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Article

Clinical Child Psychology and Psychiatry
2019, Vol. 24(1) 95–111
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DOI: 10.1177/1359104518786537
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Impairments of executive function in young children referred to child psychiatric outpatient clinic

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Abstract

Few studies have reported on the quantity and quality of executive function (EF) deficits in young children referred to child psychiatric outpatient clinic with multiple psychiatric symptoms. We evaluated the EF deficits with the Attention and Executive Function Rating Inventory–Preschool (ATTEX-P) filled out by day care teachers for 4- to 7-year-old clinical group ($n = 171$) and reference group ($n = 709$). Family background information was collected from all families by parent questionnaire. Diagnoses of the referred children were collected from medical records. Clinical group exhibited higher mean ranks across the ATTEX-P Total score and all nine subscales than reference group ($p < .001$). Most of the children in the clinical group (58.5%) showed a significant amount of EF deficits (ATTEX-P Total score over clinical cut-off) including distractibility (55.6%) and impulsivity (53.8%) regardless of their diagnoses. In a multiple logistic regression model (controlling for age, gender and parental education), children in the clinical group had increased risk (odds ratio (OR)) = 10.6, 95% confidence interval (CI) = [6.88, 16.2], $p < .001$) for scoring over the clinical cut-off point on the ATTEX-P Total score. Assessment of EFs should be a routine part of the treatment plan in young children referred to child psychiatric outpatient clinic as it may guide the treatment choices.

Keywords

Executive function, child psychiatric evaluation, preschool age, assessment of EF, EF rating scale

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Introduction

Executive functions (EFs) refer to higher order cognitive processes such as attention, inhibition, working memory, cognitive flexibility, planning, organization, problem-solving and performance monitoring (Anderson, 2002). These functions aid in the monitoring and control of thought and action and facilitate goal-directed behaviour. Inhibitory control (i.e. deliberately suppressing dominant yet inappropriate responses), working memory (i.e. actively maintaining important information in mind) and shifting (i.e. considering simultaneous representations of an object or event and/or flexibly alternating between tasks) are the basic forms of EF (Miyake et al., 2000) that emerge early in childhood, develop rapidly during the preschool period (Carlson, 2005; Durston & Casey, 2006; Garon, Bryson, & Smith, 2008) and continue to strengthen significantly throughout childhood and adolescence (Best & Miller, 2010). The development of EFs appears to play a prominent role in children's emerging academic, social, emotional and behavioural competencies (Best, Miller, & Jones, 2009). EF skills at preschool age predict later ratings of children's attention and behaviour (Gooch, Thompson, Nash, Snowling, & Hulme, 2016), are considered critical for a child's preparedness for school (Blair & Razza, 2007) and predict adult outcomes across a wide array of indices, including physical health, substance dependence, personal finances and criminal offending (Moffitt et al., 2011).

The prefrontal cortex has long been known to play an important role in cognitive control (Miller & Cohen, 2001). The prefrontal region is an association region with extensive connections to cortical, subcortical and brain stem sites, and thus, it is also a non-frontal brain region that is necessary for intact EF (Alvarez & Emory, 2006). Damage to any of these areas may affect the neuronal connections of the prefrontal cortex and, in turn, influence executive functioning. Recent neuroimaging data (magnetic resonance imaging (MRI)) and event-related potential (ERP) measures of EF in preschool-aged children show consistently rapid brain growth during the preschool period and age-related changes in the activation of multiple cortical (frontal, anterior cingulate, parietal) and subcortical (striate, cerebellum) brain regions during the EF task (Anderson & Reidy, 2012; Downes, Bathelt, & De Haan, 2017; Lenroot & Giedd, 2006).

Difficulties in EF skills are noted in many paediatric medical, developmental and psychiatric disorders, including epilepsy, neurofibromatosis, brain tumours, head injury, learning difficulties, attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; Gioia, Isquith, Kenworthy, & Barton, 2002; Krivitzky, Walsh, Fisher, & Berl, 2016). EF deficits in young children may present as an inability to focus and maintain attention, extreme impulsivity, incapacity to inhibit established behaviours, difficulties transitioning to new activities or situations, inability to switch between conflicting demands and difficulties monitoring or regulating performance (Anderson & Reidy, 2012). Thus, many child psychiatric conditions, such as ADHD (Gioia et al., 2002; Krivitzky et al., 2016; Schoemaker et al., 2012), oppositional defiant disorder (ODD) (Gioia et al., 2002; Monette, Bigras, & Guay, 2015; Saarinen, Fontell, Vuontela, Carlson, & Aronen, 2015) and ASD (Gioia et al., 2002; Smithson et al., 2013) are associated with EF deficits. Relative to healthy preschoolers, children with ADHD diagnosis are at a higher risk of EF deficits, particularly impairments in inhibitory control (Schoemaker et al., 2012; Skogan et al., 2015) and working memory (Skogan et al., 2015). In a longitudinal study, these EF deficits observed at preschool age appeared to predict school-age executive control problems associated with ADHD (Schoemaker, Bunte, Espy, Dekovic, & Matthys, 2014). Evidence also suggests that preschoolers with disruptive behaviour exhibit weaker EF capacities, primarily in terms of inhibition (Monette et al., 2015; Schoemaker et al., 2012). A Finnish prospective follow-up study with preschool-aged children showed that inhibitory problems on the neuropsychological test level at preschool age tend to persist in these individuals at 6–8 years of age (Poutanen et al., 2016). Deficits in inhibition and shifting in preschool-aged children reported by parents have been associated with greater depression and anxiety over 7.5 years of development than in peers with less deficits (Kertz, Belden, Tillman, & Luby, 2016).

EF structure undergoes changes during the preschool period (Garon et al., 2008), making the assessment of EF skills, particularly in younger children, challenging (Anderson & Reidy, 2012). EF deficits can be evaluated using performance-based neuropsychological tests and/or EF rating scales with items describing behaviour that are completed by parents or teachers. Many researchers see these methods as complementary (Isquith, Crawford, Espy, & Gioia, 2005). The majority of EF research has previously relied on performance-based measures – usually clinically administered tests – which provide information about specific cognitive abilities involved in self-regulation, such as working memory and inhibition. There is growing evidence, however, that EF rating scales also provide valuable information about EF deficits with respect to treatment planning and assessment of intervention outcome (Isquith, Roth, Kenworthy, & Gioia, 2014). EF rating scales are used in order to determine how EF deficits manifest themselves in everyday life as perceived by parents or teachers. The Behavior Rating Inventory of Executive Function–Preschool version (BRIEF-P; Gioia, Espy, & Isquith, 2003) may be the most widely used and studied EF rating scale in young children. Lately, the Childhood Executive Functioning Inventory (CHEXI) (Thorell & Nyberg, 2008) is also used. It is well established, however, that EF rating scales often correlate minimally with performance measures of executive function and cognitive and behavioural measures appear to tap into different constructs of EF (Anderson et al., 2002; Mahone & Hoffman, 2007).

Earlier studies on EF deficits in preschool-aged children who had been referred to child psychiatric evaluation have mostly investigated relations between clinical diagnoses and EF deficits. Of these studies, the majority of assessment of EF deficits has been based on the neuropsychological tests rather than EF rating scales. However, referred children might have many types of symptoms, and the severity of symptoms varies, hindering diagnostic evaluation. For preschool-aged children particularly, EF deficits may not be obvious in clinical observation, and it is essential to obtain evaluations from environments, in which the EF problems present themselves clearly. There is a limited research on the assessment of both quantity and quality of EF deficits assessed with rating scales in young children referred to child psychiatric evaluation. Many child psychiatric conditions are associated with different EF profiles (Gioia et al., 2002), and identifying the specific disabilities of the EF could be beneficial for the planning of interventions in affected children. In this study, we evaluated (1) the amount and (2) the quality of EF deficits in young children referred to child psychiatric evaluation and (3) compared EF deficits in this clinical group with EF skills in the reference group. EF deficits were assessed using the Finnish Attention and Executive Function Rating Inventory–Preschool (ATTEX-P) (Klenberg, Tommo, Jämsä, & Häyrinen, 2017), which is a standardized and validated questionnaire for the evaluation of EF deficits. Based on the previous research, we hypothesized that (1) clinical group has more EF difficulties than reference group and (2) age, gender and parental education are associated with EF skills both in clinical and in reference groups.

Subjects and methods

Subjects

Clinical group was recruited from two outpatient clinics (in Helsinki and Vantaa) evaluating and treating preschool children at Helsinki University Hospital, Child Psychiatry Unit. The data were collected from children attending the clinics between March 2015 and May 2017. Inclusion criteria for clinical group were (1) age between 4 and 7 years, (2) Finnish-speaking parents, and (3) in day care. Of the 351 children attending the two outpatient clinics during data collection, altogether 252 met the inclusion criteria and 171 returned all study questionnaires. The families were reminded by phone call if the questionnaires were not returned within 2 weeks. Parents were reminded two more times by phone call in case of missing questionnaires. Parents were responsible for reminding day care teachers to return the ATTEX-P. Ethical approval for the study was granted by the Helsinki University Central Hospital Ethics Committee for Pediatrics, Adolescent Medicine and Psychiatry.

Participants in standardization of the ATTEX-P (Klenberg et al., 2017) comprised the reference group for this study. Data were collected from day care centres in the city of Lahti between August 2014 and May 2015. Inclusion criteria for the reference group were (1) age between 4 and 7 years and (2) Finnish-speaking parents. A total of 709 children from 28 day care units met the inclusion criteria and returned all study questionnaires.

Methods

Background information. Information on age, gender and parents' education level was collected from parents via a short questionnaire. Information on clinical diagnoses (International Classification of Diseases, Tenth Edition (ICD-10)) determined by the clinicians in charge of referred children's assessments and treatments was collected from medical records.

EF rating scale. The ATTEX-P (Klenberg et al., 2017) is a rating scale with 44 items describing difficulties in inhibition, attention and EF in day care settings. The day care teacher rates the frequency best describing the child's behaviour on a 3-point scale (0 = 'not a problem', 1 = 'sometimes a problem', 2 = 'often a problem'). ATTEX-P comprises a Total score and the following nine clinical scales, each reflecting different types of difficulties in EF behaviours: (1) Distractibility (5 items), (2) Impulsivity (10 items), (3) Motor Hyperactivity (5 items), (4) Directing Attention (5 items), (5) Sustaining Attention (4 items), (6) Shifting Attention (4 items), (7) Initiative (3 items), (8) Planning (3 items) and (9) Execution Of Action (5 items). The EF Total score and scales have demonstrated good internal consistency (ranging from .73 to .94), test–retest reliability (ranging from .81 to .94) and construct validity (correlations ranging from .49 to .75) (Klenberg et al., 2017). Cut-off scores, indicating clinically relevant deficits in EF behaviours (above 90th percentile), are available for the Total score and all nine scales, separately for boys and girls. The Total score cut-off point for boys is 45 and for girls is 30.

Sample. The original sample consisted of 880 participants, 171 in the clinical group and 709 in the reference group. Of these, 8.3% had one or more missing observations in the ATTEX-P. These missing observations were replaced with the participant's mean value for the other scale items. Twenty-four cases from the reference group with more than two missing observations in one or more scales in the ATTEX-P were excluded from data analyses. The imputed dataset consisted of 856 participants, 685 in the reference group and 171 in the clinical group.

Data analysis. The variable describing family's educational level was the higher educational level of the parents. Parental education was classified into the following categories: high ('higher academic degree' and 'licentiate/doctor'), intermediate ('lower academic degree' and 'some college') and low ('less than some college' and 'no further education').

To assess group differences between the clinical and reference groups, chi-square test and non-parametric Mann–Whitney *U*-tests were used. Chi-square test was performed to test differences in frequencies of gender and parental education between clinical and reference groups. Non-parametric Mann–Whitney *U*-test was used to evaluate differences in mean age between clinical and reference groups.

Table 1. Descriptive data on clinical ($n = 171$) and reference ($n = 685$) groups.

	Clinical group	Reference group
Age*		
Months, mean (*SD*)	68.4 (8.7)	72.0 (8.7)
Range, months	54–88	46–89
Gender, *n* (%)*		
Girls	49 (28.7)	343 (48.4)
Boys	122 (71.3)	366 (51.6)
Parental education, *n* (%)*		
High	23 (13.5)	169 (23.8)
Intermediate	61 (35.7)	288 (40.6)
Low	83 (48.5)	236 (33.3)
Missing	4 (2.3)	16 (2.3)
Special support at day care, *n* (%)*	130 (76.0)	54 (7.8)

SD: standard deviation.
The chi-square test was used to test differences in frequencies of gender, parental education and special support at day care between clinical and reference groups.
Non-parametric Mann–Whitney *U*-test was used to test differences in mean age between clinical and reference groups.
*$p < .001$.

Non-parametric Mann–Whitney *U*-test of mean ranks was applied to compare the mean ranks of the ATTEX-P Total and subscale scores for clinical and reference groups. Median scores and interquartile range (IQR) were used in Figures 1 to 3 to present the differences on the ATTEX-P Total score and nine subscale scores in the clinical and reference groups.

Logistic univariate and multiple regression analyses were performed to predict scores over clinical cut-off point on the ATTEX-P Total score in the clinical and reference groups. The first model was for the whole sample (clinical group and reference group), and the ATTEX-P Total scores were categorized as 'normal' or 'abnormal; the ATTEX-P Total score 39 or above'. The second model was for girls in the clinical and reference groups, and the ATTEX-P Total scores were categorized as 'normal' or 'abnormal; the ATTEX-P Total score 30 or above'. The third model was for boys in the clinical and reference groups, and the ATTEX-P Total scores were categorized as 'normal' or 'abnormal; the ATTEX-P Total score 45 or above'. In the analysis, child's age and gender and parental education were treated as covariates.

Multiple linear regression analysis was performed to determine associations between EF, age, gender and parental education in the clinical and reference groups. In the regression equation, child's age and gender and parental education were entered as independent variables and the ATTEX-P Total score as a dependent variable.

Results

Descriptive data on the clinical and reference groups

Most of the children in the clinical group were boys (71.3%), and the age range was between 4.5 and 7.3 years. In the clinical group, parental education was high or intermediate in 49.2% of families. Of the children in the clinical group, 130 (76.0%) received special support at day care, such as a smaller class size or support from a special education teacher. Descriptive data and differences between the clinical and reference groups are shown in Table 1.

According to clinical diagnoses (ICD-10), set up by clinicians in charge of the referred children's evaluation and treatment, 39 children (22.8%) had ADHD and 29 children (17.0%) had conduct disorder (CD) or ODD diagnoses. Other neurodevelopmental disorder diagnoses were also common ($n=34$, 19.9%), including learning, speech and motor system disorders, as well as ASD. Sixty-nine children (40.4%) had one unspecified neurodevelopmental diagnosis (F88 or F89). Of the referred children, 34 (19.9%) had at least one *Z*-diagnosis describing psychosocial stress such as parents' divorce or another negative life event in the family. Boys in the clinical group had significantly more ADHD and CD/ODD diagnoses than girls in the clinical group ($p<.001$). Of the girls in the clinical group, four (8.2%) had ADHD diagnosis and four (8.2%) had ODD/CD diagnosis. Of the boys in the clinical group, 35 (28.7%) had ADHD diagnosis and 25 (20.5%) had ODD/CD diagnosis.

Descriptive data on ATTEX-P in clinical and reference groups

Day care teachers reported a high amount of EF deficits in the clinical group, more so in boys than in girls. The means and standard deviations of the ATTEX-P in the clinical group are presented in Table 2. Of the children in the clinical group, over half of the boys scored over the clinical cut-off point for boys in the ATTEX-P Total score and the six subscales of Distractibility, Motor Hyperactivity, Impulsivity, Initiative, Planning and Execution of Action. In the clinical group, girls showed fewer EF deficits than boys, and 32.7% scored over the clinical cut-off point for girls in the ATTEX-P Total score. The execution of Action subscale of the ATTEX-P was the only subscale where over half (51.0%) of the girls in the clinical group scored over the clinical cut-off point for girls.

In the reference group, boys had higher mean scores than girls in the ATTEX-P Total score and all nine subscales (Table 2). Of the reference boys and girls, 11.1% and 10.5%, respectively, scored over the clinical cut-off point in the ATTEX-P Total score. Reference boys scored over the clinical cut-off point most frequently in the Initiative (17.4%), Planning (14.9%), and Execution of Action (14.4%) subscales of the ATTEX-P. Reference girls showed problems (subscale score over the clinical cut-off point for girls) most frequently in Planning (14.1%), Sustaining Attention (14.0%), and Execution of Action (12.6%). Frequencies of children scoring over clinical cut-off points for girls and boys in the ATTEX-P Total and subscale scores in the clinical and reference group children are presented in Table 3.

EFs in clinical group compared with reference group

Significant differences emerged in the mean ranks of the ATTEX-P Total score and all nine subscale scores between the clinical group and the reference group (all $p<.001$). Figure 1 presents the median scores of the ATTEX-P Total scores and all nine subscale scores in the clinical and reference groups. Both girls and boys in the clinical group had higher mean ranks of the ATTEX-P Total score and all nine subscale scores than girls and boys in the reference group (all $p<.001$). Boys in the clinical group had 2.7-fold higher ATTEX-P Total mean score (45.62, standard deviation (SD)=18.49) than boys in the reference group (16.88, SD=18.80). Figures 2 and 3 present the median scores of the girls (Figure 2) and boys (Figure 3) in clinical and reference groups.

In the logistic univariate model, clinical group had an increased risk (OR=12.4, 95% confidence interval (CI)=[8.36, 18.3], $p<.001$) for showing a significant amount (ATTEX-P Total score $\geqslant$39 points) of EF deficits compared with the reference group. In the univariate model, boys in the clinical group had an increased risk (OR=4.52, 95% CI=[2.99, 6.83], $p<.001$) for EF deficits compared with girls in the clinical group. Univariate analysis showed that older children had a slightly lower risk (OR=0.97, 95% CI=[0.95, 0.98], $p<.001$) for EF deficits (the ATTEX-P Total score $\geqslant$39 points) than younger children. High parental education reduced the risk for showing EF deficits (OR=0.22, 95% CI=[0.10, 0.52], $p<.001$). According to the multiple logistic model

Table 2. Descriptive statistics of the ATTEX-P Total and subscale scores in clinical ($n = 171$) and reference ($n = 685$) groups.

	Clinical group ($n = 171$)						Reference group ($n = 685$)					
	All ($n = 171$)		Girls ($n = 49$)		Boys ($n = 122$)		All ($n = 685$)		Girls ($n = 334$)		Boys ($n = 351$)	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Total Score	40.8	21.4	28.6	23.7	45.6	18.5	13.0	17.1	8.94	14.1	16.9	18.8
Distractibility	5.68	2.86	3.78	3.02	6.44	2.41	1.95	2.61	1.34	2.21	2.53	2.82
Motor Hyperactivity	4.42	3.32	2.90	3.19	5.02	3.19	1.26	2.24	0.79	1.79	1.71	2.52
Impulsivity	10.2	6.31	6.86	6.28	11.6	5.82	3.22	4.65	2.18	3.83	4.20	5.13
Directing Attention	3.87	2.66	3.14	2.89	4.16	2.51	1.57	2.21	1.23	2.02	1.89	2.34
Sustaining Attention	3.73	2.54	2.27	2.43	4.31	2.34	1.05	1.87	0.63	1.48	1.44	2.10
Shifting Attention	3.74	2.52	2.73	2.74	4.14	2.32	1.21	1.90	0.91	1.67	1.49	2.05
Initiative	2.54	1.97	2.27	1.96	2.65	1.98	0.97	1.48	0.80	1.36	1.13	1.56
Planning	2.45	1.87	1.60	1.82	2.79	1.79	0.71	1.32	0.50	1.09	0.92	1.49
Execution of Action	4.11	2.57	3.10	2.57	4.51	2.46	1.21	1.80	0.89	1.56	1.52	1.95

SD: standard deviation; ATTEX-P: Attention and Executive Functions Rating Inventory–Preschool.

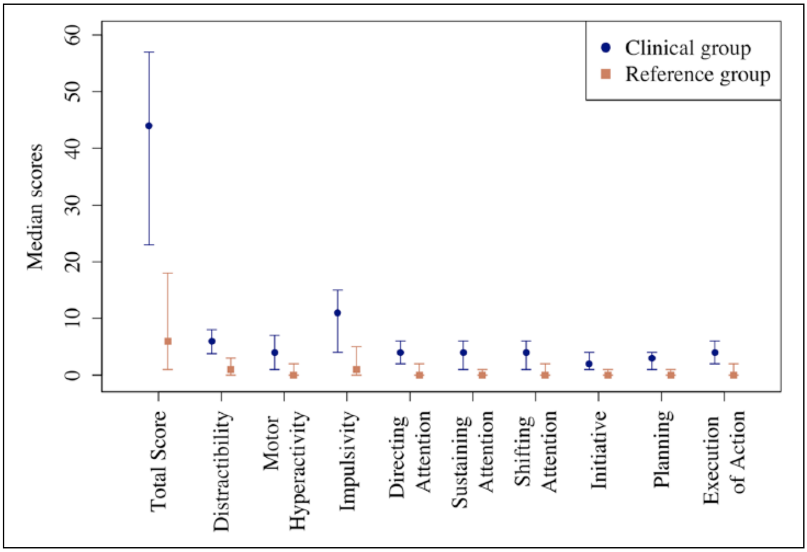

Figure 1. Median scores of the ATTEX-P and nine subscales in the clinical (n=171) and reference (n=685) groups. All scores were statistically significantly different (p<.001) between the two groups, with clinical group showing higher scores than reference group.

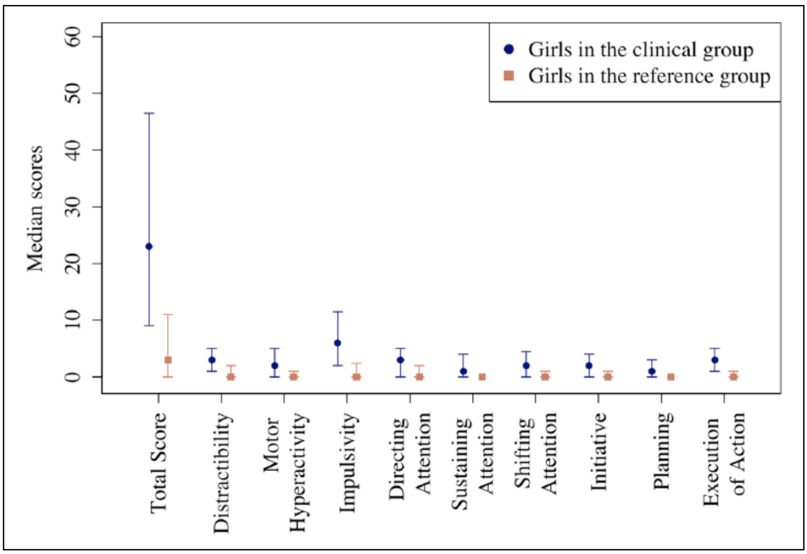

Figure 2. Median scores of the ATTEX-P scores and ninesubscales in girls in the clinical (n=49) and reference (n=343)groups. All scores were statistically significantly different (p<.001) between the two groups, with girls in the clinical group showing higher scores than girls in the reference group.

(controlling for age, gender and parental education), clinical group had an elevated risk (OR = 10.6, 95% CI = [6.88, 16.2], $p < .001$) for showing a significant amount of EF deficits.

Clinical group had an increased risk of showing EF deficits also when girls and boys were analysed separately in univariate and multiple logistic regression models. In analyses that included only

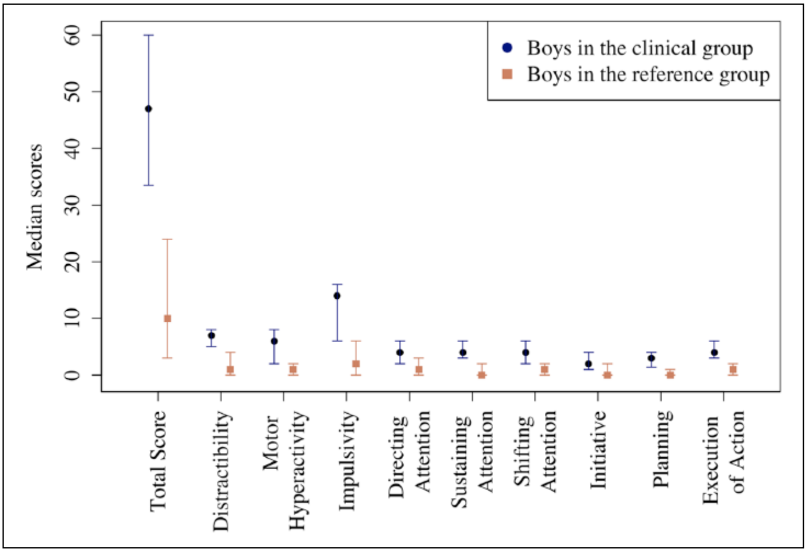

Figure 3. Median scores of the ATTEX-P scores and nine subscales in boys in the clinical (n=122) and reference (n=366)groups. All scores were statistically significantly different (p<.001) between the two groups, with the boys in the clinical group showing higher scores than boys in the reference group.

the girls, girls in the clinical group had an increased risk (OR = 4.14, 95% CI = [2.07, 8.28], $p < .001$) for scoring over the clinical cut-off point for girls in the ATTEX-P Total score (⩾30 points) in univariate logistic regression model. Univariate analysis showed older girls having slightly reduced risk for EF deficits relative to young girls (OR = 0.96, 95% CI = [0.93, 1.00], $p < .05$). Parental education was not statistically significant in univariate analysis ($p > .05$). In the multiple logistic regression model for girls (controlling for age and parental education), the odds ratio (OR) for girls in the clinical group scoring over the clinical cut-off point in the ATTEX-P Total score (⩾30 points) remained statistically significant (OR = 3.72, 95% CI = [1.75, 7.92], $p = .001$). In the multiple logistic regression model for girls, parental education and child's age were not statistically significant factors (all $p > .05$) in explaining the clinical amount of EF deficits (Table 4).

In logistic univariate model including only the boys, boys in the clinical group had an increased risk (OR = 9.74, 95% CI = [5.98, 15.9], $p < .001$) for showing a significant amount (the ATTEX-P Total score ⩾45 points, the clinical cut-off for boys) of EF deficits relative to reference subjects. In univariate analysis, higher parental education and older age of the child reduced the risk of EF deficits (ps < .05). The multiple logistic regression model (controlling for age and parental education), showed the increased risk of boys in the clinical group (OR = 8.75, 95% CI = [5.29, 14.4], $p < .001$) for scoring over the clinical cut-off in the ATTEX-P Total score (⩾45 points). In this model for boys, parental education and child's age were not significant factors (all $p > .05$) in explaining the clinical amount of EF deficits (Table 4). The ORs for children scoring over the clinical cut-off point in the ATTEX-P Total score by age, gender, parental education and case-reference setting are presented in Table 4.

Factors associated with executive function in the clinical and reference groups

Multiple linear regression analysis was used to assess the ability of three measures (child's gender and age and parental education) to predict the ATTEX-P Total score in the clinical and reference groups. The outcome variable was the ATTEX-P Total score. In the multiple linear regression

Table 3. Frequencies of children scoring over the clinical cut-off point (all, girls, boys) on the ATTEX-P Total and subscale scores in clinical ($n = 171$) and reference ($n = 685$) groups.

	Clinical group ($n = 171$)			Reference group ($n = 685$)		
	All ($n = 171$)	Girls ($n = 49$)	Boys ($n = 122$)	All ($n = 685$)	Girls ($n = 334$)	Boys ($n = 351$)
	Clinical, *n* (%)	Clinical, *n* (%)	Clinical, *n* (%)	Clinical, *n* (%)	Clinical, *n* (%)	Clinical, *n* (%)
Total Score	100 (58.5)	16 (32.7)	67 (54.9)	70 (10.2)	35 (10.5)	39 (11.1)
Distractibility	95 (55.6)	18 (36.7)	68 (55.7)	85 (12.1)	34 (9.9)	50 (13.8)
Motor Hyperactivity	85 (49.7)	20 (40.8)	63 (51.6)	70 (9.9)	37 (10.8)	41 (11.2)
Impulsivity	92 (53.8)	18 (36.7)	65 (53.3)	79 (11.2)	35 (10.3)	39 (10.7)
Directing Attention	66 (38.6)	18 (36.7)	48 (39.3)	86 (12.2)	35 (10.3)	51 (14.1)
Sustaining Attention	99 (57.9)	24 (49.0)	58 (47.5)	79 (11.2)	48 (14.0)	37 (10.1)
Shifting Attention	87 (50.9)	22 (44.9)	53 (43.4)	80 (11.3)	40 (11.7)	41 (11.2)
Initiative	75 (43.9)	22 (44.9)	53 (43.4)	98 (13.9)	35 (10.2)	63 (17.4)
Planning	86 (50.3)	18 (36.7)	70 (57.4)	77 (10.9)	48 (14.1)	54 (14.9)
Execution of Action	101 (59.1)	25 (51.0)	81 (66.4)	72 (10.2)	43 (12.6)	52 (14.4)

ATTEX-P: Attention and Executive Functions Rating Inventory–Preschool.

Table 4. Odds Ratios (OR)s for the ATTEX-P Total score rated in the clinical range by age, gender, parent's educational level and case-reference setting.

	Total score ⩾39				Girls, Total score ⩾30				Boys, Total score ⩾45			
	Univariate model		Multiple logistic regression model		Univariate model		Multiple logistic regression model		Univariate model		Multiple logistic regression model	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Case-reference	12.4	[8.36, 18.3***]	10.6	[6.88, 16.2***]	4.14	[2.07, 8.28***]	3.72	[1.75, 7.92**]	9.74	[5.98, 15.9***]	8.75	[5.29, 14.4***]
Age	0.97	[0.95, 0.98***]	–	ns	0.96	[0.93, 1.00*]	–	ns	0.97	[0.95, 0.99**]	–	ns
Parent's educational level	0.22	[0.10, 0.52***]	–	ns	–	ns	–	ns	0.29	[0.09, 0.90*]	–	ns
Gender	4.52	[2.99, 6.83***]	4.45	[2.79, 7.12***]	–	–	–	–	–	–	–	–

OR: odds ratio; CI: confidence interval; ATTEX-P: Attention and Executive Functions Rating Inventory–Preschool.
*$p < .05$; **$p < .01$; ***$p < .001$***; ns: not significant.

Table 5. Multiple linear regression models for child's age, child's gender and parent's educational level predicting the ATTEX-P Total score in the clinical (n = 171) and the reference (n = 685) groups.

	Clinical group			Reference group		
	B	β	95% CI	B	β	95% CI
Age	0.10	0.04	ns	−0.23	−0.12	[−0.37, −0.09**]
Gender	16.8	0.35	[10.0, 23.5***]	8.12	0.24	[5.65, 10.6***]
Parent's educational level	−3.19	−0.19	[−5.58, −0.81**]	−2.54	−0.19	[−3.52, −1.57***]

β: standardized regression coefficient; B: unstandardized coefficient; CI: confidence interval.
*p < .05; **p < .01; ***p < .001; ns: not significant.

analysis, there was a significant gender difference, with boys having higher scores than girls in the ATTEX-P Total score in both the clinical and reference groups. Parent's educational level was associated with the ATTEX-P Total score and lower parental education increased the risk of the child having high scores in the ATTEX-P questionnaire. In the clinical group, child's age was not associated with the ATTEX-P Total score, while in the reference group younger children had higher scores than older children. Table 5 provides the linear multiple regression models of age, gender and parental education in predicting the ATTEX-P Total score in clinical and reference groups.

Discussion

In this study, we evaluated the amount and quality of EF deficits in 4- to 7-year-old children referred to child psychiatric outpatient clinic because of behavioural/psychological/emotional issues or developmental disorders and compared EF in the clinical group with EF in the reference group. Clinical group exhibited higher mean ranks across the ATTEX-P Total score and all nine subscale scores than reference group (all p < .001). Boys in the clinical group had higher scores in the ATTEX-P Total score and all nine subscale scores than boys in the reference group (all p < .001), and girls in the clinical group had higher scores in the ATTEX-P Total score and all nine subscale scores than girls in the reference group (all p < .001). Clinical group had over threefold higher ATTEX-P Total mean score than the reference group. Over half of the clinical group (58.5%) scored over the clinical cut-off point on the ATTEX-P Total score, and the most frequent EF deficits reported by day care teachers in the clinical group were difficulties in Execution of Action (59.1%), Sustaining Attention (57.9%), Distractibility (55.6%) and Impulsivity (53.8%). In a multiple logistic regression model (controlling for age, gender and parental education), clinical group had increased risk (OR = 10.6, 95% CI = [6.88, 16.2], p < .001) for scoring over the clinical cut-off point on the ATTEX-P Total score.

Our study showed that approximately 10% of reference children from community had Total EF deficits score on the clinical range, which is in line with findings by Selvam et al. (2016) in a sample of typically developing preschoolers. Of the reference children, the majority showed no specific EF deficits; only a few showed hyperactivity or impulsivity and the most frequent problems were in the Initiative (13.9%) and Directing Action (12.2%) subscales of the ATTEX-P. By contrast, the majority (58.5%) of the children in the clinical group showed impairments in EF, that is, ATTEX-P Total score over the clinical cut-off point. Majority of the children in the clinical group were considered to show problems in Execution of Action (59.1%), Sustaining Attention (57.9%), Distractibility (55.6%) and Impulsivity (53.8%). Problems in Execution of Action were the most reported problem in the clinical group. This subscale includes questions about a child's need for frequent adult supervision and support in everyday tasks and daily routines. Children in the clinical group needed additional, individual supervision to accomplish tasks, left tasks uncompleted, had difficulties in stopping activities and obtained poorer results because of hurrying compared with reference children. We propose that, in order to execute action, multiple EF domains (inhibition, working memory, shifting) are needed and a deficit in one or more of the EF components may lead to the deficits in the execution of action. Thus, the high prevalence of problems in Execution of Action subscale likely reflects this subscale tapping into multiple EF domains.

In the clinical group, day care teachers reported a high amount of hyperactivity, impulsivity and distractibility in the relevant subscales of the ATTEX-P. Especially boys in the clinical group showed considerably more of these EF deficits than reference boys. Normative preschoolers are known to undergo marked development of inhibitory control between the ages of 3 and 6 years, with continued maturation beyond the preschool period (Anderson & Reidy, 2012). On the other hand, preschoolers with diagnosed ADHD or CD/ODD demonstrate EF deficits in neuropsychological tests (Monette et al., 2015; Schoemaker et al., 2012) and in evaluations based on rating scales (Gioia et al., 2002; Mahone & Hoffman, 2007). The finding that boys in the clinical group showed more hyperactivity, impulsivity and distractibility than reference boys may be partly explained by one-third of them having an ADHD and one-fifth a CD/ODD diagnosis and other neurodevelopmental diagnoses including ASD. Gioia et al. (2002) showed school-aged children with ADHD and ASD diagnoses to exhibit high elevations across all Behavior Rating Inventory of Executive Function (BRIEF) scales, and Mahone and Hoffman (2007) reported that preschool-aged children with ADHD have significantly higher scores than matched controls on all five BRIEF-P scales. However, our clinical group had highly increased risk (OR = 10.6, 95% CI = [6.88, 16.2], $p < .001$) for having a significant amount (over the clinical cut-off on the ATTEX-P Total score) of EF deficits, although the majority did not meet the diagnostic criteria for ADHD or CD/ODD and many had an unspecified diagnosis.

Our study showed that boys were considered to show more EF deficits than girls in both the clinical and reference groups. Also, lower parental education level was associated with increased ATTEX-P Total score in both the clinical and reference groups. In line with our findings, previous population-based studies of EF measured by rating scales have demonstrated significant effects of gender and parental education on EF scores in school-aged children (Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010) and with preschool-aged children (Gioia et al., 2003). Lower parental education has been associated with higher scores in EF rating scales (Gioia et al., 2003; Klenberg et al., 2010), and preschool-aged boys showed higher scores in these questionnaires than girls (Ezpeleta, Granero, Penelo, de la Osa, & Domènech, 2015; Gioia et al., 2003). In a Finnish population sample, typically developing school-aged boys demonstrated substantially more problematic behaviour measured by the ATTEX questionnaire in all EF areas, including poor impulse control and motor hyperactivity as well as difficulties in directing attention and in initiation and evaluation of action, than girls (Klenberg et al., 2010). This gender difference on the ATTEX-P Total score and all nine subscale scores both in the clinical and in the reference groups may arise from the lower symptom levels and/or better coping strategies of girls, possibly reflecting earlier maturation of frontal parts of female brains (Vuontela et al., 2003). In the clinical group, it might reflect also the different psychiatric profiles among girls and boys. However, our reference children did not have clinical diagnoses, and still, boys exhibited more EF deficits than girls.

Scales measuring EF in typically developing children show evidence of increases in EF skills with age, albeit with lower ratings in older children than younger children (Gioia et al., 2003; Gioia, Isquith, Guy, & Kenworthy, 2000). Consistent with previous findings, our research revealed that younger children in the reference group had higher scores on ATTEX-P Total score than older ones. By contrast, age was not associated with the ATTEX-P Total score in our clinical group, contrary to expectations based on earlier research (Gioia et al., 2002; Schoemaker et al., 2014). Our clinical group represented young children with multiple symptoms, with the majority also suffering from EF deficits. Other possible confounding factors, such as child's adverse life events, parental stress and various psychiatric profiles in the clinical group, might explain why age was not associated with EF deficits in the clinical group. There is evidence that environmental factors, for example, the family environment and parenting styles, are associated with a child's EF development (Hughes & Ensor, 2009) and EF deficits have been reported in children who have suffered from severe adverse environmental conditions such as early care deprivation (Colvert et al., 2008).

As EF skills undergo marked improvements between the ages of 4 and 6 years (Carlson, 2005; Durston & Casey, 2006; Garon et al., 2008), there is growing interest in interventions targeting EF in children as young as 4–5 years (Diamond, 2012; Diamond & Lee, 2011). Our study suggests that young children referred to child psychiatric outpatient clinic show numerous EF deficits regardless of diagnoses. The majority of the children in the clinical group were considered to show deficits in distractibility, hyperactivity and impulsivity. These young children are at subsequent risk for ADHD and ODD (Schoemaker et al., 2014), emphasizing the need for early assessment and interventions to strengthen EF. In line with these suggestions, Diamond and Lee (2011) concluded that children with the weakest EF abilities appear to gain the most from interventions improving EF skills. For preschool-aged children with many EF deficits, there are only a few evidence-based early behavioural intervention programmes available (Healey & Halperin, 2015; Thompson et al., 2009). Intervention studies are needed to determine the most effective way to improve EFs in preschool-aged children referred to child psychiatric outpatient clinic with high amounts of impulsivity and distractibility. Even small but lasting improvements in these children's EF skills could lead to reductions in health problems, crime, financial difficulties and unemployment rates (Diamond & Lee, 2011; Moffitt et al., 2011).

Limitations

Our study had some limitations that must be addressed. First, there was a significant difference in the mean age, gender and mean parental education level between the clinical and the reference groups. However, in both groups, the children were preschoolers and the age range was about the same (clinical group: 4.5–7.3 years, reference group: 3.8–7.4 years). Our study's aim was to examine the differences in EF profiles between clinical and reference groups. An age-, gender-, and parental education–matched reference group would not have represented the general population as well as the present reference sample. The effects of gender, age and parental education were statistically controlled in the multiple analyses. Second, our findings were only drawn from day care teachers' ratings. This could be biased without other indicators of EF (parent ratings and performance-based assessment) and we do not know whether these behaviours at day care are consistent across other settings. Furthermore, when using the EF rating scales, factors other than the actual behaviour of the child may influence the respondent's evaluation and responses. Teachers may have been influenced by knowing that the child has been evaluated in a child psychiatric clinic. However, day care teachers can be considered reliable informants of children's behaviour in group situations as they see many children of the same age, facilitating recognition of children with EF impairments compared with typically developing children.

Conclusion

EF skills should be assessed with preschool-aged children who have been referred to child psychiatric evaluation. Already at preschool age, EF deficits can present in many forms. Reliable questionnaires designed to assess EFs are easy to deliver and questionnaires provide the clinician with important, detailed information about a child's everyday function and possible EF impairments. It is important to identify specific EF deficits as early as possible in order to prevent and relieve the associated academic, emotional, behavioural and social consequences. The most effective way to improve EFs in referred children with high amounts of impulsivity and distractibility remains to be elucidated. EF deficits are often present in young referred children, emphasizing the need for relatively short-term, evidence-based EF training programmes for these children to be implemented at home or in day care.

Acknowledgements

We gratefully acknowledge the children and their caregivers for participation in this study. We also thank our statistical advisor Anna But. E.T.A., H.W. and L.K. conceived and designed the experiments. H.H. and P.H.B. analysed the data. H.H. wrote the first draft of the manuscript. E.T.A. and L.K. contributed to the writing of the manuscript. E.T.A., H.W., L.K., P.H.B. and H.H. agree with manuscript results and conclusions.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethics approval and consent to participate

The Ethics Committee of Helsinki University Central Hospital approved the study protocol. Informed consent was obtained from all study participants.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by grants from Helsinki University Central Hospital Research Funds, a non-profit organization (TYH2013205 and TYH 2016202), and Children's Castle Hospital Foundation grant for the first author.

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