43% of preterm adopted children performed at the normal level and did

TABLE 3 Associations in the linear regression analysis between the DCD level MABC-2 test performance (below the 5th percentile) results and the internalising and externalising CBCL test results of the internationally adopted children.

CBCL scores								
	Assessment 1[a]				Assessment 2[b]			
MABC-2	Estimate	Std. error	Statistic	*p*-value	Estimate	Std. error	Statistic	*p*-value
Internalising scores at assessment 1								
Manual dexterity	−0.06	0.06	−0.99	0.33	0.06	0.07	0.85	0.40
Aiming and catching	0.01	0.12	0.10	0.92	−0.20	0.15	−1.30	0.20
Balance	−0.02	0.07	−0.29	0.77	0.03	0.12	0.23	0.82
Total test score	0.17	0.09	1.78	0.08	0.07	0.10	0.68	0.50
Externalising scores at assessment 1								
Manual dexterity	0.23	0.10	2.17	0.04	0.21	0.13	1.66	0.10
Aiming and catching	−0.26	0.21	−1.28	0.21	−0.10	0.26	−0.37	0.71
Balance	−0.00	0.13	−0.02	0.99	0.03	0.22	0.13	0.90
Total test score	0.13	0.10	1.23	0.23	0.27	0.15	1.77	0.08
Internalising scores at assessment 2								
Manual dexterity	−0.15	0.08	−1.94	0.06	0.01	0.09	0.11	0.91
Aiming and catching	0.22	0.14	1.60	0.12	0.12	0.24	0.50	0.62
Balance	−0.05	0.10	−0.50	0.62	0.11	0.14	0.82	0.42
Total test score	0.29	0.14	2.17	0.04	−0.08	0.13	−0.60	0.56
Externalising scores at assessment 2								
Manual dexterity	−0.14	0.13	−1.06	0.30	0.16	0.13	1.21	0.24
Aiming and catching	−0.13	0.22	−0.61	0.55	0.19	0.36	0.54	0.60
Balance	−0.17	0.16	−1.07	0.29	0.06	0.21	0.30	0.77
Total test score	−0.09	0.23	−0.40	0.69	0.19	0.19	1.02	0.32

Abbreviations: CBCL, Child Behavior Checklist; CD, developmental coordination disorder; MABC-2, The Movement Assessment Battery for Children—second edition.

[a]6 months after arrival in the adoptive family.

[b]18 months after arrival in the adoptive family.

not show motor difficulties. These children with motor difficulties should be followed more carefully and intervention programmes should be started at an early stage.[8,26]

Our study did not show any significant differences between the sexes in most of the MABC-2 test results, but the girls did have better manual dexterity. The child's sex did not explain the overall prevalence of DCD-level performance. However, a study by Smits-Engelsman et al. reported that the MABC-2 test showed a higher prevalence of DCD among boys.[27] Internationally adopted children are already at higher risk of developmental problems, due to their pre-adoptive conditions.[1–4,6] That is why it is important to highlight our findings that they were a risk population for DCD.

Many earlier studies concluded that the aetiology of DCD was likely to be multifactorial and motor difficulties were only part of a more general dysfunction of the brain.[8,9] Many brain imaging studies of preterm children have shown that they often had brain abnormalities that may have affected their development[14,15] and provided a strong underlying cause for their poor motor development. Pre-adoptive adversities may provide additional risk factors for normal developmental outcomes. These could include missing medical appointments during pregnancy, prenatal alcohol exposure, poor nutrition, adversities in orphanages and multiple pre-adoptive placements at an early age.[3,4,28,29] In addition, brain imaging studies of non-adopted term children with DCD indicated differences in these children's brain structures and functioning when they were compared with normally developing children.[30] Both brain abnormalities and pre-adoptive adversities may explain the higher prevalence of adopted children with DCD-level motor challenges than those with DCD in the general child population.

A study of children aged 4–5 years who had not been adopted showed that children with DCD-level motor delays had more emotional and behavioural problems than typically developing children.[13] In our study, the association with earlier DCD-level motor delays and internalising behavioural problems were seen at the 18 month follow-up visit. Both findings suggest that early motor problems could help to promptly identify children who face an increased risk for later broader developmental problems. However, our study showed that abnormal MABC-2 results during the second assessment had no association with higher CBCL domains.

Another study found that being younger at the time of adoption predicted better improvements in development during the child's early years in adoptive families.[3] Internationally adopted children may not have had previous opportunities to learn and practise the essential motor skills that are measured by age-appropriate tests, such as the MABC-2. The children in our study arrived in Finland at a median age of 3.1 years and more than 60% of them demonstrated fine motor difficulties during the first assessment 6 months after their arrival. However, our results are encouraging, because more than half of these children showed marked improvements and performed normally when they took the MABC-2 test 1 year later. International adoption could be regarded as an intervention that promoted the motor skills of these children, because it provided them with more possibilities to practise their daily activities in their new homes.

It is notable that studies have reported that a child's motor challenges have an impact on their well-being and quality of life, as well as the well-being of the entire family.[8,20,26] Evidence suggests that individually planned interventions improve children's motor skills, whether a child has milder or DCD-level motor difficulties. They may also improve their self-confidence, social and emotional well-being and daily activities.[8,9,26] Internationally adopted children that have motor difficulties 18 months after their adoption should be treated in the same way as other children with motor challenges, to improve their development and well-being. It would be interesting to see whether these children display major changes in motor development, their prevalence of DCD and behavioural symptoms at school age.

4.1 | Strengths and limitations

The strengths of our study were that we used the MABC-2, which has been shown to have a good test–retest reliability and validity in this age group. The MABC-2 was carried out twice, with a 1-year gap, to avoid test-specific practice. However, our study had some limitations. Our original aim was to evaluate the neurodevelopment of internationally adopted children 3 months after they arrived in Finland, but it was not possible to do this before an average of 6 months. Most families were burdened by the lifestyle changes of a new child entering the family. In addition, our study meetings put extra pressure on those families, because they were held at the same time as health appointments at the local health centres.

The lack of more detailed pre-adoptive information was also a limitation and other studies have also reported this. In addition, not all the families who attended both assessments returned both CBCL questionnaires. This may have contributed to the fact that the association between DCD symptoms and behavioural symptoms only emerged in the CBCL internalising scores. Another limitation was that some families did not provide more detailed information about their family characteristics, such as the mother's education.

Furthermore, we were not able to diagnose clinical DCD, as we only used the objective movement test, which forms part of the diagnosis. In addition, the children were also too young for an exact DCD diagnosis. We only used one observer and did not collect parental MABC-2 questionnaires or ask the children's teachers or day care professionals to provide observations on their motor skills and daily activities.

5 | CONCLUSION

This study found that more than one-third of the internationally adopted children who had arrived in Finland an average of 6 months earlier had marked motor developmental delays at the DCD level. During the follow-up 1 year later, half of these children had improved their movement skills, but 13% still had DCD symptoms. This was double the rate in the general child population.[8,9] Further studies are needed to determine how these children perform at school age. Our findings support previous studies,[12,13] as they confirm the association between DCD-level motor performance and behavioural symptoms. This was despite the normalised motor development seen at follow-up visits. This suggests that motor problems in early childhood could be a risk factor and a recognisable sign for broader developmental symptoms.

AUTHOR CONTRIBUTIONS

Anna-Riitta Heikkilä: Writing – original draft; writing – review and editing; conceptualization; methodology; data curation; investigation; resources; visualization; validation; funding acquisition. **Marko Elovainio:** Writing – review and editing; methodology; formal analysis; supervision; conceptualization; data curation; software; visualization; validation. **Hanna Raaska:** Conceptualization; methodology; writing – review and editing; validation; data curation. **Helena Lapinleimu:** Conceptualization; methodology; writing – review and editing; validation; project administration; software; supervision; data curation; resources; funding acquisition; investigation.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

This paper is based on health data that cannot be shared with third parties.

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REFERENCES

1. Hernanz Lobo A, Berzosa Sánchez A, Escolano L, et al. International adoption of children with special needs in Spain. Children (Basel). 2023;10(4):690. doi:10.3390/children10040690
2. Miller L, Canzi E, Ranieri S, et al. Special needs of internationally adopted adolescents in 4 receiving European countries: relation to mothers' adoption satisfaction. CYSR. 2022;137:106471. doi:10.1016/j.childyouth.2022.106471
3. Dalen M, Theie S. Internationally adopted children from non-European countries: general development during the first two years in the adoptive family. ScientificWorldJournal. 2012;2012:375436. doi:10.1100/2012/375436
4. Welsh JA, Viana AG. Developmental outcomes of internationally adopted children. Adopt Q. 2012;15(4):241-64. doi:10.1080/10926755.2012.731029
5. Jacobs E, Miller LC, Tirella LG. Developmental and behavioral performance of internationally adopted preschoolers: a pilot study. Child Psychiatry Hum Dev. 2010;41(1):15-29. doi:10.1007/s10578-009-0149-6
6. Park H, Bothe D, Holsinger E, Kirchner HL, Olness K, Mandalakas A. The impact of nutritional status and longitudinal recovery of motor and cognitive milestones in internationally adopted children. Int J Environ Res Public Health. 2011;8(1):105-16. doi:10.3390/ijerph8010105
7. Roeber BJ, Gunnar MR, Pollak SD. Early deprivation impairs the development of balance and bilateral coordination. Dev Psychobiol. 2014;56(5):1110-8. doi:10.1002/dev.21159
8. Blank R, Barnett AL, Cairney J, et al. International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. Dev Med Child Neurol. 2019;61(3):242-85. doi:10.1111/dmcn.14132
9. Biotteau M, Albaret JM, Chaix Y. Developmental coordination disorder. Handb Clin Neurol. 2020;174:3-20. doi:10.1016/b978-0-444-64148-9.00001-6
10. Bolk J, Farooqi A, Hafström M, Åden U, Serenius F. Developmental coordination disorder and its association with developmental comorbidities at 6.5 years in apparently healthy children born extremely preterm. JAMA Pediatr. 2018;172(8):765-74. doi:10.1001/jamapediatrics.2018.1394
11. Spittle AJ, Dewey D, Nguyen TN, et al. Rates of developmental coordination disorder in children born very preterm. J Pediatr. 2021;231:61-67. e62. doi:10.1016/j.jpeds.2020.12.022
12. King-Dowling S, Missiuna C, Rodriguez MC, Greenway M, Cairney J. Co-occurring motor, language and emotional-behavioral problems in children 3-6 years of age. Hum Mov Sci. 2015;39:101-8. doi:10.1016/j.humov.2014.10.010
13. Rodriguez MC, Wade TJ, Veldhuizen S, Missiuna C, Timmons B, Cairney J. Emotional and behavioral problems in 4- and 5-year old children with and without motor delays. Front Pediatr. 2019;7:474. doi:10.3389/fped.2019.00474
14. Setänen S, Lehtonen L, Parkkola R, Matomäki J, Haataja L. The motor profile of preterm infants at 11 y of age. Pediatr Res. 2016;80(3):389-94. doi:10.1038/pr.2016.90
15. Dewey D, Thompson DK, Kelly CE, et al. Very preterm children at risk for developmental coordination disorder have brain alterations in motor areas. Acta Paediatr. 2019;108(9):1649-60. doi:10.1111/apa.14786
16. Draghi TTG, Cavalcante Neto JL, Rohr LA, Jelsma LD, Tudella E. Symptoms of anxiety and depression in children with developmental coordination disorder: a systematic review. J Pediatr. 2020;96(1):8-19. doi:10.1016/j.jped.2019.03.002
17. Wilson P, Ruddock S, Rahimi-Golkhandan S, et al. Cognitive and motor function in developmental coordination disorder. Dev Med Child Neurol. 2020;62(11):1317-23. doi:10.1111/dmcn.14646
18. Karras HC, Morin DN, Gill K, Izadi-Najafabadi S, Zwicker JG. Health-related quality of life of children with developmental coordination disorder. Res Dev Disabil. 2019;84:85-95. doi:10.1016/j.ridd.2018.05.012
19. Redondo-Tébar A, Ruiz-Hermosa A, Martínez-Vizcaíno V, Martín-Espinosa NM, Notario-Pacheco B, Sánchez-López M. Health-related quality of life in developmental coordination disorder and typical developing children. Res Dev Disabil. 2021;119:104087. doi:10.1016/j.ridd.2021.104087

20. Cleaton MAM, Lorgelly PK, Kirby A. Developmental coordination disorder: the impact on the family. Qual Life Res. 2019;28(4):925-34. doi:10.1007/s11136-018-2075-1
21. Achenbach TM, Rescorla LA. Manual for the ASEBA Preschool Forms & Profiles. University of Vermont, Research Center for Children; 2001.
22. Henderson S, Sugden DA, Barnett AL. Movement Assessment Battery for Children −2 (Examiner's Manual). Pearson Assessment; 2007.
23. Schulz J, Henderson SE, Sugden DA, Barnett AL. Structural validity of the movement ABC-2 test: factor structure comparisons across three age groups. Res Dev Disabil. 2011;32(4):1361-9. doi:10.1016/j.ridd.2011.01.032
24. Griffiths A, Toovey R, Morgan PE, Spittle AJ. Psychometric properties of gross motor assessment tools for children: a systematic review. BMJ Open. 2018;8(10):e021734. doi:10.1136/bmjopen-2018-021734
25. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development. 2006.
26. Smits-Engelsman B, Verbecque E. Pediatric care for children with developmental coordination disorder, can we do better? Biom J. 2022;45(2):250-64. doi:10.1016/j.bj.2021.08.008
27. Smits-Engelsman B, Coetzee D, Valtr L, Verbecque E. Do Girls Have an Advantage Compared to Boys when their Motor Skills Are Tested Using the Movement Assessment Battery for Children, 2nd edition? Children (Basel). 2023;10(7):1159. doi:10.3390/children10071159
28. Miller LC. Immediate behavioral and developmental considerations for internationally adopted children transitioning to families. Pediatr Clin N Am. 2005;52(5):1311-30. doi:10.1016/j.pcl.2005.06.011
29. Grotevant HD, McDermott JM. Adoption: biological and social processes linked to adaptation. Annu Rev Psychol. 2014;65:235-65. doi:10.1146/annurev-psych-010213-115020
30. Wilson PH, Smits-Engelsman B, Caeyenberghs K, et al. Cognitive and neuroimaging findings in developmental coordination disorder: new insights from a systematic review of recent research. Dev Med Child Neurol. 2017;59(11):1117-29. doi:10.1111/dmcn.13530

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