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ORIGINAL PAPER

Family structure, birth order, and aggressive behaviors among school-aged boys with attention deficit hyperactivity disorder (ADHD)

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Abstract

Purpose To evaluate the associations between family structure, birth order, and aggressive behaviors among school-aged boys with attention deficit hyperactivity disorder (ADHD).

Methods We conducted a matched case–control study. Data were retrieved from medical records at a psychiatry center in northern Taiwan. School-aged boys with ADHD who first visited the outpatient department at the psychiatric center between 2000 and 2011 were identified. The Child Behavior Checklist was used for aggressive behavior assessment. Boys with ADHD with T scores higher than 70 on the aggressive subscale were classified as cases and others with T scores lower than 70 were classified as controls at a 1:4 ratio. After controlling for other familial, personal, and parental factors, a multivariate conditional logistic regression was performed to evaluate the effects of family structure and birth order on aggressive behaviors of boys with ADHD.

Results 277 cases and 1108 controls were included in the final analysis. Compared with living in a traditional family with both parents, living in a non-traditional family in which one or both parents were absent increased the risk of aggressive behaviors by 1.47-fold, with the highest risk for those in single parent families. Being the firstborn increased risk by 1.45-fold and the risk was higher when the firstborn had siblings.

Conclusions Living in non-traditional families in which one or both parents were absent, and being the firstborn increased risk of aggression in school-aged boys with ADHD. Identification of this high-risk population and development of adequate preventive strategies are warranted.

Keywords ADHD · Aggression · Family structure · Birth order

Introduction

Childhood psychiatric disorders can interrupt the normal development of children, increase parental distress, and create a burden for society [1–3]. Attention deficit hyperactivity disorder (ADHD) is the most prevalent psychiatric disorder in children and adolescents, with children classically presenting with inattention, hyperactivity, and impulsivity. Symptoms often emerge in early childhood and persist throughout adolescence and adulthood. The clinical presentation of ADHD symptoms and the resulting impairment also evolve throughout several childhood developmental stages [1]. If not adequately treated, ADHD can result in problems in emotional regulation, learning ability, academic performance, self-esteem, and social adaption, as well as psychiatric or medical comorbidities, accidental injury, substance abuse, or criminality [1, 4, 5].

Aggressive behavior is another mental health concern in children and is responsible for a significant disease burden on both the children and parents [6]. Traditionally, aggressive behaviors include overt as well as indirect aggression and are indicative of severe emotional and behavior disturbances [7]. Aggression can occur early, beginning at the toddler stage, and change in frequency and intensity as

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the child develops [8]. Despite the general decrease in the occurrence of aggressive behaviors in children, continued aggression is associated with further negative outcomes [9–11]. Aggressive children have a higher risk of violence in adolescence and adulthood than non-aggressive children [9]. Delinquency, depressive symptoms, emotional disturbances, abusive behaviors, unemployment, poverty, forensic problems and other adverse outcomes are also common [6, 9]. Children with ADHD, who manifest with overt impulsive tendencies, have a higher tendency to develop aggressive behaviors and experience more severe negative consequences [10, 12, 13]. Therefore, both the tremendous impact of ADHD and aggressive behaviors on affected children, their peers, their families, and society have become a great public health concern.

The etiology of emotional and behavioral disturbances in children is complex. Biological, psychological, and socio-environmental factors all contribute to the occurrence and persistence of emotional and behavioral problems [11, 12, 14, 15]. Neurophysiological evidence suggests that both an altered reward system and impaired inhibitory function are associated with aggression in children [12]. Psychological and behavioral research also report that the child, their parents, and environmental factors contribute to childhood aggression [7, 15, 16]. Behavior and neuroimaging studies have demonstrated links between feelings of frustration, unsatisfied gratification, impaired neuro-circuit function of inhibition, and aggressive behaviors in ADHD children [12], but the correlations and associated factors remain less thoroughly investigated. Additionally, the strength of the genetic influence decreases with age, but the roles of social factors such as family environment, school and peers become more important [6]. Furthermore, although research mostly focuses on the genetic and neurological basis of aggressive behaviors in ADHD, the roles of psychological and socio-environmental factors have been emphasized less. Nonetheless, one study has investigated non-genetically related parent–child dyads, reporting that the spillover of inter-parental conflict can result in childhood aggression independent of hereditary effects [17]. In addition to direct effects, family environment can also interact with genetic or neurophysiological components to influence developmental and behavioral outcomes [18].

The household is the first environment with which a child comes into contact, and it therefore plays a significant role in development. The investigation of family-related risk and protective factors may provide useful information for understanding both genetic and environmental factors in emotional and behavioral disturbances in children [19]. An adequate family environment can facilitate normal development, while an adverse family environment can have negative consequences [20, 21]. In this study, we focused on two family environmental factors: family structure and birth order. Family structure defines the social context in which the child lives and comprises the macro-level environment. Birth order is related to different growth trajectories and reflects contextually specific parenting practices, rearing attitudes, resource utilization, and family roles [20, 22, 23].

With regard to family structure, living with a single parent or being reared by grandparents is associated with negative outcomes for children. Depressive symptoms, behavioral disturbances, being overweight, poor nutrition, reduced access to healthcare, and poor physical and mental health are all proposed to be related to growing up in non-traditional family in which one or both parents were absent [24–29]. Early changes to family structure also predict an increased risk of behavioral problems. The effects on child health are substantial and can persist into adulthood [30, 31]. Birth order also influences the development and personality of children. According to Adler's classic theory, firstborns are "dethroned" after the birth of siblings and face a challenging adjustment to siblinghood [19, 31, 32]. Birth order is also related to the mental health of children. Some studies report that birth order is related to ADHD, childhood emotional disturbances, and psychiatric admission during adulthood, but there is controversy over these findings [19, 33, 34]. Moreover, the impact of family structure and birth order on child development may differ between races, genders, and cultural contexts, though the research is still limited. The values of harmony and maintenance of family success in traditional Eastern societies have recently been changing in Asian countries. Additionally, the awareness of individual human rights, especially in women, and the economic difficulties also result in altered family structures and attitudes toward child rearing. However, there has been limited published research about the effects of such changes on Asian populations. The relationship between aggressive behaviors and ADHD in children is also seldom evaluated. Furthermore, both the incidence of ADHD and the occurrence of aggressive behaviors are more common among school-aged boys than girls and the negative outcome of childhood aggression is also worse in male population [35, 36]. Therefore, the evaluation of family factors and aggressive behaviors among ADHD patients, especially in school-aged boys, is important and deserves more clinical attention.

In this study, we used a hospital-based database to evaluate the effect of family structure and birth order on aggressive behaviors among school-aged boys with ADHD. The objectives of our study were: (1) to compare demographic characteristics between school-aged boys with ADHD with and without aggressive behaviors; and (2) to investigate the impact of family factors (i.e., living in a non-traditional family in which one or both parents were absent, and being the firstborn child) on the risk of aggressive behaviors in school-aged boys with ADHD.

Methods

Data sources

The Tao-Yuan Psychiatric Center (TYPC), a historical public hospital in Taiwan under the coverage of the National Health Insurance (NHI) system, provides ambulatory services, inpatient services, emergent services, and daycare services for patients with psychiatric disorders. The Child and Adolescent Department of the TYPC provides specialized psychiatric services for patients younger than 18 years.

During their first visit, the child's main caregiver completes the Child Behavior Checklist (CBCL) and is interviewed by a trained interviewer to collect information about personal, familial, and parental characteristics. Both the child and their main caregiver are also interviewed by board-certified psychiatrists to identify psychiatric symptoms and signs, and to make psychiatric diagnoses. All data are subsequently stored in both electronic and paper formats in the medical records database.

Study design and participants

Using electronic and paper medical records at the TYPC, we identified male patients aged 6–11 years who first visited the Child and Adolescent Psychiatry Department as outpatients between 2000 and 2011 with a diagnosis of ADHD (International Classification of Diseases, 9th Version, Clinical Modification [ICD-9-CM]: 314.XX). Subscales of the CBCL were obtained by first calculating specific items, followed by transformation of the raw score to a T score according to norms established by previous domestic research. For each subscale, a T score greater than 70 is indicative of more severe problematic behaviors for that domain. The aggressive behaviors subscale of the CBCL was used as a proxy measure of aggressive behaviors in children.

In this study, we defined "cases" as school-aged boyswith ADHD who had T scores greater than 70 on the aggressive subscales, while we defined "controls" as boys with ADHD who had scores of less than 70. Subsequently, we randomly matched controls to cases by age and calendar year of first visit at a ratio of 1:4. The medical records and personal, familial, and parental information for both aggressive cases and non-aggressive controls were retrospectively retrieved for further analysis.

Data collection

Demographic characteristics and personal, family, and parental factors

During the first ambulatory visit, a paper-and-pencil questionnaire was completed by the child's main caregiver. After the questionnaire was completed, a trained interviewer performed a face-to-face interview to ensure accuracy. Family factors such as birth order, number of siblings, family structure, and family history of psychiatric disorders were collected. During the medical record review, birth order and number of siblings were recorded, and the child was classified according to two factors: being firstborn or later-born, and having siblings or not having siblings. Information about family structure (i.e., a family with both parents, with a single parent, with grandparents only, or others) was also recorded and classified into two categories: "traditional family" which indicated a family in which both parents were present or "non-traditional family" which included other family structures mentioned previously, in which one or both parents were absent, regardless of circumstances. The existence of relatives with psychiatric disorders was also recorded.

Personal factors such as birth term, birth mode, birth weight, prenatal complications, perinatal complications, status of medical comorbidities, and parental factors such as education level, work status, and age at birth of child were also collected. Collected data were further classified into dichotomous categories for preterm birth or full-term birth, normal spontaneous delivery or cesarean section, low birth body weight (< 2500 g) or normal birth body weight (≥ 2500 g), having prenatal complications or not, and having perinatal complications or not. Parental information was also categorized into dichotomous groups, as follows: more than 12 years of schooling or less, employed or unemployed, and early parenthood (i.e., being younger than 20 years at childbirth) or not.

Psychiatric and medical comorbidities

Both the child and caregiver were interviewed by a board-certified psychiatrist during the first visit. Based on the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revised (DSM-IV, TR), a principal diagnosis of ADHD and other psychiatric diagnoses were made and recorded in the electronic medical records database. Data regarding medical comorbidities were first obtained from the paper-and-pencil questionnaire completed by the caregiver (as described above), followed by confirmation by another trained interviewer.

Aggressive behavior

The main caregiver completed the CBCL at the first visit. The CBCL measures problematic behaviors in children with items on a 3-point scale. The CBCL measure of aggressiveness reflects an overall tendency to engage in aggressive behavior [11]. In our study, raw scores for aggressiveness were obtained after reviewing medical records and were subsequently transformed to T scores according to norms established by previous domestic research. A T score higher than 70 (i.e., 2 standard deviations from the mean) was indicative of statistically significant deviance from normal behaviors and was used as the cutoff point to distinguish boys with ADHD with aggressive behaviors from those without (see also *Study design and participants* above).

Statistical analysis

Selected familial, personal, and parental characteristics for school-aged boys with aggressive behaviors (i.e., the case group) and without aggressive behaviors (i.e., the matched control group) were compared with a Chi-squared test. Conditional logistic regression was used to evaluate the risk of aggressive behaviors in school-aged boys with different family characteristics. We first used an unadjusted conditional logistic model to examine the extent to which family characteristics, especially birth order and family structure, and other selected familial, personal and parental factors were associated with aggressive behavior in school-aged boys with ADHD.

Subsequently, multivariate conditional logistic regression was conducted to evaluate the effect of the factors mentioned above, with simultaneous adjustment for other variables to reduce confounding effects. In addition to the main predictor of familial factors, personal and parental factors were also included in the full model. Another two models, including personal or parental factors, were also used to illustrate the possible effects of other factors on the association between familial factors and aggressive behaviors in school-aged boys with ADHD. Using the categorizations described above, we further investigated the effects of different family structure and birth order with or without the presence of siblings on aggressive behavior.

Association estimates were indexed as an odds ratio (OR) and 95% confidence intervals (CI). All analyses were performed with SAS 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

Among all the 1855 school-aged boys screened for medical record review, 277 cases and 1108 controls were identified for final analysis. We observed several differences in familial, personal, and parental characteristics between school-aged boys with ADHD exhibiting aggressive behaviors and their matched controls (Table 1). Those exhibiting aggressive behaviors were more likely than their matched controls to be a firstborn (65.0% vs. 55.1%, $p=0.003$), live in a non-traditional family (26.7% vs. 18.1%, $p=0.001$), and have a family history of psychiatric disorders (49.8% vs. 43.1%, $p=0.04$). With regard to personal and parental factors, cases more frequently had medical comorbidities (26% vs. 17.8%, $p=0.002$) and were more likely to have perinatal complications (34.7% vs. 26.0%, $p=0.004$) than controls. Furthermore, cases also tended to be born into families in which the father had a lower education level (65.0% vs. 58.5%, $p=0.04$) and the mother was younger at childbirth (6.1% vs. 3.3%, $p=0.03$).

Table 2 presents the unadjusted and adjusted association estimates between familial, personal, and parental factors and aggressive behaviors in school-aged boys with ADHD. Being the firstborn and living in a non-traditional family predicted the occurrence of aggressive behaviors in ADHD boys in both unadjusted and adjusted models. The risk of being aggressive is higher in firstborn boys with ADHD than in later-born boys (unadjusted OR 1.51, 95% CI 1.15–1.99; fully adjusted OR 1.45, 95% CI 1.06–1.98). Living in a non-traditional family also increased the risk (unadjusted OR 1.67, 95% CI 1.22–2.28; fully adjusted OR 1.47, 95% CI 1.04–2.08). Slight variations in the point estimate and statistical significance were noted when we controlled for more hypothetical confounding factors. However, the effect of birth order and family structure remained consistent.

Table 3 presents the risk between different family structures and aggressive behaviors in school-aged boys with ADHD. Compared with living in a traditional family with both parents, the risk of aggressive behavior was 1.63-fold higher in boys with ADHD living in a single parent family (adjusted OR 1.63, 95% CI 1.18–2.37). Living in a family with grandparents only also increased the risk, but this was not statistically significant (adjusted OR 1.29, 95% CI 0.59–2.82).

We also performed an additional analysis to evaluate whether the effect of being the firstborn differs depending on the existence of siblings (Table 4). Compared with later-born school-aged boys with ADHD, being the firstborn without any siblings (i.e., being an only child) and being the firstborn with siblings both increased the risk of aggressive behaviors. The risk was higher when boys

Table 1 Characteristics of school-aged boys with attention deficit hyperactivity disorder with aggressive behaviors and non-aggressive controls ($n = 1385$)

Variables	Cases $n = 277$ n (%)	Controls $n = 1108$ n (%)	p value
Familial factors			
Birth order			0.003
Firstborn	180 (65.0)	611 (55.1)	
Later-born	97 (35.0)	497 (44.9)	
Family structure			0.001
Non-traditional family[a]	74 (26.7)	201 (18.1)	
Traditional family[b]	203 (73.3)	907 (81.9)	
Sibling status			0.16
Without siblings	60 (21.7)	199 (18.0)	
With siblings	217 (78.3)	909 (82.0)	
Family history of psychiatric disorders			0.04
Yes	138 (49.8)	477 (43.1)	
No	139 (50.2)	631 (56.9)	
Personal factors			
Birth term			0.45
Preterm birth	29 (10.5)	134 (12.1)	
Full-term birth	248 (89.5)	974 (87.9)	
Birth mode			0.45
NSD	183 (66.1)	705 (63.6)	
C/S	94 (33.9)	403 (36.4)	
Birth body weight			0.08
Low birth body weight[c]	22 (7.9)	58 (5.2)	
Normal birth body weight	255 (92.1)	1050 (94.8)	
Prenatal complications			0.13
Yes	65 (23.5)	215 (19.4)	
No	212 (76.5)	893 (80.6)	
Perinatal complications			0.004
Yes	96 (34.7)	288 (26.0)	
No	181 (65.3)	820 (74.0)	
Medical comorbidity			0.002
Yes	72 (26.0)	197 (17.8)	
No	205 (74.0)	911 (82.2)	
Psychiatric comorbidity			0.53
Yes	128 (46.2)	489 (44.1)	
No	149 (53.8)	619 (55.9)	
Parental factors			
Paternal education level			0.04
> 12 years	97 (35.0)	460 (41.5)	
≤ 12 years	180 (65.0)	648 (58.5)	
Maternal education level			0.93
> 12 years	99 (35.7)	399 (36.0)	
≤ 12 years	178 (64.3)	709 (64.0)	
Paternal occupational status			0.25
Employed	262 (94.6)	1065 (96.1)	
Unemployed	15 (5.4)	43 (3.9)	
Maternal occupational status			0.57
Employed	177 (63.9)	728 (65.7)	
Unemployed	100 (36.1)	380 (34.3)	
Early fatherhood[d]			0.21
Yes	3 (1.1)	5 (0.5)	
No	274 (98.9)	1103 (99.5)	
Early motherhood[e]			0.03
Yes	17 (6.1)	37 (3.3)	
No	260 (93.9)	1071 (96.7)	

NSD normal spontaneous delivery, *C/S* caesarean section

[a]Non-traditional family: family in which one or both parents were absent; [b]Traditional family: family in which both parents were present

[c]Low birth body weight: birth body weight lower than 2500 g

[d]Early fatherhood: parental age younger than 20 years at childbirth

[e]Early motherhood: maternal age younger than 20 years at childbirth

with ADHD were the firstborn with siblings than when they were the firstborn without siblings (OR: 1.45, 95% CI 1.06–1.98; OR 1.35, 95% CI 1.03–1.81, respectively).

Discussion

Our results suggest that two important family factors, family structure and birth order, are associated with aggressive behaviors in school-aged boys with ADHD. School-aged boys with ADHD were more likely to be aggressive when they were living in a non-traditional family, or when they were the firstborn child. These results were consistent when other personal, familial, or parental factors were taken into account.

Previous research has thoroughly documented the negative impact of single parenthood on child development [24–26]. Indeed, some studies have emphasized that single parenthood is associated with psychiatric and medical comorbidities in children [20, 31, 37]. Such multi-comorbidities might be one explanation for our results. That is, living in a non-traditional family in which one or both parents were absent increases the risk of having psychiatric comorbidities in school-aged boys with ADHD. Comorbidities such as anxiety, mood, or disruptive behavior disorders may result in aggressive behaviors then. However, the associations remained robust after adjustment for physical and mental comorbidities in our study. Therefore, our results indicate that living in a non-traditional family may be associated with aggressive behaviors in school-aged boys with ADHD independently of the influence of comorbid conditions.

Table 2 Unadjusted and adjusted estimates linking familial, personal, and parental factors with aggressive behaviors in school-aged boys with attention deficit hyperactivity disorder ($n = 1385$)

Variables	Crude estimate OR [95% CI]	Model 1 OR [95% CI]	Model 2 OR [95% CI]	Model 3 OR [95% CI]	Model 4 OR [95% CI]
Family factors					
Birth order					
Firstborn vs. later-born	1.51 [1.15, 1.99]	1.51 [1.12, 2.04]	1.46 [1.07, 1.98]	1.50 [1.11, 2.04]	1.45 [1.06, 1.98]
Family structure					
Non-traditional family[a] vs. traditional family[b] with both parents	1.67 [1.22, 2.28]	1.57 [1.14, 2.17]	1.52 [1.09, 2.12]	1.51 [1.08, 2.11]	1.47 [1.04, 2.08]
Sibling status					
Without vs. with siblings	1.27 [0.91, 1.75]	0.95 [0.65, 1.36]	0.96 [0.66, 1.38]	0.93 [0.65, 1.35]	0.94 [0.64, 1.36]
Family history of psychiatric disorders					
Yes vs. no	1.32 [1.01, 1.71]	1.29 [0.99, 1.69]	1.22 [0.93, 1.61]	1.26 [0.96, 1.65]	1.18 [0.90, 1.56]
Personal factors					
Birth term					
Preterm vs. full-term birth	0.85 [0.55, 1.30]		0.67 [0.42, 1.07]		0.65 [0.41, 1.05]
Birth mode					
C/S vs. NSD	0.90 [0.68, 1.19]		0.93 [0.70, 1.23]		0.91 [0.68, 1.21]
Birth body weight					
Low[c] vs. normal	1.56 [0.94, 2.60]		1.59 [0.91, 2.75]		1.58 [0.91, 2.76]
Prenatal complications					
Yes vs. no	1.28 [0.93, 1.77]		1.14 [0.82, 1.59]		1.17 [0.84, 1.64]
Perinatal complications					
Yes vs. no	1.51 [1.14, 2.01]		1.44 [1.06, 1.95]		1.46 [1.08, 1.99]
Medical comorbidity					
Yes vs. no	1.64 [1.20, 2.25]		1.50 [1.09, 2.09]		1.48 [1.07, 1.99]
Psychiatric comorbidity					
Yes vs. no	1.08 [0.84, 1.40]		1.05 [0.81, 1.38]		1.05 [0.79, 1.37]
Parental factors					
Paternal education level					
> 12 vs. ≤ 12 years	0.75 [0.57, 0.99]			0.69 [0.49, 0.97]	0.68 [0.48, 0.96]
Maternal education level					
> 12 vs. ≤ 12 years	0.99 [0.75, 1.31]			1.29 [0.92, 1.81]	1.34 [0.95, 1.89]
Paternal occupational status					
Employed vs. unemployed	0.71 [0.39, 1.29]			0.81 [0.44, 1.52]	0.82 [0.44, 1.54]
Maternal occupational status					
Employed vs. unemployed	0.93 [0.70, 1.22]			0.87 [0.66, 1.15]	0.88 [0.66, 1.17]
Early fatherhood[d]					
Yes vs. no	2.40 [0.57, 10.1]			1.25 [0.25, 6.16]	1.40 [0.27, 7.15]
Early motherhood[e]					
Yes vs. no	1.91 [1.05, 3.46]			1.41 [0.72, 2.79]	1.40 [0.70, 2.81]

Model 1 included family factors only; model 2 included family and personal factors; model 3 included family and parental factors; model 4 included family, personal and parental factors. All factors and associated estimates in model 1 to model 4 were listed

C/S caesarean section, *NSD* normal spontaneous delivery

[a]Non-traditional family: family in which one or both parents were absent

[b]Traditional family: family in which both parents were present

[c]Low birth body weight: birth body weight lower than 2500 g

[d]Early fatherhood: parental age younger than 20 years at childbirth

[e]Early motherhood: maternal age younger than 20 years at childbirth

Table 3 The effect of different family structures on aggressive behaviors among school-aged boys with attention deficit hyperactivity disorder ($n = 1385$)

Family structure	*N*	OR	[95% CI]
Traditional family			
Family with both parents	1110	1	
Non-traditional family			
Family with single parent	202	1.63	[1.18, 2.37]
Family with grandparents only	38	1.29	[0.59, 2.82]
Others[a]	35	0.85	[0.35, 2.10]

Adjusted for birth order, sibling status, family history of psychiatric disorder, birth term, birth mode, birth body weight, prenatal complications, perinatal complications, medical comorbidity, psychiatric comorbidity, parental education level, maternal education level, paternal occupational status, maternal occupational status, parental age at childbirth, and maternal age at childbirth

[a]Others included: living with relatives, reared by neighborhood or living in a foster care institute

Table 4 The effect of birth order on aggressive behaviors among school-aged boys with attention deficit hyperactivity disorder ($n = 1385$)

Patterns of birth order	*n*	OR	[95% CI]
Being later-born	594	1	
Being firstborn without siblings	259	1.35	[1.03, 1.81]
Being firstborn with siblings	532	1.45	[1.06, 1.98]

Adjusted for family structure, family history of psychiatric disorder, birth term, birth mode, birth body weight, prenatal complications, perinatal complications, medical comorbidity, psychiatric comorbidity, paternal education level, maternal education level, paternal occupational status, maternal occupational status, paternal age at childbirth, and maternal age at childbirth

This independent association may be explained in several possible ways. First, family structural changes might affect family finances and material resources, and are associated with greater poverty and a higher burden of child rearing [18, 24]. Lack of supervision, difficulties with transportation, and limited conversation time and parent–child interactions might occur and contribute to problematic behaviors [24, 38]. Second, single parenthood has also been found to increase the risk of inadequate parenting, such as overinvolvement, and excessive control, or inversely, rejection of children [24, 39]. Negative parenting styles foster a hostile and neglectful environment for the child and inhibit their abilities to appropriately self-regulate disruptive behaviors [24, 40]. Third, children of separated parents often have more adjustment problems than do children of non-separated parents [24, 27], and aggressive behavior may be an effective way for a child to have his/her own distress acknowledged. Fourth, school-aged boys with ADHD are highly sensitive to external stimuli, and therefore, emotional and behavioral responses are usually exaggerated. Aggressive behavior is often a consequence of a genetic–environmental interaction between the altered family structure and the impulsive tendencies of ADHD [18]. Consistent with previous evidence that supports the negative effect of single parenthood on children, our study highlights similar effects among school-aged boys with ADHD, who are known to be a high-risk population for adverse life experience with vulnerability to maladaptive behaviors. In addition to single parenthood, children who were not living with both parents may be reared by grandparents, relatives, neighborhood, or living in a foster care institute. Although there are fewer studies, most researches suggest that the effect of grandparent caregiving is similar to that of single parenthood. The physical burden and emotional strain on grandparents can also interfere with adequate parenting, child's well-being, developmental status, and promotion of prosocial behavior in the child, which is consistent with our results.

Our study also reported that being the firstborn was associated with a high risk of showing aggressive behaviors among school-aged boys with ADHD, especially when they had siblings. According to the developmental ecological model, a child is nested within an ecological system, and child development is influenced by the interaction between the child and the whole system [41]. Firstborn children face certain challenges during maturation. First, as described by the theory of Adler, firstborns are "dethroned" after the birth of siblings, and their interactions with caregivers change. Second, when another sibling arrives, the firstborns must face the challenge of transition to siblinghood. It is proposed that this transition influences the child's recognition of social interactions, relationships with parents, verbalization ability, affect regulation, and feeling of competence [41]. Studies investigating self-worth have also reported that having younger siblings changes the sense of self-worth of the firstborn, often in a negative way [41]. Third, parents' expectations, attitudes, and responses toward the firstborn often differ from those towards later-born children [22, 32]. In traditional Eastern cultures, firstborn boys were often expected to be models for the other children or to be their parents' heir, both of which could bring them remarkable stress. Fourth, parents might gain experience from rearing their firstborn and modify their parenting tactics with subsequent children, which may improve the efficiency or flexibility of their parenting style. Such a learning process may be protective for their younger children but may negatively impact the firstborn. School-aged boys with ADHD are often impulsive, vulnerable to frustration, and can increase the burden on parents. Therefore, issues of parental or social expectations, competition with peers, and sibling rivalry may have a greater impact on male children with ADHD, especially when more socially undesirable behaviors are

exhibited as a result of their symptoms. Aggressive behaviors may be one way to cope with such difficulties.

Limitations and strengths

Our study is subject to some methodological limitations, which should be considered when interpreting our results. First, we performed a cross-sectional study; therefore, the inferences on causal relationships are weaker than in a longitudinal study. Although it is less likely that aggressive behaviors of children caused the changes in family structure or the birth of other siblings, the interpretation of a causal relationship should be conservative. Second, personal, familial, and parental data were based on the report of the main caregiver during the first clinical visit; therefore, its accuracy may be doubted. However, the main caregiver was also interviewed by one trained interviewer after completion of the questionnaire. Besides, the psychometric stability of the tool used to evaluate aggressive behaviors, the CBCL, is also well-studied [42]. Therefore, both the accuracy and validity of the measurements are sufficient. Third, although we used T scores greater than 70 for the aggressive subscale of the CBCL as an indication of aggressive behavior in boys with ADHD, we did not evaluate the frequency, intensity, forms, or object of aggressive behaviors. However, T scores have been broadly used in previous studies, and former research reports that the aggressive subscale of the CBCL is a predictor of negative consequences [43, 44]. Therefore, despite the limitations of using simple binary outcomes (e.g., the presence or absence of aggressive behavior), our research still has clinical significance. Fourth, we did not include female population, which also deserved clinical attention but was not evaluated in our study.

Although some limitations exist in our study, its strengths should also be highlighted. First, previous studies have generally focused on the influence of family structure and birth order on the incidence of child psychiatric disorders, primarily ADHD. Our study broadens these perspectives and further evaluates the effects on the specific aggressive behavior among school-aged boys with ADHD, which is important due to its associations with worse negative outcomes. Second, the study population was from Taiwan, an Eastern country strongly influenced by traditional Chinese cultural values of family harmony and in which the expectations of firstborn boys are high. Boys with ADHD in such a social context may face different stresses than boys living in a Western culture. Our study provides an understanding of the association between social factors, disease, and behaviors of boys with ADHD within the unique context of Eastern culture. Third, all psychiatric diagnoses were made by board-certified psychiatrists, which ensured their correctness and accuracy. The results suggest that there is a need to identify school-aged boys with ADHD who are at higher risk of aggressive behavior and offer them adequate intervention.

Conclusions

Living in a non-traditional family and being the firstborn increases the risk of aggressive behaviors in school-aged boys with ADHD. These two factors may set the stage for adverse outcomes in boys with ADHD, who present with physiologically inattentive, hyperactive, and impulsive tendencies. Various negative consequences may result from this. Therefore, both the identification of risky populations of ADHD and prevention strategies, such as the provision of an adequate family environment and assistance in adaptation are clinically important.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval Ethical approval for this study was obtained from the institution review board of the Tao-Yuan Psychiatric Center, Ministry of Health and Welfare, Taiwan. The study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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