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ORIGINAL PAPER

Family Context and ADHD Symptoms in Middle Childhood: an Explanatory Model

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Abstract

Recent research suggests that Attention Deficit Hyperactivity Disorder (ADHD) may be influenced by interactions between the individual and their social context. This study examined the predictive value of family context variables and attentional control levels on child ADHD symptoms. A new explanatory model of the relationship amongst these variables was also tested. A sample of 754 families with children aged 7 to 11 was assessed through the Conners Parent Rating Scale, the Haezi-Etxadi Family Assessment Scale, and the Attention Network Test. Path analysis models showed a predictive association between children ADHD symptoms and Social Support Network, Parental Stress, Parental Self-efficacy, Attentional Control and being male. Furthermore, a stronger Social Support Network was associated with greater Parental Self-efficacy, a variable that predicted Parental Stress levels and children ADHD symptoms. In conclusion, a new multi-influence model of variables linked to ADHD symptomatology during mid-childhood is provided, which may be useful to support the design of family interventions.

Keywords ADHD · Parental stress · Parental self-efficacy · Social support networks · Middle childhood

Highlights

- Qualitatively different measures from prior research on the presence of ADHD in school-aged children were analysed.
- The path model showed that parents who perceived a stronger social support network showed greater parental self-efficacy.
- Greater parental self-efficacy was associated with lower parental stress; both factors related to children's ADHD symptoms.
- Attentional control and male sex were also directly related to ADHD symptoms in the path SEM model.
- Results showed that even non-clinical samples might benefit from primary preventive interventions in positive parenting.

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders affecting children and young people today, resulting in a behavioural pattern characterised by lack of attention, hyperactivity and impulsiveness (American Psychiatric Association 2013). According to recent estimates, the prevalence of ADHD among school-aged children at a worldwide level varies between 2 and 7%, with an average of around 5% (Sayal et al. 2018); a further 5% of children have significant difficulties with over-activity, inattention and impulsivity that are just sub-threshold to meet full diagnostic criteria for ADHD. Moreover, the ADHD prevalence varies worldwide and although increasing over time, is still relatively under-recognised and under-diagnosed in most countries,

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specifically in girls and older children. In Spain, the prevalence among the under-18 population is estimated at 6.8% (Catalá-López et al. 2012). Finally, if it is taken into account that ADHD has high comorbidity with other more prevalent disorders, such as anxiety (Reale et al. 2017), progress in research on its causes is more necessary with the ultimate goal of developing accurate intervention strategies.

In the aetiology of ADHD, a hereditary genetic predisposition has been identified as the reason for the sex differences observed (Faraone and Mick 2010), with the ratio of males to females in diagnosed cases being 3:1 (Greven et al. 2018). However, Archer et al. (2011), stated that simple genetics associations were not complex enough to explain the variability of the ADHD spectrum. In this sense, recent research suggests that this disorder may in fact be the result of interaction between genes and the environment, mediated by an epigenetic process (Hamza et al. 2017). A recent publication by Mirkovic et al. (2020) supports this approach pointing out that DNA is not the single mode of inheritance in humans and suggests that the heritability of this disorder also implies Gene x Environment interactions, as well as epigenetic imprints and their transgenerational effect. Recent studies on epigenesis have identified chemical processes in the genome, among them DNA methylation, that may be heritable and which determine gene expression, thereby altering the course of development (Kundakovic and Champagne 2015). In this line, the study of ADHD biomarkers is a fruitful research field. For instance, Mooney et al. (2020), studied the associations between DNA methylation and ADHD in two groups of children (clinically established ADHD and controls) in the age range of 7 to 12 years. Their results confirmed previous associations reported in the literature between DNA methylation and ADHD and provided new biomarkers linked to this specific disorder. Supporting this finding, Weib et al. (2021) observed in a sample of diagnosed adults that methylation associated with gene TARBP1 is a new candidate linked to the presence of ADHD symptoms and, similarly, Li et al. (2021) identified DNA methylation in genes LIME1 and SPTBN2 linked to children clinically diagnosed with ADHD.

Some works argue that the behavioural pattern of ADHD may stem from an atypical development of executive functions (Friedman and Rapoport 2015; Mueller et al. 2017), which may, in turn, be the result of epigenetic processes influenced by interactions between the individual and their social context. This view highlights that this disorder and executive functions (EF) are interrelated and that some of the genes that affect EF may also affect ADHD (Miller et al. 2019). Supporting the link between EF and ADHD, the evidence reflects that poor development of executive functions is related to a reduced capacity for self-regulation of emotions, thoughts and behaviour (Diamond 2013), a frequent characteristic in children with ADHD. Additionally, some key aspects of self-regulation such as inhibitory control -the ability to voluntarily suppress a dominant response- (Diamond 2013; Miller et al. 2019), and attentional control -the ability to focus on a task while inhibiting irrelevant stimuli in the environment (Diamond 2013; Perri 2020) are poorly developed in children with ADHD.

Although some authors suggest an integrated inhibitory control model (See Perri 2020), some others support that inhibitory and attentional control are independent constructs contributing to EF (see Tiego et al. 2018). Within this framework, the ANT task was designed to measure both attentional control and response inhibition and has been used to assess the maturity of executive functions, revealing that attentional control may be an important indicator of this maturation process (Friedman and Rapoport 2015; Mueller et al. 2017). Behavioural studies which have used this task have found that the two measures (attentional control and inhibition) reveal different development patterns up until the age of 11 and that the attentional control measure reveals faster progress than the inhibition one (Tiego et al. 2018), and can therefore be used as a reliable measure of the early development of executive functions in middle childhood (Rueda et al. 2004).

Another source of evidence comes from studies using magnetic resonance imaging, which have shown that the attentional control measures obtained using the ANT task depend on the activation and maturity of the prefrontal cortex, which is also linked to regulation processes (Friedman and Rapoport 2015; Miyake and Friedman 2012). Curiously, children with ADHD have been found to have an atypical development of these brain structures (Friedman and Rapoport 2015), and in addition to scoring significantly lower than their non-ADHD counterparts for attentional control, also have a lower level of activation in the prefrontal areas of their brain during execution (Mueller et al. 2017). These findings support the idea that attentional control may be an important early indicator of the adequate development of the executive functions which subsequently enable the acquisition of other skills such as self-regulation, problem-solving and action planning (Miyake and Friedman 2012).

Some other works focus on the role of family interactions as key contributors to the epigenetic process of ADHD. One of the most widely-documented variables in terms of its relationship with the development of psychopathological problems during childhood and adolescence is exposure to parental conflict (Harold and Sellers 2018). When this exposure is prolonged and the conflict is not adequately resolved, it may trigger a cascade of different effects, starting with the disruption of the child's feeling of emotional security and predictability of the environment (Davies and Martin 2014). This in turn may increase cortisol levels,

causing perturbations in the brain and the stress response system (Kundakovic and Champagne 2015), which has also been found to be disrupted in ADHD patients (Chen et al. 2019). In addition, some studies show that the association between ADHD and cortisol responsiveness may be moderated by other variables that play an important role in psychobiological processes, such as emotion dysregulation, which may also be influenced by the sensitivity and quality of parent-child interactions (Norona and Baker 2017; Taylor et al. 2020).

The literature shows that parents with children suffering from some kind of developmental disorder, experience greater child-rearing stress (Ben-Naim et al. 2019). Also interesting is the work carried out by Hutchison et al. (2016) who, in a sample of children and adolescents 7 to 18 years, found that those with ADHD and Autism Spectrum Disorder had more executive functioning deficits, and their parents reported more stress and greater use of a permissive parenting style than parents of typically-developing children. Moreover, parental stress has been associated with attention deficits, poor self-regulation and behaviour problems among children (Barroso et al. 2018). In this sense, Deater-Deckard (2004) highlights that parenting stress could arise from trying to adapt to the demands of parenthood and that it could also be influenced by parental and child adjustment.

Recent studies have linked parental self-efficacy with the ability to cope adequately with stress. This variable, which may also be influenced by the characteristics of the child, has a buffering effect enabling the parent in question to manage external demands which are perceived as stressful (Ben-Naim et al. 2019; Benedetto and Ingrassia 2018). In this sense, Heath et al. (2015) implemented a parental self-efficacy improvement programme designed to reduce parental stress levels and, after the intervention, they found a reduction in ADHD symptoms among participants' 7-to-12-year-old children. These findings suggest that the protective effects of parental self-efficacy may help reduce the negative effects of stress and foster the development of attention processes during childhood.

The presence of ADHD symptoms has also been linked to negative parenting styles, characterised by high levels of demandingness and psychological control and low levels of support and affect (Stevens et al. 2019). Similarly, institutionalised minors who have suffered from social deprivation generally have greater executive deficits and more pronounced ADHD than their counterparts who have lived in foster families and have received high-quality parental care (Nelson et al. 2019). Some studies suggest that, alongside the setting of limits, family contexts that foster the understanding and control of emotions help lay the groundwork for the development of self-regulation, the deficit of which is one of the main factors associated with ADHD (Pauli-Pott et al. 2018). Other family context variables may also play a protective role in terms of childhood ADHD, this is the case of maternal sensitivity which has been found to be an inverse predictor of ADHD symptoms in the longitudinal study by Choenni et al. (2019) and the case of social support networks available to the family showing a direct (Mastoras et al. 2018) and indirect (Wüstner et al. 2019) influence on ADHD symptoms. Another significant factor is parental knowledge of child development, which helps reduce the severity of the symptoms (Climie and Henley 2018) and enables high-quality parent-child interactions.

Finally, variables such as psychosocial context and socioeconomic status should also be taken into consideration, as they have been linked to ADHD prevalence levels (Russell et al. 2016). Low income and financial difficulties, as well as low parental education level, have all been associated with the presence of ADHD symptoms among children and adolescents (Russell et al. 2016). Some authors have suggested that these variables may modulate the quality of the interactions which take place in the family context, thereby influencing the manifestation of the disorder (Wirth et al. 2019).

As seen, previous evidence has emphasized the role of cognitive and family variables in the development of ADHD symptoms. It is important to note, however, that many of the studies cited above are based on correlation analysis and either analyse contextual variables in an isolated manner or focus solely on the clinical population. The present study aims to overcome these limitations by exploring the influence of the above-mentioned family context variables, and of attentional control, on the presence of ADHD symptoms in a broad sample of typically-developing children aged 7 to 11. We set out to explore three main research questions: (a) do attentional control and family variables independently contribute to ADHD symptoms at different ages? (b) do self-efficacy and stress exert a direct or mediated influence on ADHD symptoms?, and (c) does any other variables in the family context exert an influence on these key family variables?. An exploratory approach will be used in this study, carrying out statistical analysis in order to find significant associations with the final goal of providing a complex and multi-influence explanatory model of ADHD symptoms.

Method

Participants

A total of 754 children (mean age = 9.39 years; $SD = 1.57$; 51.7% girls) of two Spanish birth cohorts participated in the study. Gipuzkoa cohort (Autonomous Community of the Basque Country) and Valencia cohort (Autonomous

Community of Valencia) formed part of a multi-centre study entitled the INMA (Infancia y Medio Ambiente - Childhood and Environment) Project, which aims to study the effects of environmental exposures and other contextual variables on children's health and physical and neuropsychological development. Between 2004 and 2008, pregnant women were recruited during their first prenatal visit (10–13 weeks gestation) to the principal hospital in each region: Zumárraga Hospital in Gipuzkoa and La Fe Hospital in Valencia. The main variables for this study were collected between 2014 and 2016, during the 7–8 year follow-up phase in Gipuzkoa (mean age 7.88, $SD = 0.12$; 50.9% girls) and the 10–11 year follow-up phase in Valencia (mean age 10.98, $SD = 0.29$; 52.6% girls). The sample comprised 754 families and their children ($n = 387$ in Gipuzkoa; $n = 367$ in Valencia). The mean age of the mother at data collection was 41.33 ($SD = 3.82$), and in the case of the father, it was 43.38 ($SD = 4.66$). Women had a higher education level than men, with 43.7% of mothers having a university degree, as opposed to 25.6% of fathers. The full details of the characteristics of the sample are shown in Table 1.

Table 1 Descriptive analysis of sample's characteristics ($N = 754$)

Parental characteristics	MOTHER	FATHER
Age (Years). Mean (*SD*)	41.33 (3.82)	43.38 (4.66)
Education level	*n* (%)	
Primary	133 (17.7)	229 (30.6)
Secondary	291 (38.6)	328 (43.8)
University	329 (43.7)	192 (25.6)
Social class		
Low	329 (43.6)	442 (58.8)
Medium	216 (28.7)	127 (16.9)
High	209 (27.7)	182 (24.2)
(Father) Smoking during the mother's pregnancy (YES)	–	171 (23)
(Mother) Smoking during the 1st trimester (YES)	218 (29.3)	–
(Mother) Smoking during the 3rd trimester (YES)	132 (17.8)	–
(Mother) Alcohol consumption during pregnancy (YES) (At least one drink per week)	61 (8.3)	–
Children characteristics		
Age (Years). Mean (*SD*)	9.39 (1.57)	
Sex	*n* (%)	
Female	390 (51.7)	
Male	364 (48.3)	
Preterm birth (<37 weeks) (YES)	31 (4.1)	
Breastfeeding		
None	80 (10.9)	
16 weeks	155 (21.1)	
24 weeks	123 (6.8)	
>24 weeks	375 (51.2)	
Siblings		
None	128 (17)	
1	499 (66.2)	
>2	127 (16.8)	
Family structure		
Nuclear	649 (86.1)	
Single-parents	91 (12)	
Step family	14 (1.9)	

Note: *M* Mean; *SD* Standard Deviation

Procedure

The families were contacted by telephone in order to arrange a face-to-face session, held in the health centre, for completing the family context assessment questionnaire. They also completed the Conners Scale, which assesses the presence of ADHD symptoms. To evaluate attentional control, a strict protocol was established which was followed in both cohorts to minimise measurement errors: a single trained evaluator was assigned to each child; there was sufficient space in the room between participants to prevent any interaction, and the instructions were always given in the same order. All families signed an informed consent document and the local institutional ethical review boards approved the study and the assessment protocol.

Instruments and Measures

Conners parent rating scale revised (Conners 1997)

This scale assesses children's behaviour, with a special focus on symptoms associated with ADHD. The short version of the instrument consists of 28 items that parents must answer on a 4-point Likert-type scale (0 = not true at all to 3 = very much true). Scores ranged between 0 and 81, with high scores indicating more symptoms. Specifically, we used the ADHD Index subscale, which had a high internal consistency index for the sample used in this study ($\alpha = 0.84$). Continuous scores were used instead of dichotomised scores based on a clinical cut off point because the aim was not to detect the influence of contextual variables in diagnosed cases, but rather to determine the distribution of symptoms among the general population.

Haezi-etxadi family assessment scale 7–11 (HEFAS 7–11) (Barreto-Zarza et al. 2021)

This is a self-report questionnaire to assess the quality of family context, completed jointly by the mother and the father or the main caregiver in the presence of a professional

Table 2 Descriptive data and correlation analysis between family context variables, attentional control and ADHD symptoms

	ADHD index	Min-Max	Mean	*SD*
Subscale 1. Promotion of cognitive and linguistic development (1)	−0.188**	33.33–100	70.09	12.79
1.1 Presence of learning materials	−0.113**	29.17–100	69.29	15.87
1.2 Cognitive and linguistic scaffolding	−0.144**	33.33–100	71.18	15.21
1.3 Encouraging reading	−0.183**	16.67–100	69.60	18.82
Subscale 2. Promotion of social and emotional development (1)	−0.161**	53.03–100	83.35	8.78
2.1 Emotional expressiveness	−0.088*	44.44–100	93.95	8.77
2.2 Setting of limits and optimal frustration	−0.081*	33.33–100	83.43	11.45
2.3 Fostering autonomy and self-esteem	−0.164**	37.50–100	78.74	13.92
2.4 Precedents of self-regulated learning	−0.238**	45.83–100	87.33	10.67
2.5 Quality of sibling relations	−0.052	38.89–100	76.43	12.36
Subscale 3. Organisation of the physical environment and social context (1)	−0.176**	62.75–100	88.06	7.34
3.1 Quality of the physical environment	−0.108**	38.89–100	93.73	9.38
3.2 Social support networks	−0.206**	44.44–100	89.23	10.54
3.3 Promotion of child's social relationships	−0.077*	27.78–100	73.28	17.54
3.4 Relations with the school	−0.057	46.67–100	92.09	10.25
Subscale 4. Parental stress and conflict (1)	−0.374**	30.56 98.61	77.76	10.19
4.1 Low parental stress	−0.384**	16.67–100	71.15	16.67
4.2 Low frequency of and exposure to conflict	−0.159**	23.33–100	84.29	9.72
4.3 Conflict resolution	−0.153**	16.67–100	77.39	18.35
Subscale 5. Parental profile fostering child development (1)	−0.307**	46.83–100	80.14	9.22
5.1 Parental self-efficacy	−0.345**	16.67–100	77.36	17.28
5.2 Knowledge of psychological development	−0.223**	22.22–100	83.10	12.04
5.3 Assertiveness	−0.042	16.67–100	88.75	10.73
5.4 Environmentalist outlook on development	−0.178**	16.67–100	78.69	17.83
5.5 Involvement of the father or second reference figure	−0.175**	16.67–100	75.91	14.96
Attentional control (2)	0.175**	72–495.97	262.76	82.88
ADHD index	–	0–34	6.74	6.93

Note. *SD* Standard desviation; *ADHD* Attention deficit hiperactivity disorder

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; (1) Pearson's correlation; (2) Spearman's correlation

who was there to help answer any questions. The variables are grouped into 5 individual subscales: 1. Promotion of Cognitive and Linguistic Development (PCLD); 2. Promotion of Social and Emotional Development (PSED); 3. The organisation of the Physical Environment and Social Context (OPESC); 4. Parental Stress and Conflict (PSC); and 5. Parental Profile fostering child development (PPFCD). These 5 batteries had Cronbach's alphas of 0.79, 0.83, 0.73, 0.75 and 0.80, respectively. The subscales in turn comprise different factors (see Table 2), which are distributed across 83 items, rated on a 6-point Likert-type scale (1 to 6). Weighted scores were used within a range of 16.67 to 100. High scores indicate a high quality of the family context, even in the Parental Stress and Conflict subscale, where high scores would indicate low parental stress and low frequency of family conflict. The scale took approximately 15–20 min to be completed.

Attention network Test -ANT- (Rueda et al. 2004)

This is a computerized task to assess attention function. An exhaustive description of the ANT is published elsewhere (Forns et al. 2014). Participants were asked to press, as quickly as possible, the right or left touchpad of a laptop depending on the direction in which the fish in the middle of a horizontal line of five fishes was facing. We used the Hit Reaction Time-Standard Error (HTR-*SE*) as a response consistency measure throughout the test. High HTR-*SE* scores indicate high variability in response reactions and poor attentional control (López-Vicente et al. 2016).

Co-variables

Sociodemographic information about parents' education level, socioeconomic status (according to the Spanish

National Classification of Occupations, CON-94), alcohol consumption and smoking during pregnancy, premature birth, duration of breastfeeding, marital status and number of siblings, was gathered by means of a questionnaire. The descriptive results of the variables are shown in Table 1.

Statistical Analyses

Descriptive analyses were carried out with the socio-demographic characteristics of the sample and the variables studied. The associations between family context factors and ADHD symptoms were analysed using Pearson's correlation. Associations with attentional control were measured using Spearman's correlation because of the high range of responses on the attentional measure, which may show good or poor attentional control. Next, to determine the predictive value of the variables, a linear regression analysis using the step-by-step method (Wagner and Shimshak 2007), was conducted for each set of predictor factors on the ADHD symptoms. The same type of analysis was then repeated including only those variables, which had been found to be statistically significant; all the models were adjusted for cohort and child age. All analyses were carried out using the SPSS 24 statistical package.

The next step was to test those variables which had been found to be statistically significant in the linear regression models, using path analysis models. This was done using the AMOS 24 statistical package. In this study, the models were tested separately for the two cohorts. Various indicators were estimated to test the models' goodness of fit: the chi-squared statistic (χ^2) and the Chi-Square/degrees of freedom ratio (χ^2/df), for which values of between 2 and 5 are considered acceptable, the Comparative Fit Index (CFI) and the Tuker Lewis Index (TLI), for which values of above 0.90 are considered adequate, and the Root Mean Square Error of Approximation (RMSEA) with values considered acceptable below 0.08 (Morata-Ramirez et al. 2015). Finally, in order to test the invariance of the regression weights between groups (Gipuzkoa/Valencia), a multigroup analysis was performed with the final model (Deng et al. 2005; Henseler et al. 2015).

Results

Correlation Analyses between the Variables Studied

The correlation analyses revealed that the five subscales of the HEFAS-7-11 for evaluating family context were significantly and negatively associated with the Conners scale. In general, children with a higher-quality family context had fewer ADHD symptoms. Furthermore, low scores on the ANT test were associated with more ADHD symptoms. The descriptive statistics of family variables, attentional control and ADHD symptoms are shown in Table 2.

Linear Regression Models between Predictor Variables and the Presence of ADHD Symptoms

Linear regression models were calculated using the step-by-step method with the entire sample. Regarding family context variables, those factors that were significant in relation to the criterion variable were: in subscale 1 (SCLD), the factor Encouraging Reading ($\beta = -0.16$, $p < 0.001$); in subscale 2 (SSED), the factors Precedents of Self-regulated Learning ($\beta = -0.22$, $p < 0.001$), Setting of Limits and Optimal Frustration ($\beta = 0.13$, $p = 0.009$), and Fostering Autonomy and Self-esteem ($\beta = -0.094$, $p = 0.048$); in subscale 3 (OPESC), the factors Social Support Networks ($\beta = -0.15$, $p < 0.001$) and Quality of the Physical Environment ($\beta = -0.092$, $p = 0.012$); in subscale 4 (PSC), the factors Low Parental Stress ($\beta = -0.36$, $p < 0.001$) and Low Frequency of and Exposure to Conflict ($\beta = -0.10$, $p = 0.004$); in the fifth and final subscale (PP), the factors Parental Self-efficacy ($\beta = -0.34$, $p < 0.001$) and Knowledge of Psychological Development ($\beta = -0.09$, $p = 0.016$). Attentional control was also found to be a significant predictor of the presence of ADHD symptoms ($\beta = 0.17$, $p < 0.001$). Finally, the sociodemographic variables that were found to be significant were: sex ($\beta = -0.18$, $p < 0.001$) and father's education level ($\beta = -0.16$, $p < 0.001$).

This analysis was then repeated a second time, including only those variables that were found to be statistically significant in the previously tested models. The final model revealed that high levels of parental self-efficacy ($\beta = -0.23$, $p < 0.001$) and less parental stress ($\beta = -0.19$, $p < 0.001$) were associated with lower ADHD symptomatology in children; poorer performance on the attentional control test was associated with higher ADHD scores ($\beta = 0.13$, $p < 0.001$). In addition, child's sex ($\beta = 0.16$, $p < 0.001$) and father's education level ($\beta = -0.12$, $p < 0.001$) were also associated with the criterion variable. All the models were adjusted for cohort (Gipuzkoa/Valencia) and child age.

Path Analysis Models

The first step was to test a model that was consistent with the theoretical perspective, including those variables found to be statistically significant in the last linear regression model. In model 1, which was tested first with the Gipuzkoa cohort ($n = 387$), all the factors were directly related to ADHD symptoms, although Parental Self-efficacy was also affected by the father's education level, while at the same time mediating Low Parental Stress. This first model did not reject the null hypothesis providing a good fit to the

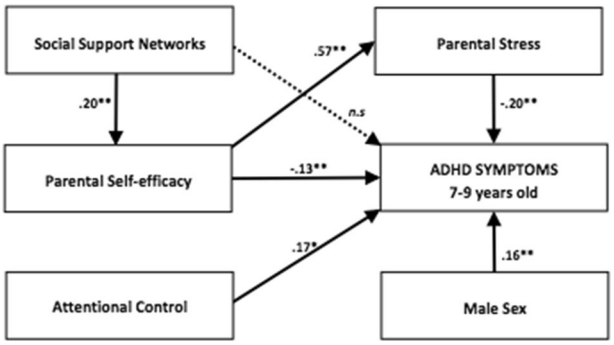

Fig. 1 Final model (num. 3). Variables associated with ADHD symptoms in Gipuzkoa cohort ($n = 387$). $^{**}p < 0.001$; $^{*}p < 0.01$

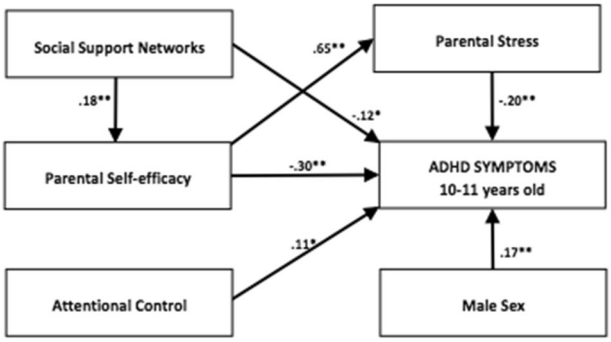

Fig. 2 Final model (num. 3). Variables associated with ADHD symptoms in Valencia cohort ($n = 367$). $^{**}p < 0.001$; $^{*}p < 0.01$

data [$\chi 2$ (8) =13.59, $p = 0.093$, $\chi 2/df = 1699$, CFI = 0.98, TLI = 0.93, RMSEA = 0.04].

Subsequently, the same model (num. 1) was tested with the Valencia cohort ($n = 367$), but in this case the model rejected the null hypothesis and did not fit the data well [$\chi 2$ (8) = 21.206, $p = 0.007$, $\chi 2/df = 2.651$, CFI = 0.96, TLI = 0.90, RMSEA = 0.06]. In addition, in this case, the relationship between father's education level and ADHD symptoms was not found to be statistically significant ($\beta = -0.08$, $p = 0.073$). This prompted us to test a second model in which the relationship between these variables was excluded. This second model rejected the null hypothesis in both Gipuzkoa [χ^2 (9) =20.450, $p = 0.015$, $\chi 2/df = 2.272$, CFI = 0.95, TLI = 0.88, RMSEA = 0.05] and Valencia cohorts [χ^2 (9) =24.339, $p = 0.004$, $\chi 2/df = 2.704$, CFI = 0.95, TLI = 0.89, RMSEA = 0.06].

Based on these results, a third model was tested (see Fig. 1), replacing the variable father's education level with the family context factor Social Support Networks. This variable was found to be statistically significant ($\beta = -0.15$, $p < 0.001$) in the first regression models calculated in accordance with the entire set of predictor variables and even in the correlation analysis ($r = -0.206$, $p < 0.01$). Additionally, recent studies support an inverse relationship between social support and ADHD, as the former is a protective factor for psychological wellbeing in both children and their families (Mastoras et al. 2018; Wüstner et al. 2019). According to Kline (2016), an optimum structural equations model or path analysis model is one which attempts to verify a sound and consistent theoretical perspective.

The third model proposed, which was tested in the Gipuzkoa cohort, provided a very good fit to the data [χ^2 (8) = 10.802, $p = 0.213$, $\chi^2/df = 1.350$, CFI = 0.99, TLI = 0.97, RMSEA = 0.03]. However, as shown in Fig. 1, the variable Social Support Network was not found to be significantly related to ADHD symptoms, although a significant association was found with Parental Self-efficacy. Moreover, higher levels of Parental Self-efficacy were associated with fewer ADHD symptoms and, this same variable was also found to mediate Low Parental Stress, a factor also linked to fewer ADHD symptoms. As expected, poorer performance on the attentional control test was associated with higher scores for the critical variable, and a relationship was also observed between ADHD symptoms and sex. A means comparison analysis revealed that in the Gipuzkoa cohort, boys (49%) had more ADHD symptoms ($M = 7.92$; $SD = 7.50$) than girls ($M = 5.70$; $SD = 5.76$), t (384) = 3.26, $p < 0.001$, $d_{z\ Cohen} = 0.33$.

When tested with the Valencia cohort, the χ^2 value of the third model (Fig. 2) was found to be at the limit of significance, although it was accompanied by optimum fit indexes [χ^2 (8) =16.107, $p = 0.041$, $\chi^2/df = 2.013$, CFI = 0.98, TLI = 0.94, RMSEA = 0.05]. In this sense, some authors (Barrett 2007; Kline 2016) question the SEM significance test, arguing that in large samples ($n \geq 200$) p values are often statistically significant. In this sense, it is important to estimate the fit of the model based on other parameters beyond the significance test.

In the Valencia cohort, the Social Support Networks variable was significantly associated with ADHD symptoms. Moreover, as in the Gipuzkoa cohort, boys (47.4%) had more ADHD symptoms ($M = 8.25$; $SD = 7.66$) than girls ($M = 5.25$; $SD = 6.29$), t (363) = 4.10, $p < 0.001$, $d_{z\ Cohen} = 0.43$. The estimated parameters of model 3 for both cohorts are shown in Table 3. Finally, multigroup analysis, to test the invariance of the regression weights between the groups, yields a chi-square $\chi 2 = 6.986$ with 6 degrees of freedom (df), and a significance value $p = 0.322$. The results show that the comparison of models is not statistically significant and, therefore, that the regression weights are invariant between groups, Gipuzkoa and Valencia cohorts, (Deng et al. 2005; Henseler et al. 2015).

Discussion

The purpose of this study was to test using a path analysis a possible explanatory model of the onset of ADHD

Table 3 Estimated parameters of the final model (*n*°3) with Gipuzkoa ($n = 387$) and Valencia ($n = 367$) cohorts

			Gipuzkoa cohort ($n = 387$)				Valencia cohort ($n = 367$)			
		Predictive variables	Estimate	*SE*	*CR*	*p*	Estimate	*SE*	*CR*	*p*
Parental self-efficacy	<–	Social support networks	0.347	0.085	4.105	0.001	0.287	0.083	3.469	0.001
Low parental stress	<–	Parental self-efficacy	0.551	0.040	13.743	0.001	0.631	0.039	16.325	0.001
ADHD symptoms	<–	Male sex	−2.132	0.632	−3.374	0.001	−0.111	0.022	−5.055	0.001
ADHD symptoms	<–	Low parental stress	−0.092	0.026	−3.516	0.001	−2.421	0.624	−3.877	0.001
ADHD symptoms	<–	Attentional control	0.016	0.004	3.530	0.001	−0.075	0.022	−3.353	0.001
ADHD symptoms	<–	Parental self-efficacy	−0.049	0.025	−1.943	0.05	0.010	0.004	2.400	0.016
ADHD symptoms	<–	Social support networks	−0.049	0.035	−1.374	0.17	−0.073	0.027	−2.702	0.007

Note. SE Standard error; *CR* Critical relation; *ADHD* Attention deficit hiperactivity disorder; *ANT* Attention network test; HTR-*SE* Hit Reaction time standard error

symptomatology in middle and late childhood, based on existing literature emphasizing the role of attentional control and family context variables. Our path model analysis revealed that; (a) family context variables and attentional control contribute independently to ADHD symptoms in both the 7–9 and 10–11 age ranges; (b) stress and parental self-efficacy emerge as key direct predictors for the presence of ADHD symptoms at both ages; (c) there is also an indirect role of parental self-efficacy in ADHD through its impact on parental stress, and in addition, parental self-efficacy is affected by the social support received by the family.

As part of an initial assessment of the results, it is worth mentioning that the predictor variable group regression model identified several family context variables that are related to ADHD symptoms: encouraging reading, precedents of self-regulated learning, fostering autonomy and self-esteem, quality of the physical environment, low frequency of and exposure to conflict, and knowledge of psychological development. Moreover, and consistent with previous findings, the linear regression model also revealed that attentional control (Miyake and Friedman 2012; Mueller et al. 2017) is understood as an indicator of the development of self-regulation, being male (Arnett et al. 2015; Greven et al. 2018) and father's education level (Russell et al. 2016) all predict ADHD symptoms, together with the key family context variables reported by the literature, namely parental stress, parental self-efficacy, and social support networks (Barroso et al. 2018; Heath et al. 2015; Mastoras et al. 2018).

In general, the preliminary results of the relationship between variables are consistent with the findings outlined in the introduction. In this regard, it is key to highlight that the interactions inherent in shared reading or the act of reading itself (Tomopoulos et al. 2006), as well as maternal responsiveness, and the existence of regulated planning and learning models in the family context (Hughes and Ensor 2009; Pauli-Pott et al. 2018), may have a positive relation to the development of attention, thereby helping to prevent the onset of ADHD symptoms. One finding that requires special attention is linked to the family context variable Setting of Limits and Optimal Frustration, as the results reveal a positive relationship between higher scores in this factor and the presence of ADHD symptoms. Generally speaking, good practice of this factor, which assesses the laying down of rules, is related to better psychological adjustment. However, an excessive limit setting is associated with a poorer development of executive functions during early and middle childhood (Stevens et al. 2019). One possible explanation of our results may be the specific character of children with ADHD symptoms. In other words, children with symptoms may require a greater degree of flexibility in terms of setting limits within the family system. Also, the presence of rigid rules, which other children can perhaps tolerate, may serve only to accentuate the presence of symptoms in children with ADHD, putting individuals with clear inhibition difficulties in various developmental domains under excessive pressure.

Regarding our key research questions, the path analysis model reveals a comprehensive panorama of simultaneous influences of qualitatively different factors on the criterion variable. In relation to our first research question, the model revealed that children with poorer attentional control had more ADHD symptoms, an association that coincides with that observed in previous studies (Martel et al. 2007; Mueller et al. 2017). Additionally, this influence was independent of family context variables. This finding supports the idea of a delay in the development of the brain structures involved in attentional and cognitive control among children with ADHD (Friedman and Rapoport 2015; Miyake and Friedman 2012; Vuontela et al. 2013) and suggests that, alongside other family context variables, attention regulation should be assessed and fostered during early and middle childhood.

In relation to the second research question, the map of influences revealed by the SEM path analysis showed that high levels of stress and conflict and low parental self-

efficacy which is consistent with the results found previously by other authors (Ben-Naim et al. 2019; Ferretti et al. 2019). Parental self-efficacy reflects parents' personal estimation of their own child-rearing competencies, and high levels of parental self-efficacy have been linked to positive parenting (Sanders and Woolley 2005). Parents with a stronger feeling of self-efficacy tend to assess their parental behaviour and adapt it to their children's needs, a process that is associated with high-quality parenting. In this sense, Benedetto and Ingrassia (2018) point out that parental competence emerges as the result of parents' capacity for self-regulation, which enables them to adapt their behaviour and respond in a flexible manner to their children's needs.

In addition, Parental stress defined as a negative psychological reaction to the challenges posed by parenthood has been negatively linked in previous literature to the quality of parent-parent and parent-child relationships (Heath et al. 2015). Stress has been associated with inappropriate parenting strategies, such as the authoritarian and permissive parenting styles (Hutchison et al. 2016). Similarly, previous research has found that parents of children with some kind of developmental disorder experience a greater degree of stress (Ben-Naim et al. 2019), (Cherry et al. 2019). Nevertheless, families which learn to manage the stress generated by adverse events during childrearing in an appropriate manner are able to mitigate the effects of said events on the appearance of ADHD symptoms (Rosenqvist et al. 2019). Furthermore, the lack of routines and unpredictable environments associated with parental stress and chaotic households (Semenov and Zelazo 2019) could significantly affect children with ADHD, who need the presence of caregivers who help them anticipate patterns and plan the future that helps children regulate their behaviour, thinking and emotions.

In our study, the variable parental self-efficacy emerges as a buffer for the effect of the characteristics of the child on parental competencies. It also plays a mediating role in relation to the presence of stress in the family system, a function identified also by Benedetto and Ingrassia (2018). This mediating role suggests that parents who have a better perception of their own parenting skills feel more confident about their ability to cope with any possible adversities in the family system, including parental stress. The results of our study could be interpreted in terms of bidirectional systemic regulations, as indeed suggested by authors such as Breaux and Harvey (2018) and Deater-Deckard (2017). Supporting this systemic view, Ben-Naim et al. (2019) reported a mediating role of parental stress and self-efficacy between children's ADHD and marital satisfaction. However, because the final model obtained here does not identify bidirectional relationships, this is an issue on which future studies may wish to focus.

Regarding the remaining research question, the final SEM model also reveals the positive impact of the variable social support networks on parental self-efficacy. The present study provides clear evidence of the influence of this factor on children's symptoms, due to its capacity to modulate parents' perceptions of their own efficacy. These results suggest that families with greater social support resources construct a more solid perception of their self-efficacy than their more isolated counterparts. This finding is consistent with that reported by previous studies (Deater-Deckard 2017; Izzo et al. 2000). Another noteworthy finding is that stronger social support networks are positively associated with fewer ADHD symptoms. Our results are therefore consistent with that observed in other studies which have found both a direct (Mastoras et al. 2018) and an indirect relationship (Wüstner et al. 2019) between these two variables. Nevertheless, it is important to point out that, in this study, this direct relationship was only found in one of the cohorts studied (Valencia). One possible explanation may be linked to the socioeconomic differences which could exist between the two areas in which the study was carried out, which in turn may generate circumstances prompting participants to have greater or lesser recourse to extended family and friends.

Clearly, our study replicates and expands existing knowledge on ADHD by providing a comprehensive predictive model of ADHD symptomatology in middle and late childhood. However, it has certain limitations that should be taken into consideration. Firstly, it should be noted that the principal instruments used were self-report measures. Nevertheless, in the case of family context at least, this type of assessment was necessary in order to gain information about an important predictor variable, namely parental self-efficacy, a subjective variable by nature that could not have been measured otherwise; this is also the case for the measurement of parental stress. Furthermore, the variable social support networks have been found to have greater predictive power on other variables when it is evaluated through self-perceptions than when it is assessed using objective measures (Solomon et al. 1987; Wang et al. 2018). In addition, regarding other variables, it is also important to highlight the fact that, given the recent advances in identifying biomarkers linked to ADHD symptoms, future studies should test and weight its co-influence with other family context variables.

Regarding the criterion variable (ADHD symptoms), although the Conners scale is widely used in research, future studies may wish to consider using this instrument in conjunction with other measures, with the aim of ensuring a more precise evaluation of the presence of ADHD symptoms. It is also important to note that the age range is different for the two study cohorts. Having tested the model in two samples with a wide age range across middle childhood, to a certain extent and taking it with caution, allows

us to generalise the results to this developmental period. However, in future studies, we expect to test the models in other samples of similar age to see if the results can be generalised to the rest of the population. Finally, it must be noted that the effect sizes found are, to some extent, low; this is one of the consequences of working with large samples (see Bujang and Baharum 2016). However, we believe that testing the models on a representative sample of the population would make it possible to generalise and reinforce the conclusions.

In sum, these results offer important practical implications, because they allow us to determine those variables of family context that are susceptible to be included in the design of individualized family treatments. These findings highlight that even non-clinical samples would benefit from primary preventive interventions focused on positive parenting in the field of paediatrics and public health. In this line, a recent programme designed by Chesterfield et al. (2020), has shown the influence of a brief behavioural parenting intervention to reduce child disruptive behaviour, dysfunctional parenting, and ADHD symptom severity. From a systemic point of view, in the case of parent-focused interventions, it would help to improve the quality of interactions with children and to introduce new routines which would allow for a reduction in ADHD symptoms in children, which translates into an improvement in family functioning. Specifically, it should be emphasized the importance of detecting daily routines which have been shown to be a protective factor for children whose parents experience high levels of stress (Fiese and Fisher 2019). Furthermore, structured daily routines could help parents strengthen their sense of parental self-efficacy in dealing with a stressful parenting situation building up a structure to properly address ADHD symptoms. In this sense, identifying routines that can be included in the family system should be a criterion to be taken into account when assessing family contexts and for planning interventions designed for families of children with ADHD.

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Compliance with Ethical Standards

Conflict of Interest The authors declare no competing interests.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Participation in this research was voluntary and Informed Consent was obtained from all families.

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