Finnish-born children of immigrants are more likely to be diagnosed with developmental disorders related to speech and language, academic skills and coordination

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Short title: Developmental disorders among children of immigrants

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ABSTRACT

Aim: We examined the association between having at least one parent born abroad and being diagnosed with a developmental disorder related to speech and language, academic skills or coordination.

Methods: This nested case-control study was based on Finnish population records for 1996–2007. Cases from the Finnish Hospital Discharge Register were diagnosed with developmental disorders of speech and language, academic skills and coordination by the end of 2012. We identified 28,192 cases and 106,616 matched controls.

Results: Children were more likely to be diagnosed with developmental disorders if they had an immigrant mother than children with two Finnish-born parents, with an adjusted odds ratio (aOR) of 1.3 and 95% confidence interval (95% CI) of 1.2–1.4, an immigrant father (aOR 1.2, 95% CI 1.1–1.3) or two immigrant parents (aOR 1.5, 95% CI 1.3–1.6). The level of development of the parental country of origin was not associated with receiving a diagnosis.

Conclusion: Children of immigrant parents were more likely to be diagnosed with developmental disorders and the association was strongest with regard to speech and language disorders. There were similar adjusted odd ratios for mothers, fathers and both parents. The development level of the country of origin was irrelevant.

Key notes:

- In this nationwide register-based study, Finnish-born children with a diagnosis of a developmental disorder of speech and language, academic skills or coordination were compared with matched controls.
- The 28,192 cases and 106,616 controls were born in 1996-2007 and cases had received a diagnosis of developmental disorder by the end of the year 2012.

- Children with at least one immigrant parent were more likely to be diagnosed with a developmental disorder of speech and language, academic skills or coordination than children with both parents born in Finland.

Keywords: developmental delay, immigrants, learning disorders, risk factors, speech and language problems

BACKGROUND

The number of immigrants has increased rapidly in many countries in recent years, particularly the number of asylum seekers and refugees. In 2015, there were almost 1.3 million first-time applications for asylum in the European Union and about one-third of them were minors who were less than 18 years of age (1). Decision makers and service providers need to rise to the challenge of developing services to promote the integration and wellbeing of immigrants. The academic performance of immigrants is an important indicator of integration and of great interest to educational and health services. The Programme for International Student Assessment, which is a survey carried out by the Organisation for Economic Co-operation and Development, showed that in most countries both first-generation and second-generation immigrant students performed worse than native-born students when it came to reading, mathematics and problem solving (2). The Programme's researchers stated that this lower performance could be partly explained by low parental educational levels, low levels of child pre-school education, high concentrations of socioeconomically disadvantaged immigrants in schools and insufficient exposure to the language of the host country (2). However, it is also important to identify other reasons for learning problems. The children of refugee families, in particular, face multiple challenges as these families often experience psychological distress, changes in family relationships and financial difficulties and the children may experience

bullying, discrimination and inappropriate educational expectations and grade placements at school (3-5).

Developmental disorders of speech and language, academic skills and coordination are some of the most common childhood psychiatric and developmental disorders. In Finland, the cumulative incidence by the age of 14 years has been reported to be 5.5% (6). Learning problems are more common in children whose parents have low educational levels (7), low incomes (7,8) or health problems (8). However, little is known about their prevalence when the children or their parents are immigrants. One German study that was based on screening all children before they entered primary school in Southern Bavaria, found that children who were not born in Germany experienced more delays in motor, cognitive and psychosocial development than native-born German children (9). The screening procedure was not as thorough as a diagnostic assessment and no possible confounding factors were considered in that study. In reports based on the National Surveys of Children's Health, which were conducted in the USA, the prevalence of learning disabilities was reported to be lower among immigrants (10) and among those whose primary language was not English (7), but the information about learning disabilities was based on a single question answered by the parents. No population-based studies on the risk of developmental disorders of speech and language, academic skills and coordination have been published that have included a reliable diagnostic assessment of the children of immigrant parents and compared them with the children of native-born parents.

This population-based study on the association between parental immigration and being diagnosed with a developmental disorder of speech and language, academic skills or coordination in Finland, was based on a large nationwide sample. It included comprehensive register data on the diagnoses and the possible confounding factors. In our earlier studies, we showed that the children of immigrant parents were more likely to be diagnosed with attention-deficit hyperactivity disorder (11) and childhood autism (12), but less likely to be diagnosed

with Asperger's syndrome (13) than the children of Finnish-born parents. The aim of the current study was to examine the association between having one or two immigrant parents and being diagnosed with developmental disorders of speech and language, academic skills and coordination. Based on our earlier studies, we hypothesised that the children of immigrant parents would be more likely to be diagnosed and that this association would be stronger when both parents were immigrants or came from countries with low developmental levels.

METHODS

This study was a national case-control study based on national Finnish registers. None of the participants were contacted during this study and no informed consent was obtained. The personal identification code issued to all Finnish residents at birth, or when they move to the country, was replaced by a research code and the individuals could not be identified. These codes enable data to be linked in all national Finnish registers and are invaluable for research purposes. Ethical approval for the study was provided by the Ethics Committee of the Hospital District of Southwest Finland and the National Institute for Health and Welfare.

Cases and controls

The cases were identified from the Finnish Hospital Discharge Register, a nationwide database maintained by the National Institute for Health and Welfare. This study included all 33,234 singletons born in Finland in 1996-2007 who had been diagnosed with developmental disorders of speech and language, academic skills and coordination by 2012. The Discharge Register included all diagnoses given to individual receiving inpatient care during the whole follow-up period and those given in specialist outpatient services since 1998. Most diagnoses of developmental disorders of speech and language, academic skills and coordination are given in outpatient services. All children in Finland are covered by the public healthcare system, which includes comprehensive services provided by primary care and specialist units. Most children

attend free health check-ups at least 15 times during the first six years of life and after that they receive yearly health check-ups at school. If a neurodevelopmental delay is suspected, children are referred to publicly funded specialist units and assessments are usually conducted at an outpatient clinic by a multi-professional team led by a paediatrician or paediatric neurologist. The team typically includes a psychologist, occupational therapist, physiotherapist and nurse. Standardised assessment procedures are used to evaluate developmental delays in speech and language and in academic or motor skills. A doctor is responsible for diagnostic decisions. Other specialities, such as child psychiatry, phoniatrics or child surgery, are consulted if needed.

In Finland it is obligatory to use diagnostic codes based on the International Classification of Diseases (ICD). In this study, the cases were diagnosed according to the Tenth Revision (ICD-10), using: specific developmental disorders of speech and language (F80), specific developmental disorders of academic skills (F81), specific developmental disorders of motor function (F82) and mixed developmental disorders (F83). Disorders of speech and language are characterised by disturbances in normal patterns of language acquisition. Academic disorders refer to impairments in acquiring reading, spelling or arithmetical skills. Motor function disorders refer to impaired fine and gross motor coordination development. Mixed developmental disorders cover a combination of specific developmental disorders of speech and language, academic skills and motor function, but none of these are sufficiently dominant to account for the primary diagnosis. This category is usually, but not always, associated with mild general impairment of cognitive functions. All the analyses in this study were conducted using the category any developmental disorder, which referred to having received one or more diagnoses in the categories F80–F83. In addition, separate analyses were conducted using just speech and language disorder outcomes (F80), just academic disorders (F81), just coordination disorders (F82) and mixed disorders (F83) or at least two diagnostic classes. We excluded the 3,048 cases who had been diagnosed with an intellectual disability (ID) using ICD-10 codes F70–F79 and the 1,990 cases diagnosed with autism spectrum disorders (ASD) using the ICD-

10 category F84. Four cases had to be excluded due to the exclusion of all four matched controls. The final number of cases was 28,192.

The four controls per case were selected by linking the Discharge Register and the Finnish Central Population Register, which is a national register that contains basic information about Finnish citizens and permanent residents in Finland. The controls had to be singletons and alive and resident in Finland when the matched cases were diagnosed. The cases and controls were matched by the region they were born in, their sex and their date of birth, plus or minus 30 days. The exclusion criteria for the controls were developmental disorders of speech and language, academic skills and coordination intellectual disabilities or ASD (ICD-10 codes F80-83, F70-79, F84) according to the Discharge Register. In addition, 19 controls had to be excluded because the mother's personal identification code was unknown or illogical. The final number of controls was 106,616.

Information on parental migration

The immigrant population in Finland is small, but it has been growing in recent years. In 2015, 6.1% of the population had been born abroad (14). In this study, the information on parental country of birth and native language were collected from the Population Register. Immigrant parents were defined as those who were born abroad and were not native speakers of one of the official languages of Finland: Finnish, Swedish or Sami. Those who were born in Finland and, or spoke one of those three languages were defined as Finnish. The primary classification for parental immigration comprised the following categories: both parents Finnish (reference), immigrant mother and Finnish father, immigrant father and Finnish mother and both parents immigrants. In addition, two regional classifications were formed separately for mothers and fathers based on their country of origin. The first classification was based on geographical, and to some extent, socioeconomic factors. The seven categories included Finland (reference), Western countries (most European countries, North America, Australia and New Zealand),

countries that were part of the former Soviet Union or former Yugoslavia, Sub-Saharan Africa, North Africa and the Middle East, Asia (excluding the Middle East) and Latin America. A similar classification was used in our previous studies on ASD and ADHD (11-13). The second regional classification was based on the Human Development Index, which reflects the level of income and education as well as the life expectancy in different countries (15). Countries were placed into the following categories based on the 2014 Human Development Report (16), with Finland as the reference category and four categories for very high, high, medium and low human development.

Covariates

The inclusion of covariates was based on analyses of bivariable associations between the selected variables from different registers and the outcome of any developmental disorder and between the same variables and the parents' immigration status among the controls. The variables that were evaluated included maternal and paternal ages and education levels, the mother's relationship status when the child was born, maternal smoking during pregnancy, parity, the child's birth weight for gestational age and Apgar scores at one minute. The categories can be seen in Table 1. Information on paternal age was obtained from the Population Register, information on the parents' education was obtained from the Register of Completed Education and Degrees and information on all other variables were obtained from the Finnish Medical Birth Register. The Education Register is maintained by the Statistics Finland and includes the highest education achieved after comprehensive school for every person living in Finland. Information was available for both parents for the birth year of the child as well as for the year 2012. The information on the immigrant parents' education may have been unreliable, especially at the time of the child's birth, because the education achieved in their country of origin may not have been acknowledged in Finland. In addition, if the parent died or emigrated from Finland during the follow-up period, the educational level at the child's birth may have

been the highest one available. For these reasons, the highest reported educational level from any of these two time points was used. The Birth Register is a national register maintained by the National Institute for Health and Welfare and it links the mothers' and children's personal identify codes. It includes information on maternal background, pregnancy and the prenatal and neonatal period up to the age of seven days for all births in Finland.

Statistical analysis

Bivariable analyses were conducted using Pearson's chi-square test for the selection of covariates among the controls. Conditional logistic regression was then used to test for the association between covariates and outcome. The covariates were considered to confound the odds ratio (OR) if they were associated with the parents' immigration status and the outcome at $p<0.10$. The association between parental immigration and developmental disorders of speech and language, academic skills and coordination was quantified by calculating unadjusted and adjusted ORs with 95% confidence intervals (95% CI) using conditional logistic regression analysis and the three different classifications for parental immigration. The reference group in each analysis was Finnish parents. When the regional categories for parental migration were used, only any developmental disorder was used as an outcome to provide sufficient statistical power. The statistical significance level was set at two-sided 5%. Statistical analyses were performed with SAS software, version 9.4 (SAS Institute Inc, Cary, North Carolina, USA).

RESULTS

The selection of covariates for adjusted analyses

The relationship between the evaluated covariates and the parents' immigration status, as well as between the covariates and any developmental disorder diagnosis, are shown in Table 1. All the covariates were associated with a developmental disorder. In addition, all the covariates,

except for the Apgar scores, were associated with parental immigration and were included in the adjusted analyses.

Age at diagnosis

The mean age for being diagnosed with a developmental disorder for the first time was 5.5 ±2.7 years. It was 4.8 ± 2.1 years for those with just a speech and language disorder, 8.7 ±2.7 years for those with just a academic disorder and 5.0 ±2.5 years for those with just a coordination disorder. Only 2.3% of cases were first diagnosed with a developmental disorder at the age of 13 or older. The proportion was 0.6% for just speech and language disorders, 2.0 % for just academic disorders and 0.2 % for just coordination disorders. It should be noted that only those who were born in 1999 or earlier were followed until the age of 13 or older.

Subtypes of developmental disorders among children of immigrant parents

As shown in Table 2, 4.2% of the children with any developmental disorder had two parents who were immigrants, 2.3% had an immigrant mother and 2.4% had an immigrant father, while the respective percentages were 2.2%, 1.6% and 2.0% for the controls. Table 3 shows that the adjusted odds ratio of a child being diagnosed with any developmental disorder was 1.3 (95% CI 1.2–1.4) among children with an immigrant mother, 1.2 (1.1–1.3) with an immigrant father, and 1.5 (1.3–1.6) with two immigrant parents, when compared to children with two Finnish parents.

Tables 2 and 3 also show the results for subgroups of developmental disorders. Similar to any developmental disorder, the adjusted ORs of just receiving a diagnosis of a speech and language disorder were 1.8 among children with an immigrant mother, 1.3 among children with an immigrant father and 2.2 among those with two immigrant parents. In contrast, the adjusted ORs of only having a diagnosis of an academic disorder or a coordination disorder, or at least

two of the diagnostic categories or a mixed developmental disorder, ranged between 0.7 and 1.8.

Developmental disorders by parental country of origin

The geographical classification for the parental country of origin in relation to developmental disorders of speech and language, academic skills and coordination among children is shown in Table 4. If the mother or the father was an immigrant from the Former Soviet Union or former Yugoslavia, North Africa or Middle East, Sub-Saharan Africa or Asia, the adjusted ORs for developmental disorders ranged between 1.2 and 1.7 for maternal immigration and between 1.2 and 1.5 for paternal immigration. In addition, maternal immigration from Latin America was associated with increased odds of developmental disorders (1.8). Paternal immigration from Western countries was associated with an adjusted OR of 1.1, while maternal immigration from Western countries was actually associated with decreased odds of developmental disorders (0.9).

Since the odds of being diagnosed with a developmental disorder of speech and language, academic skills or coordination was very similar among children of Finnish and other Western parents, an additional analysis without children of parents from Western countries was conducted. It was found that the adjusted OR for receiving a diagnosis was 1.4 (95 % CI 1.3–1.5) for children of fathers from non-Western countries when compared with Finnish fathers and 1.4 (1.3–1.5) also for mothers from non-Western countries when compared with Finnish mothers.

When parental countries were categorised by the Human Development Index (Table 5), associations were shown between developmental disorders of speech and language, academic skills and coordination in their offspring and mothers and fathers coming from a country with a high or medium index. The adjusted ORs were 1.4 for both parents from high index countries

and 1.6 for mothers and 1.5 for fathers from medium index countries. The same was true for fathers from very high index countries (1.2), but not for mothers (1.0). However, neither maternal nor paternal immigration from low index countries were significantly associated with developmental disorders of speech and language, academic skills and coordination.

DISCUSSION

Having an immigrant background was associated with a child being diagnosed with a developmental disorder of speech and language, academic skills or coordination and the association was strongest for speech and language disorders, which were also the most common subtype of disorders. Contrary to our hypotheses, only small differences were found between having an immigrant mother, immigrant father or two immigrant parents and no association was found between the low level of development of the parental country of origin and the child having a developmental disorder of speech and language, academic skills or coordination. It is notable that all the children in this study were born in Finland and most of them would have probably attended Finnish day care centres and schools, which means that the results could not be explained by differences in educational systems or the lack of opportunities to practice certain skills. In fact, the relatively high standard of living, and the high quality of educational system and public health services, may have contributed to smaller differences in development than might have been detected in countries with smaller and more unequally distributed resources.

The genetic background of developmental disorders of speech and language, academic skills and coordination is complex and little is known about the interactions between genetic and environmental factors (17,18). There is no particular reason to assume that immigrants who move to Finland come from regions with a higher genetic risk for such disorders or that those

with a higher genetic risk selectively migrate. However, it is possible that genetic effects are moderated by environmental factors that are more common in immigrant families. The environmental risk factors for developmental disorders of speech and language, academic skills and coordination include prenatal and perinatal factors, such as prenatal alcohol exposure (19) and prematurity (20). There are also social risk factors that may be related to biological effects or to the level of cognitive stimulation the child receives at home, such as low parental socioeconomic status (7,8) or parental health problems (8). We were able to control for several risk factors for developmental disorders of speech and language, academic skills and coordination, but there may be others that were not included in this study and that are more common among immigrant families. For example, we did not have any information on the traumatic experiences or stress that the parents may have experienced and those are both factors that may have affected their offspring's wellbeing and learning (21). The developmental disorders of speech and language, academic skills and coordination are heterogeneous and their aetiology is multifactorial. Our study showed very little differences between the risks of children being diagnosed based on whether they were the children of immigrant mothers and fathers and between the parents' regions of origin. As a result, it is difficult to pinpoint specific environmental risk factors that may explain the results.

Parental immigration status was most strongly associated with speech and language disorders, which raises questions about the role of multilingualism and the challenges of assessing children of immigrant parents. Research is scarce, but there is currently no evidence of a higher prevalence of speech and language disorders among multilingual children (22). Even though some studies conducted in language units (23,24) have suggested that the language problems of bilingual children are more severe than those of monolingual children, there have also been many studies that have found no differences in severity (22,25). The challenge for clinicians is to identify children who actually have a language-related developmental problem and not to interpret the characteristics of normal language development in multilingual children as language impairment. It is normal for the language skills of multilingual children to be unevenly

distributed between different languages (22). Their performance may be underestimated by language assessments that only focus on one language and use monolingual norms, because multilingual children typically have smaller vocabularies and demonstrate slower grammatical development in each language they use (22,26,27). To conduct a valid assessment, it is recommended that clinicians collect information from multiple sources, use tests in all the languages that the child speaks, use criterion-referenced methods instead of norm-referenced tests, carry out dynamic assessments following the test-teach-retest format and use the sociocultural approach (22,27,28). Some of these methods may be impractical in countries with a small number of immigrants, due to the lack of bilingual professionals and validated tests in different languages. When speech and language disorders are detected, clinicians have to be aware of the commonly co-occurring neurodevelopmental problems.

In addition to problems related to standardised tests, assessing the children of immigrant parents can often be more complicated due to communication problems with the parents. A study in the UK found that immigrant parents could be less informed about healthcare and special education systems and be less involved in their child's assessment and rehabilitation processes (29). Meanwhile, a qualitative study in the USA found that refugee parents had higher thresholds when it came to being concerned about developmental problems, they were not familiar with monitoring developmental milestones and there were many barriers to seeking and accepting developmental care (30). A Swedish study found that when language impairment was suspected, the families of bilingual children were more likely to refuse referrals and assessments and the children were more likely to be discharged from specialist services because of non-attendance than children who only spoke Swedish (24). It is possible that parents who come from countries with a low Human Development Index are least familiar with the Finnish service system and the fact that we did not find an increased likelihood of developmental disorders of speech and language, academic skills and coordination among their children may partly be explained by their underuse of services. Teachers at day care centres and schools have an important role to play in detecting possible developmental problems, especially when parents

are not actively seeking help. It is possible that problems related to language are more easily detected in these environments than, for example, coordination problems, which were diagnosed less often in this study among the children of immigrant parents than those born to Finnish parents.

Strengths and limitations

The sample size was large and based on national data. The register data on maternal and paternal factors and birth outcomes was comprehensive and the information on parental migration was reliable. However, only the parents' country of birth could be used, because ethnicity and the reason for migration are not registered in Finland. The validity of register-based diagnoses of developmental disorders of speech and language, academic skills and coordination in Finland has not been studied and some of the less severe cases may have been missing. However, the screening system is comprehensive and there is universal access to specialist services that are run by highly qualified professionals, such as paediatric neurologists. The youngest participants were only followed until the age of five. Some of the controls could have been diagnosed at older age, but it is not possible to know if the proportion of these children was different among children of immigrants and children of Finnish-born parents.

CONCLUSION

Children with at least one immigrant parent were more likely to be diagnosed with developmental disorders of speech and language, academic skills and coordination in Finland. It is important that similar studies to ours are carried out in other cultural, language and socioeconomic environments. Clinicians need reliable tools to assess the development of speech and language in particular. In addition, more attention should be paid to the exchange of information between parents and professionals when working with families with one or more

foreign-born parents, as this is likely to raise more complex issues than dealing with families that share a common language and similar cultural background to clinicians.

LIST OF ABBREVIATIONS

ADHD, attention-deficit hyperactivity disorder; aOR, adjusted odds ratio; ASD, autism spectrum disorders; CI, confidence interval; ICD, International Classification of Diseases; OR, odds ratio; SD, standard deviation

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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Table 1. Covariates in relation to immigration status in controls and in relation to the risk of any developmental disorder

	Immigration					**Relationship between covariates and any disorder (**p value)
Covariates	**Both parents Finnish** n (%)	**Mother immigrant** n (%)	**Father immigrant** n (%)	**Both parents immigrants** n (%)	p value	
Mother over the median age of 29 years	56,297 (56.0)	1,034 (60.7)	1,292 (61.8)	1,045 (45.1)	<0.001	<0.001
Father over the median age of 31 years	55,565 (55.9)	1,282 (75.2)	1,237 (59.1)	1,463 (63.1)	<0.001	0.003
Single mother[1)]	4,669 (5.0)	70 (4.4)	174 (9.3)	86 (3.9)	<0.001	<0.001
Maternal education at child's birth[2)]					<0.001	<0.001
Master degree or licentiate degree or PhD	16,806 (16.7)	295 (17.3)	452 (21.6)	157 (6.8)		
College degree or bachelor university degree	34,678 (34.5)	340 (19.9)	624 (29.8)	247 (10.7)		
Vocational degree or secondary school graduate	40,732 (40.5)	551 (32.3)	779 (37.2)	721 (31.1)		
No education after comprehensive school	8,286 (8.2)	519 (30.4)	237 (11.3)	1,192 (51.5)		
Paternal education at child's birth[1) 7)]					<0.001	<0.001
Master degree or licentiate degree or PhD	14,062 (14.2)	266 (15.6)	312 (14.9)	203 (8.8)		
College degree or bachelor university degree	23,845 (24.0)	431 (25.3)	330 (15.8)	283 (12.2)		
Vocational degree or secondary school graduate	47,275 (47.6)	685 (40.2)	618 (29.5)	882 (38.1)		
No education after comprehensive school	14,160 (14.3)	323 (18.9)	832 (39.8)	949 (41.0)		
Maternal smoking during pregnancy[3)]	14,340 (14.7)	169 (10.6)	268 (13.9)	168 (7.7)	<0.001	<0.001
Previous births ($\geq$2)[4)]	25,622 (25.6)	292 (17.9)	426 (21.4)	857 (37.5)	<0.001	<0.001
Weight for gestational age[5)]					<0.001	<0.001
Small	2,728 (2.7)	34 (2.1)	65 (3.3)	95 (4.2)		
Appropriate	93,693 (94.1)	1,545 (95.0)	1,866 (94.2)	2,139 (93.9)		
Large	3,157 (3.2)	48 (3.0)	49 (2.5)	45 (2.0)		
Apgar scores (<7 at 1 minute)[6)]	4,256 (4.3)	61 (3.7)	78 (3.9)	111 (4.9)	0.292	<0.001

[1)] missing 7448 controls, [2)] imputed with 2012 education level, [3)] missing 3532 controls, [4)] missing 775 controls, [5)] missing 1152 controls, [6)] missing 900 controls, [7)] missing 116

Table 2. Parental immigration status and developmental disorders of speech and language, academic skills and coordination in cases and controls by frequencies, n (%)

	Any learning or coordination disorder		Speech only		Academic only		Coordination only		At least 2 / mixed	
	Cases n=28 192	Controls n=106 616	Cases n=11 142	Controls n=42 391	Cases n=3868	Controls n=14 945	Cases n=2600	Controls n=10 062	Cases n=10 582	Controls n=39 218
Both parents Finnish	25,679 (91.1)	100,502 (94.3)	9,845 (88.4)	39,945 (94.2)	3,637 (94.0)	14,149 (94.7)	2,482 (95.5)	9,422 (93.6)	9,715 (91.8)	36,986 (94.3)
Mother immigrant	652 (2.3)	1705 (1.6)	366 (3.3)	707 (1.7)	52 (1.3)	212 (1.4)	34 (1.3)	170 (1.7)	200 (1.9)	616 (1.6)
Father immigrant	683 (2.4)	2,092 (2.0)	272 (2.4)	810 (1.9)	106 (2.7)	296 (2.0)	51 (2.0)	222 (2.2)	254 (2.4)	764 (2.0)
Both parents immigrants	1,178 (4.2)	2,317 (2.2)	659 (5.9)	929 (2.2)	73 (1.9)	288 (1.9)	33 (1.3)	248 (2.5)	413 (3.9)	852 (2.2)

Table 3. Parental immigration status and developmental disorders of speech and language, academic skills and coordination by unadjusted and adjusted odds ratios

	Any learning or coordination disorder		Speech only		Academic only		Coordination only		At least 2 / mixed	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Both parents Finnish	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Mother immigrant	1.5 (1.4–1.6)	1.3 (1.2–1.4)	2.1 (1.8–2.4)	1.8 (1.5–2.0)	1.0 (0.7–1.3)	1.0 (0.7–1.3)	0.8 (0.5–1.1)	0.8 (0.5–1.1)	1.2 (1.04–1.4)	1.1 (0.9–1.3)
Father immigrant	1.3 (1.2–1.4)	1.2 (1.1–1.3)	1.4 (1.2–1.6)	1.3 (1.1–1.5)	1.4 (1.1–1.7)	1.3 (1.03–1.7)	0.9 (0.6–1.2)	0.9 (0.6–1.2)	1.3 (1.1–1.5)	1.2 (1.04–1.4)
Both parents immigrants	2.0 (1.9–2.1)	1.5 (1.3–1.6)	2.9 (2.6–3.2)	2.2 (2.0–2.5)	1.0 (0.8–1.3)	0.7 (0.5–0.96)	0.5 (0.3–0.7)	0.5 (0.3–0.7)	1.8 (1.6–2.1)	1.2 (1.1–1.4)

OR = odds ratio, aOR = adjusted odds ratio

Table 4. Any developmental disorder of speech and language, academic skills or coordination (ICD-10 F80-83) by parental region of origin, frequencies and odds ratios

	Cases n (%)	**Controls n (%)**	**OR (95% CI)**	**aOR (95% CI)**
Mothers				
Finland	25,829 (91.6)	100,707 (94.5)	Reference	Reference
Western countries	514 (1.8)	2,093 (2.0)	0.96 (0.9–1.05)	0.9 (0.8–0.96)
Former Soviet Union and former Yugoslavia	824 (2.9)	1,833 (1.7)	1.8 (1.6–1.9)	1.5 (1.4–1.7)
Sub-Saharan Africa	281 (1.0)	593 (0.6)	1.8 (1.6–2.1)	1.2 (1.01–1.4)
North Africa, Middle East	159 (0.6)	260 (0.2)	2.4 (2.0–3.0)	1.7 (1.4–2.1)
Asia	531 (1.9)	1,036 (1.0)	2.0 (1.8–2.2)	1.4 (1.2–1.5)
Latin America	54 (0.2)	94 (0.1)	2.2 (1.6–3.1)	1.8 (1.2–2.7)
Fathers				
Finland	25,313 (91.7)	99,545 (94.4)	Reference	Reference
Western countries	657 (2.4)	2,322 (2.2)	1.1 (1.03–1.2)	1.1 (1.02–1.2)
Former Soviet Union and former Yugoslavia	476 (1.7)	1071 (1.0)	1.8 (1.6–2.0)	1.5 (1.4–1.7)
Sub-Saharan Africa	340 (1.2)	791 (0.8)	1.7 (1.5–1.9)	1.2 (1.03–1.4)
North Africa, Middle East	325 (1.2)	721 (0.7)	1.8 (1.6–2.0)	1.4 (1.2–1.6)
Asia	444 (1.6)	867 (0.8)	2.0 (1.8–2.3)	1.4 (1.3–1.6)
Latin America	41 (0.2)	121 (0.1)	1.3 (0.9–1.9)	1.2 (0.8–1.7)

OR = odds ratio, aOR = adjusted odds ratio

Table 5. Any developmental disorder of speech and language, academic skills or coordination (ICD-10 F80-83) by the Human Development Index (HDI) of parental region of origin, frequencies and odds ratios

	Cases n (%)	**Controls n (%)**	**OR (95% CI)**	**aOR (95% CI)**
Mothers				
Finland	25,829 (91.7)	100,707 (94.5)	Reference	Reference
Very high human development	701 (2.5)	2,475 (2.3)	1.1 (1.02–1.2)	1.0 (0.9–1.1)
High human development	959 (3.4)	2,127 (2.0)	1.8 (1.6–1.9)	1.4 (1.3–1.6)
Medium human development	414 (1.5)	672 (0.6)	2.4 (2.1–2.7)	1.6 (1.4–1.8)
Low human development	275 (1.0)	617 (0.6)	1.7 (1.5–2.0)	1.1 (0.96–1.3)
Fathers				
Finland	25,313 (91.8)	99,545 (94.4)	Reference	Reference
Very high human development	770 (2.8)	2,573 (2.4)	1.2 (1.1–1.3)	1.2 (1.1–1.3)
High human development	705 (2.6)	1,629 (1.6)	1.7 (1.6–1.9)	1.4 (1.3–1.6)
Medium human development	452 (1.6)	864 (0.8)	2.1 (1.8–2.3)	1.5 (1.3–1.7)
Low human development	334 (1.2)	805 (0.8)	1.6 (1.4–1.8)	1.1 (0.99–1.3)

OR = odds ratio, aOR = adjusted odds ratio