

# **Familial-environmental risk factors in South African children with ADHD: A case-control study**

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## Abstract

**Background:** There is evidence that genetic factors contribute to the etiology of Attention Deficit Hyperactivity Disorder (ADHD) and that susceptibility genes interact with environmental risk factors in complex ways. There have been few published studies to date examining familial-environmental risk factors in children with ADHD from resource poor countries.

**Objective:** To investigate familial and environmental risk factors in South African children diagnosed with ADHD.

**Method:** A prospective, hospital-based case control study was conducted with 50 children diagnosed with ADHD and 50 matched non-ADHD controls. The case and control children and their relatives were systematically assessed using structured diagnostic interviews. Logistic regression analysis was performed to determine the adjusted effect of familial-environmental risk factors and ADHD.

**Results:** Low birth weight (OR=1.94, 95%CI=0.69-5.43, p=0.06), prematurity (OR=2.84, 95%CI=0.92-8.79, p=0.06), birth complications (OR=4.95, 95%CI=1.30-18.81, p=0.02) parental psychiatric history (OR=23.06, 95%CI=2.92-182.21, p<0.01), traumatic experiences in early childhood (OR=5.35, 95%CI=2.15-13.30, p<0.01) and non-maternal child care (OR=0.21, 95%CI=0.07-0.57, p<0.01) were found to be significant risk factors in South African children with ADHD. Contrary to other studies, higher parental education (For both parents: OR=5.06, 95%CI=1.70-15.05, p<0.01), smaller family size (OR=2.47, 95%CI=0.94-6.46, p=0.06) and improved housing conditions (OR=0.25, 95%CI=0.07-0.82, p=0.02) were observed in the ADHD group. There was a high incidence of maternal ADHD (p=0.04) and a positive trend towards paternal ADHD in the ADHD group. Prolonged breastfeeding was found to have a protective effect (OR=2.57, 95%CI=1.07-6.15, p=0.03)

**Conclusion:** We found that certain familial, social and environmental risk factors were significantly increased in this cohort of South African children with ADHD. This highlights the need for a Bio-Psycho-Social approach towards the management of ADHD.

## Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurobehavioral disorder affecting 5-10% of children globally and an estimated 2-8% of South African children. <sup>[1]</sup> There is good evidence of a strong heritable component to ADHD. Family studies have consistently found higher rates of ADHD in parents and siblings of affected probands compared to relatives of unaffected controls with greater association between paternal versus maternal ADHD and that in the child. <sup>[2]</sup> The high heritability of ADHD has fuelled efforts to identify susceptibility genes. Candidate genes associated with ADHD include DAT1 (dopamine transported gene), DRD4 (Dopamine 4 receptor gene), DRD5 and SNAP 25. <sup>[3]</sup>

Although evidence indicates that ADHD is highly heritable, certain environmental and other modifiable risk factors have also been implicated. <sup>[4]</sup> These include prenatal substance exposure (alcohol, smoking, second hand smoking and drug use in pregnancy), maternal stress during pregnancy, <sup>[5-9]</sup> pregnancy and birth complications (anteperium hemorrhage, prematurity, low birth weight, intrauterine growth restriction, and low Apgar scores) <sup>[11-13]</sup> and external agents (nutritional factors, psychosocial adversity including physical and emotional abuse of child, family adversity and low family cohesion). <sup>[14-16]</sup> It remains unclear as to whether any of the above mentioned associations are causal. There is growing evidence from studies using genetically sensitive designs that most associations with ADHD are due, at least in part, to confounding genetic or household-level factors. <sup>[17]</sup>

This study attempted to investigate whether certain familial, social and environmental risk factors are significantly increased in children diagnosed with ADHD in resource poor countries.

## Methodology

A prospective, hospital-based case control study was conducted with 50 ADHD children and 50 non-ADHD controls of both genders. The study was conducted at Paarl Hospital, a regional public-sector hospital in the Western Cape Province of South Africa, serving a population of predominantly lower to middle socio-economic status. Fifty children diagnosed with ADHD, based on the DSM-IV criteria, were recruited from the general paediatric clinics. Fifty non-ADHD controls were recruited from the general paediatric, surgical and orthopedic clinics and wards. Visitors of inpatients were also included.

All the children and their relatives were systematically assessed with structured diagnostic interviews. ADHD was diagnosed using the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) criteria. The parent of each non-ADHD control completed the Parent and Teacher Swanson, Nolan and Pelham (SNAP-IV) questionnaires to exclude children with undiagnosed ADHD. Study participants were between the ages of 5-13 years and had to be living with at least one biological parent.

Children with intellectual disability (IQ less than 70), any congenital or chromosomal abnormalities, neurological disorders, fetal alcohol syndrome and any chronic disease, including eczema,<sup>[18]</sup> were excluded from the study. None of the children had known HIV infection.

Variables and risk factors investigated in the study included current age, age at ADHD diagnosis, ADHD subtype, smoking and drinking (quantified) during pregnancy, prenatal exposure to “second-hand” smoking and illicit drugs, low birth weight, gestational age, small for gestational age, birth complications, breastfeeding, maternal age at conception, maternal and paternal education, family size, single parenthood, parental psychiatric or addictive disorder, early traumatic events, ADHD in other siblings, maternal or paternal ADHD, principal caregiver, parental absence for longer than 3 months at a time, formal or informal housing, previous referral to a social worker and/or psychologist and participants’ HIV status.

The DSM-IV classification identifies 3 subtypes of ADHD: (1) ADHD predominantly inattentive type (2) ADHD predominantly hyperactive impulsive type and (3) ADHD combined type. Low volume drinking was defined as consumption of 1-4 drinks per week, and moderate drinking 5-8 drinks a week. A binge episode was defined as an intake of 5 or more drinks on a single occasion. Our definition of a “drink” was the amount of alcohol equivalent to 12g of pure alcohol. Prematurity was defined as delivery before 37 weeks gestation and low birth weight as < 2500g. Large family size was defined as having three or more children. Intrauterine growth restriction (IUGR) or “small for gestational age” was defined as a weight below the 10<sup>th</sup> percentile for gestational age. Birth complications included low APGAR scores (less than 6 at 5 min), antepartum hemorrhage and perinatal complications or neonatal illness.

Parental education was classified according to the years spent in formal education (grades successfully completed). South Africa has a 3-tier system of education starting with primary school (grades 1 to 7), followed by secondary school (grades 8 to 12) and tertiary education. Schooling is compulsory for all South Africans from the age of 7 years (grade 1) to the age of 15 years, or the completion of grade 9.

Exposure to early traumatic events included any of the following: divorce or separation of parents, family members with mental illness, family alcoholism or substance abuse, witnessing of death, death of a pet, death of a sibling, parent or grandparent, serious injury or violence to others, serious injury or illness of sibling, motor vehicle or motor vehicle-pedestrian accident and natural disaster.

The parents completed the ADHD Self-Report Scale-V1.1 (ASRS-V1.1) to determine whether they themselves might have ADHD.<sup>[19]</sup> This scale consist of 6 questions. A score of 4 or more might be an indication that the adult has ADHD. Adults with scores of 4 and more were counselled and given the option of referral for diagnostic work-up and management of ADHD.

The study and control groups were compared using ANOVA for continuous/ordinal variables, and cross tabulation with the Chi-square test for categorical variables. Both of these statistical methods take into account matching, as the two groups were independent. The matching was done to ensure that the groups were comparable. Logistic regression analysis was used to determine the adjusted effect of familial-environmental risk factors and ADHD.

The study was approved by the Health Reseach Ethics Committee of Stellenbosch University of Stellenbosch (S13/05/093).

## **Results**

In total, 100 children, 50 with confirmed ADHD and 50 healthy non-ADHD controls were recruited for the study over a period of 6 months (July – December 2013). The median age of ADHD diagnosis was 84 months (range 60-156 months). The two study groups were matched for age and gender. Table 1 illustrates the differences in biological factors between the ADHD children and non-ADHD control groups. Table 2 illustrates lifestyle differences between the two groups.

## Discussion

This is the first study of South African children with ADHD looking at potential familial-environmental risk factors.

Most studies in the literature have identified smoking during pregnancy as a consistent risk factor for ADHD. <sup>[6,7]</sup> The precise link between smoking and fetal brain development remains unclear. It is postulated that the risk of future ADHD is increased by stimulation of nicotine receptors in the fetal brain, which modulate and dysregulate dopaminergic activity. Chronic smoking in pregnancy may also result in fetal hypoxia, which adversely affects brain development. This study found no association between ADHD and smoking in pregnancy. Exposure to secondhand smoking was also not increased in the ADHD study group. <sup>[8]</sup> These findings are possibly explained by the very high prevalence of smoking (> 30%) in both study groups.

South Africa has one of the highest incidences of Fetal alcohol syndrome (FAS) globally, with the greatest prevalence reported in the Western Cape. <sup>[20]</sup> The behavioural phenotype of children with Fetal alcohol spectrum disorders (FASD) includes difficulties in attention. Although ADHD is diagnosed in up to 94% of children with high prenatal alcohol exposure, the exact relationship between FASD and ADHD remains unclear. <sup>[21,22]</sup> Prenatal alcohol intake was not significantly increased in the ADHD study group, which may be related to underreporting and the fact that the study excluded children with FAS.

Prematurity and intrauterine growth retardation at birth is associated with increased risk for ADHD or its symptoms. <sup>[12,13]</sup> It remains unclear whether it is more detrimental to be born too early or too small in relation to symptoms of ADHD. Studies that investigated the independent effects of prematurity and IUGR on the fetal brain found that IUGR children were at the highest risk of developing ADHD. <sup>[13]</sup> The higher risk of ADHD may be related to early life protein restriction altering cerebral dopamine circuitry. <sup>[23]</sup> In contrast to other studies, IUGR was not a significant risk factor for ADHD in our study population.

The risk for ADHD appears to increase for children who are born a month or more before their due dates and gradually rises with each additional week of prematurity. <sup>[12]</sup> Infants born between 35-36 weeks gestation have a 30% greater chance of developing ADHD compared with term infants. <sup>[24]</sup> The higher risk is thought to be related to disruption of cerebral maturational processes. <sup>[25]</sup> An additional

contributing factor may be the effects of stress that preterm infants experience such as neonatal pain, maternal separation during intensive care stay, increased auditory and visual stimulation and sleep deprivation. We similarly found the risk of ADHD significantly higher in preterm infants.

Illicit drug abuse increases the risk of childhood behavioral problems, including ADHD. <sup>[9,10]</sup> Two mothers in the ADHD study group reported illicit drug use during pregnancy; one confessed to using methamphetamine, the other using cannabis.

Birth complications such as antepartum hemorrhage, prematurity, low birth weight, intrauterine growth restriction, cord prolapse and low Apgar scores have been shown to be risk factors for the development of ADHD. <sup>[11,12]</sup> Exposure to birth asphyxia has especially been shown to lead to an increased risk of development of ADHD of up to 26%.<sup>[26]</sup> The risk of developing ADHD is also 47% higher in children who develop respiratory distress syndrome.

Prolonged breast-feeding has been shown to have a protective effect against the development of ADHD.<sup>[15]</sup> It is unclear whether the benefit relates to the breast milk itself, or to the special bond formed between mother and baby during breastfeeding. Short duration of breastfeeding (less than 3 months) was found to be a significant risk factor of ADHD symptoms in the study group.

Any psychiatric or physical illness in a parent can have an impact on the family dynamics and development of a child.<sup>[27]</sup> In this study, the prevalence of psychiatric illness proved significantly higher in parents with ADHD children.

A major Swedish study of more than a million children reported strong links between receiving medication for ADHD and single parent families, limited maternal education and welfare benefits. <sup>[28]</sup> Women who had only received the most basic education were 130% more likely to have a child on ADHD medication. Children were 54% more likely to be on ADHD medication if they came from single parent families. Children who grow up with single parents are more likely to experience cognitive, emotional and social problems. <sup>[29]</sup> These children are exposed to more stress and financial difficulty, and the parents might have a less supportive family structure. In this study, the prevalence of single parenthood was similar and alarmingly high in both study groups. However, daytime parental absenteeism was significantly increased in the ADHD group. Mothers of our children with ADHD

were often sole breadwinners and their children attended a daycare centre or were looked after by the grandmother. This might have future implications, as more mothers become the primary breadwinners in South Africa. <sup>[30]</sup>

The higher educational level of the parents in the ADHD group is in contrast with findings from most other studies. <sup>[16,28]</sup> This finding may be attributed to a referral bias due to better awareness of ADHD in more highly educated parents. Further studies are needed to compare the prevalence in the different South African socioeconomic classes with larger study populations.

Out of the total study population, 18% of parents worked away from the home for more than 3 months at a time, but this seem to have no association with occurrence of ADHD ( $p = 0.1154$ )

Traumatic events can have a profound impact on a child's development at all stages of childhood. Behavioral changes and attention difficulties are among the changes observed. The significant number of children with ADHD, who experienced a traumatic event, concurs with findings well described elsewhere. <sup>[31]</sup> Many parents noted behavioral changes in their child after the traumatic event. None of these children were referred for counseling. This suggests a need to refer any child who had experienced a traumatic event to psychology or social workers for counselling.

Adverse parenting may also act as an environmental risk factor for childhood ADHD. The prevalence of parental ADHD in children with ADHD may be as high as 30-40 %.<sup>[2]</sup> This emphasizes the importance of parental evaluation when diagnosing a child with ADHD. ADHD in children and adults increases the risk of parental difficulties and interparental discord. The familial nature of ADHD was also evident in this study; the prevalence of maternal ADHD proved significantly higher in children with ADHD. In addition there was a positive trend towards paternal ADHD in the childhood ADHD group. Future family-genetic studies will hopefully clarify the etiology and nosology of ADHD.

We acknowledge the following study limitations. Firstly, our sample was relatively small. Secondly, our ADHD and control group consisted of children who were randomly selected from the general pediatric, surgical and orthopedic clinics, which do not necessarily reflect all the children from that community (referral bias). Thirdly, the ADHD study group consisted of children diagnosed and receiving pharmacological treatment for ADHD, and therefore likely to reflect more severe cases.

ADHD Combined type, the most common subtype in the study and worldwide, especially among boys, are also more likely to be referred. <sup>[32,33]</sup>

## **Conclusion**

This hospital based case-control study identified that birth complications, low birth weight, prematurity, parental psychiatry and substance abuse, parental absenteeism, early traumatic life events and short periods of breastfeeding are associated with ADHD children in South Africa. In contrast to other studies, higher level of parental education, smaller family sizes and better housing were found in the ADHD group. The study findings again emphasize the importance of a biopsychosocial approach when managing children with ADHD. <sup>[34]</sup>

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**Table 1:** Comparison between matched and biological factors in 50 ADHD children and 50 Non-ADHD controls.

Characteristics	ADHD (n=50)	Non-ADHD Controls (n=50)	p-value	OR (95% CI)
Male	42 (84%)	38 (76%)	0.32	1.66 (0.61-4.49)
Mean Age (years)	8.76	8.84	0.85	1.02 (0.84-1.23)
<b>ADHD subtype</b>				
Combined	28 (56%)			
Inattentive	15 (30%)			
Hyperactive	7 (14%)			
Preterm (< 38 weeks)	12 (24%)	5 (10%)	0.06	2.84 (0.92-8.79)
Term	43(86%)	32(64%)	<b>0.03</b>	
Low birth weight	12 (24%)	7 (14%)	0.20	1.94 (0.69-5.43)
SGA	6 (12%)	5 (10%)	0.75	1.23 (0.35-4.32)
Birth complications	12 (24%)	3 (6%)	<b>0.02</b>	4.95 (1.30-18.81)

*Preterm:* delivery before 38 weeks gestation. *Low birth weight:* less than 2500g. *SGA (small for gestational age):* weight below 10<sup>th</sup> percentile for gestational age. *Birth complications:* Any one of the following: antepartum hemorrhage, low Apgar scores, perinatal complications or neonatal illness.

**Table 2:** Comparison of familial-environmental and life style factors 50 ADHD children and 50 Non-ADHD controls.

	<b>ADHD (n=50)</b>	<b>Non- ADHD Controls (n=50)</b>	<b>p-value</b>	<b>95% CI</b>
Mean maternal age (at conception)	27.9 yr	26.48 yr	0.31	0.97 (0.92-1.03)
<b>Maternal education</b>				
< Grade 10	12 (24%)	27 (54%)	<b>&lt;0.01</b>	0.27 (0.11-0.63)
Grade 10-12	26 (52%)	19 (38%)		
Tertiary education	12 (24%)	4 (8%)	<b>0.03</b>	3.63 (1.08-12.18)
<b>Paternal education)</b>				
< Grade 10	17 (35%)	19 (38%)	0.68	0.84 (0.37-1.91)
Grade 10-12	20 (40%)	28 (56%)		
Tertiary education	12 (25%)	2 (4%)	<b>&lt;0.01</b>	7.62 (1.61-36.19)
<b>Tertiary education both parents</b>	18 (36%)	5 (10%)	<b>&lt;0.01</b>	5.06 (1.70-15.05)
<b>Family size</b>				
Single child	16 (32%)	8 (16%)	0.06	2.47 (0.94-6.46)
More than 3 children	21(42%)	25(50%)	0.42	0.72 (0.33-1.59)
Single parent	19(38%)	18(36%)	0.84	1.09 (0.48-2.46)
Parental psychiatry	16(32%)	1 (2%)	<b>&lt;0.01</b>	23.06(2.92-182.21)
Early trauma	27 (54%)	9 (18%)	<b>&lt;0.01</b>	5.35 (2.15-13.30)
Informal housing	4 (8%)	13 (26%)	<b>0.02</b>	0.25 (0.07-0.82)
Smoked in pregnancy	16 (32%)	19 (38%)	0.53	0.77 (0.34-1.75)
Alcohol during pregnancy	8 (16%)	11 (22%)	0.44	0.68 (0.25-1.85)
Substance abuse during pregnancy other than above	2 (4%)	0 (0%)	0.15	* 1 value has 0
Mother as principal caregiver	30 (60%)	44 (88%)	<b>&lt;0.01</b>	0.21 (0.07-0.57)
<b>Duration of breastfeeding</b>				
< 3 months	21 (42%)	11 (22%)	<b>0.03</b>	2.57 (1.07-6.15)
> 3 months	29 (58%)	39 (78%)		
<b>Family history of ADHD</b>	19(38%)	8(16%)	0.06	2.47 (0.94-6.46)
Other siblings*	5 (14.7%)	4 (9.5%)	1.00	1.0 (0.27-3.69)
Mother with ADHD	4 (8%)	0 (0%)	<b>0.04</b>	* 1 value has 0
Father with ADHD	10 (20%)	4 (8%)	0.08	2.95 (0.86-10.14)

\* Families with more than 1 child

# Either parent absent for period more than 3 months/year

*Informal housing:* non-conventional low-cost housing (shack). *Alcohol during pregnancy:* > 4 drinks a week (48g of pure alcohol)

