# Factors associated with the development of attention deficit hyperactivity disorder (ADHD) in schoolchildren aged 6 to 13 years in the city of Ouagadougou, Burkina Faso

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**Abstract** The variability of prevalence rates of attention deficit disorder with or without hyperactivity (ADHD) in the literature raises questions about its etiology and the factors predisposing to its manifestation. The causes are multidimensional, but the current scientific consensus focuses on genetic predisposition and gene-environment interactions. A previous study estimated its prevalence at 13.74%. In this study, the objective was to determine the factors associated with the occurrence of ADHD in schoolchildren in the city of Ouagadougou. This was a cross-sectional study conducted in Ouagadougou, Burkina Faso, between March and August 2021. The identification of factors associated with ADHD was carried out by employing logistic regression modeling. The significance level was set at 5%. The results of this research allowed us to quantify the association between gender and age in relation to the development of ADHD. The univariate and multivariate statistical analysis allowed us to establish a causal relationship between hereditary and environmental factors and the development of ADHD. ADHD symptoms are as common among school children in Ouagadougou. The use of insecticide, gasoline odor exposure, and poor long treatment were described as risk factors for ADHD. This is an exploratory study that will add to the limited body of knowledge in the scientific literature with respect to child development.

**Keywords:** ADHD, school children, Ouagadougou, associated factors

## 1. Introduction

The World Health Organization (WHO) continues to face many emerging health concerns despite ongoing efforts to improve the living conditions of populations. Among these, attention deficit hyperactivity disorder (ADHD) among African youth in general and in Burkina Faso in particular remains a concern. It is a neurodevelopmental condition that impacts the lives of thousands of children worldwide (Polanczyk 2007).

The growing prevalence rate of ADHD has the scientific community concerned about the multitude of associated factors. The precise causes of ADHD are not well known (Simard P. 2014), but the current scientific consensus focuses on genetic predispositions and their gene-environment interactions (Banerjee 2007).

Thus, studies agree to find a slightly higher prevalence of ADHD in boys than in girls. In the United States, the results of several studies show a rate of 51% for boys and 49% for girls (Froehlich 2007). In terms of socio-economic status, children in precarious situations are more exposed to a diagnosis of ADHD (Froehlich 2007). It should be emphasized that ADHD has a very strong genetic component (Yao 2019). Data from combined studies show heritability of 76% (Smith 2009). Numerous prenatal risk factors appear to be associated with the development of ADHD. Children exposed to alcohol prenatally have an increased risk of developing various psychiatric disorders and psychosocial deficits (Huizink 2006). Several reports have established that maternal smoking during pregnancy and maternal drug abuse during pregnancy negatively impact prenatal and postnatal growth and increase the risk of fetal mortality, abnormal cognitive development, and maladaptive behaviors in children and adolescents (Linares 2006; Wasserman 1999). Also, it is recognized that maternal obesity during pregnancy has critical health consequences for the mother, as well as acute and long-lasting metabolic consequences on the development of the child (Yu 2013; Kim 2020). Specific perinatal complications implicated in ADHD include toxemia or eclampsia, poor maternal health, maternal age, prematurity, duration of labor, fetal distress, low birth weight, and antepartum hemorrhage (Maher 2018).

Environmental exposures during periods of developmental plasticity may have lifelong effects (Ha 2020). A more recent meta-analysis of 14 studies involving more than 17,000 children found that higher blood lead levels were associated with a fourfold increase in ADHD risk (Nilsen 2020).

Finally, studies examined the prevalence of mental disorders in children living in two very different geographic areas and found six risk factors within the family that were strongly correlated with child mental disorders: severe marital discord; lower social class; a large family; paternal criminality; maternal mental disorder; and foster care (Rutter 1975)

In sub-Saharan Africa, ADHD is believed to be the cause of school failure because of its lack of awareness and expensive treatment modalities. In order to better understand attention deficit hyperactivity disorder (ADHD), we were interested in the factors associated with the development of ADHD in Burkina Faso, based on the following research question: What are the factors associated with the manifestation of ADHD at the school level in the city of Ouagadougou?

## 2. Materials and Methods

The study took place in the city of Ouagadougou, the political capital of Burkina Faso. It was a cross-sectional study with an analytical focus on schools and was conducted from October to December 2021. The study involved 290 students from public and private elementary schools in the city of Ouagadougou. These students were between the ages of 6 and 13. The stratified sampling technique was used to determine the number of private and public schools per BEC. Based on the weight of the CEB, we were able to determine the sample size for each stratum. The schools selected were chosen at random from the list of schools in each stratum.

A semi-structured interview guide was used for data collection. The interviewers received training during which the interview procedure was explained and the translation of the guide into the local language, "Mooré," was explained. The use of KoBoCollect software as a data collection tool was also explained.

For data processing, R software version 3.6.0 was used. The identification of factors associated with ADHD was sought by modeling using logistic regression. The chosen threshold of significance was 5%.

In the first step, we will perform descriptive analysis, and then we will perform chi-square tests. The Chi-square test is a non-parametric. It is set up to determine the independence between two categorical variables.

The hypotheses of the test were:
● Null hypothesis: The two categorical variables are independent.
● Alternative hypothesis: The two categorical variables are related.

We opt for a classification approach that will be valid for quantitative, qualitative, or mixed data. The objective of variable classification is to construct classes of variables that are strongly related to each other and thus remove redundant information. We will use the "ClustOfVar" approach to variable classification as an alternative to factor analysis, to detect correlations between variables and group them into strongly related classes.

In each group, the variable retained will be the one that is most correlated to the principal component (a synthetic variable summarizing the information measured by the variables) of the group. The group of variables retained will therefore be made up of variables with low correlation. Following the classification of the variables, we will carry out a logistic regression. Logistic regression proposes to test a regression model whose dependent variable is dichotomous (coded 0-1) and whose independent variables can be continuous or categorical. This is the case for our dataset with the dependent variable having two modalities. However, it does not require the presence of a linear relationship between the variables since the dependent variable is dichotomous.

## 3. Results

There were 290 respondents in our study, 117 of whom were female (40.3%) and 173 male (59.7%). More than half (227, or 78.3%) lived with both parents, and (82, or 28.3%) had a CE1 level. Table 1 presents the distribution of children by socio-demographic characteristics.
Table 1 presents the distribution of children by socio-demographic characteristics;
Table 2 presents the distribution of children according to the different variables of the study;
Table 3 presents the explanatory variables independently associated with the development of ADHD in children in a regression model (multivariate analysis).

### 3.1. Multivariate analysis

At the end of the multivariate analysis, the variables (baby's birth weight, use of insecticide in the home, one parent being very active during childhood) were significantly associated with the development of ADHD in the child.

**Table 1** Distribution of children by socio-demographic characteristics.

| Socio-demographic variables | Frequency N (%) |
|---|---|
| Sex | |
| Female | 117(40.3) |
| Male | 173(59.7) |
| Interview With | |
| Mother | 231(79.7) |
| Father | 57 (19.7) |
| Father and Mother | 2(0.7) |
| Class of study | |
| 3rd grade n | 82 (28.3) |
| 4th grade n | 52 (17.9) |
| 5th grade n | 58 (20) |
| 6th grade n | 29 (10) |
| 1st grade n | 32 (11) |
| 2nd grade n | 37 (12.8) |
| Living With 1 or 2 Parent(s) | |
| Two Parents | 227 (78.3) |
| Alone | 63 (21.7) |

**Table 2** Distribution of ADHD development in children according to the different variables in the study.

| Variables | Frequency N (%) |
|---|---|
| Types | |
| mixed case | 138 (47.6) |
| Hyperactivity | 79 (27.2) |
| no TDH | 73 (25.2) |
| TDH | |
| No | 73 (25.2) |
| Yes | 217 (74.8) |
| Maternal bleeding | |
| No | 250 (86.2) |
| Yes | 40 (13.8) |
| Baby's weight at birth | |
| Good | 166 (57.2) |
| Small | 45 (15.5) |
| Too much | 79 (27.2) |
| Used Insecticides to spray your house | |
| No | 124 (42.8) |
| Yes | 166 (57.2) |
| Exposure to Toxic Waste | |
| No | 276 (95.2) |
| Yes | 14 (4.8) |
| Exposure to gasoline odor | |
| No | 255 (87.9) |
| Yes | 35 (12.1) |
| Active parenting as a child | |
| No | 145 (50) |
| Yes | 145 (50) |
| Siblings with similar behavior | |
| No | 169 (58.3) |
| Yes | 121 (41.7) |
| have Family Disputes | |
| No | 153 (52.8) |
| Yes | 137 (47.2) |
| Sufficient income | |
| No | 50 (17.2) |
| Yes | 240 (82.8) |
| Has parent had any problems Judicial ? | |
| No | 282 (97.2) |
| Yes | 8 (2.8) |
| Has the parent had any mental health problems? | |
| No | 272 (93.8) |
| Yes | 18 (6.2) |
| Forster home | |
| Non | 250 (86.2) |

| Variables | Frequency N (%) |
|---|---|
| Oui | 40 (13.8) |
| Illness of one of the parents that required a long treatment | |
| Non | 207 (71.4) |
| Oui | 83 (28.6) |
| Legitimate Child | |
| No | 36 (12.4) |
| Yes | 254 (87.6) |
| Alcohol During Pregnancy | |
| No | 218 (75.2) |
| Yes | 72 (24.8) |
| Excess weight during pregnancy | |
| No | 198 (68.3) |
| Yes | 92 (31.7) |
| Cigarettes During Pregnancy | |
| No | 211(72.8) |
| Yes | 79 (27.2) |

**Table 3** Distribution of ADHD development in children according to study variables.

| Variables | OR (CI) | P_value |
|---|---|---|
| Baby's weight at birth | | |
| Good | 1 | |
| Too much | 2.53 (1.19-5.69) | 0.019 |
| Small | 1.17 (0.53-2.73) | 0.694151 |
| Insecticide use | | |
| No | 1 | |
| Yes | 2.15 (1.21-3.86) | 0.009 |
| Gasoline Odor Exposure | | |
| No | 1 | |
| Yes | 1.72 (0,63-5,56) | 0.314034 |
| Family Home | | |
| No | | |
| Yes | 2.36 (0.95-6.82) | 0.081654 |
| Active Parent to Child | | |
| No | 1 | |
| Yes | 2.57 (1.39-4.85) | 0.003 |
| Poor_Long_Treatment | | |
| No | 1 | |
| Yes | 1.49 (0.77-3.02) | 0.244096 |
| Alcohol During Pregnancy | | |
| No | 1 | |
| Yes | 1.83 (0.90-3.95) | 0.106546 |

## 4. Discussion

In this section, the association between various possible exposure risk factors and the probability of ADHD occurrence is measured. Categorical variables such as socio-demographic information, including parental education, annual family income, pre-and postnatal conditions, and environmental and genetic factors, were used to perform statistical tests.

The evaluation of the level of association between the factors predisposing to the development of ADHD in the child-related factors such as duration of labor during delivery, assessment of the child's weight at birth, exposure to odors and essences, perception of the active or distracted nature of one of the parents during childhood, alcohol consumption during delivery, use of insecticide, foster family, foster family, and mal long treatment.

The results of our study reveal that a baby whose weight is too high compared to the normal on the parents' statement has a higher risk of antepartum hemorrhage and consequently more risk of developing ADHD. Specific perinatal complications implicated in ADHD include toxemia or eclampsia, poor maternal health, maternal age, prematurity, length of labor, fetal distress, low birth weight, and excess infant weight that could lead to antepartum hemorrhage (Amor et al 2005; Banerjee et al 2007).

A multivariate assessment of the factors identified above shows an association between the perception of a parent's active or distracted nature during childhood and the development of ADHD in the child. A child whose parent acknowledges being very active or distracted during childhood has a greater risk of developing ADHD compared to a child whose parent reported the opposite.

These findings are consistent with the literature and have a strong genetic component. Family studies have consistently shown familial clustering, with a relative risk of ADHD of approximately 5–10 times among first-degree relatives of ADHD

subjects (Kroemer et al 2018). ADHD is therefore a highly heritable disorder with respect to its familial forms. Data from combined studies show heritability of 76 (Demontis et al 2019; Smith et al 2009).

## 5. Conclusion

ADHD symptoms are as common among schoolchildren in Ouagadougou as anywhere else. Parental education, maternal alcohol consumption or smoking during pregnancy, income level, legal problems, and maternal mental health history, which have been described as risk factors for ADHD, were not identified as such in this study. However, a significant number of factors in a univariate analysis and three factors in a multivariate analysis were found to be associated with the development of ADHD in the city of Ouagadougou.

## Ethical considerations

Not applicable.

## Conflict of Interest

The authors declare no conflicts of interest.

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## References

Amor L, Ben Grizenko N, Schwartz G, Lageix P, Baron C, Ter-stepanian M, Zappitelli M, Mbekou V, Joober R (2005) Perinatal complications in children with attention-deficit hyperactivity disorder and their unaffected siblings. Rev Psychiatr Neurosci 30:120-126.

APA (2013) The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. 128 p.

Banerjee T, Das Middleton F, Faraone SV (2007) Environmental risk factors for attention-deficit hyperactivity disorder. Acta Pædiatrica 1269-1274. DOI: 10.1111/j.1651-2227.2007.00430.x

Demontis D, Walters RK, Martin J, Mattheisen M (2019) Discovery of the first genome-wide significant risk loci for attention-deficit/hyperactivity disorder. Nature Genetics 51:63-75. DOI: 10.1038/s41588-018-0269-7

Duh-leong C, Fuller A, Marron NM (2020) Associations entre les facteurs de protection familiaux et communautaires et les résultats du trouble déficitaire de l'attention / hyperactivité chez les enfants américains. J Dev Behav Pédiatre 41:1-8. DOI: 10.1097/DBP.00000000000000720.Associations

Franz A P, Bolat G U, Bolat H, Matijasevich A, Santos I S, Silveira RC, Procianoy R S, Rohde L A, & Moreira-Maia C R (2018) Attention-deficit/hyperactivity disorder and very preterm/very low birth weight: A meta-analysis. In Pediatrics. 141(1): e20171645). DOI: 10.1542/peds.2017-1645

Froehlich TE, Lanphear BP, Epstein JN, Barbaresi WJ, Katusic SK, Kahn RS (2007) Prevalence, Recognition, and Treatment of Attention-Deficit/Hyperactivity Disorder in a National Sample of US Children. Arch Pediatr Adolesc Med 161:857-64.

Gale CR, Robinson SM, Godfrey KM, Law CM, Schlotz W, Callaghan FJO (2008) Oily fish intake during pregnancy – is association with lower hyperactivity but not with higher full-scale IQ in offspring. Journal of Child Psychology and Psychiatry 10:1061-1068. DOI: 10.1111/j.1469-7610.2008.01908.x

Guxens M (2018) Air Pollution Exposure During Fetal Life, Brain Morphology, and Cognitive Function in School-Age Children. Biological Psychiatry 84 :295-303. DOI: 10.1016/j.biopsych.2018.01.016

Ha S, Yeung E, Bell E, Insaf T, Ghassabian A, Bell G, Muscatiello N, Mendola P (2020) Original Investigation Prenatal and Early Life Exposures to Ambient Air Pollution and Development Sandie. Environ Res 174:170-175. DOI: 10.1016/j.envres.2019.03.064.Original

Habib M (2011) Le cerveau de l'hyperactif: entre cognition et comportement. Développements 9:26. DOI: 10.3917/devel.009.0026

Huizink AC, Mulder EJH (2006) Maternal smoking, drinking, or cannabis use during pregnancy and neurobehavioral and cognitive functioning in human offspring. Neurosci Biobehav Rev 30:24-41.

Kim JH, Kim JY, Lee J, Jeong GH, Lee E, Lee S (2020) Environmental risk factors, protective factors, and peripheral biomarkers for ADHD: an umbrella review. The Lancet Psychiatry [Internet] 7:955-70. Disponible sur : DOI: 10.1016/S2215-0366(20)30312-6

Kroemer N B, Veldhuizen MG, Delvy R (2018) Sweet taste potentiates the reinforcing effects of e-cigarettes. European Neuropsychopharmacology, 28(10), 1089-1102. DOI: 10.1016/j.euroneuro.2018.07.102

Linares TJ, Singer LT, Kirchner HL, Elizabeth J, Min MO, Hussey P (2006) Mental health outcomes of cocaine-exposed children at 6 years of age. J Pediatr Psychol 31:85-97.

Maher GM, Keeffe GWO, Kearney PM, Kenny LC, Dinan TG, Mattsson M (2018) Association of Hypertensive Disorders of Pregnancy with Risk of Neurodevelopmental Disorders in Offspring A Systematic Review and Meta-analysis. JAMA Psychiatry 75:809-19.

Nilsen FM, Tulve NS (2020) A systematic review and meta-analysis examining the interrelationships between chemical and non-chemical stressors and inherent characteristics in children with ADHD. Env Res 180:108884.

Park J, Hoon J, Joon S, Yeon H, Hwang I, Hong Y, Kim K (2020) Association between short-term air pollution exposure and attention- de fi cit/hyperactivity disorder-related hospital admissions among adolescents: A nationwide time-series study. Environmental Pollution 266 :115369. DOI: 10.1016/j.envpol.2020.115369

Polanczyk G, Lima MS de, Horta BL, Biederman J, Rohde LA (2007) The Worldwide Prevalence of ADHD: A Systematic Review and Metaregression Analysis. Am J Psychiatry 164:942-8.

Rodriguez A, Bohlin G (2005) Are maternal smoking and stress during pregnancy related to ADHD symptoms in children? Journal of Child Psychology and Psychiatry 3:246-254. DOI: 10.1111/j.1469-7610.2004.00359.x

Rutter M, Cox A, Tupling C, Berger Mi, & Yule W (1975) Attainment and Adjustment in Two Geographical of Psychiatric Disorder. British journal of Psychiatry 126:493-509.

Shih P, Huang CC, Pan SC, Chiang, TL, Guo YL (2020) Hyperactivity disorder in children related to traffic-based air pollution during pregnancy. Environmental Research 109588. DOI: 10.1016/j.envres.2020.109588

Simard P (2014) Activité physique (ap) et trouble déficitaire de l'attention/hyperactivité (TDAH). L'impact de l'activité physique avec ou sans médication sur le TDAH.

Smith AK, Mick E, Faraone SV (2009) Advances in genetic studies of Attention-Deficit / Hyperactivity Disorder. Current Psychiatry Reports 11:143-148.

Thapar A (2003) Maternal Smoking During Pregnancy and Attention Deficit Hyperactivity Disorder Symptoms in Offspring. Am J Psychiatry 12:1985-1989.

Vaurio L, Riley E P, Mattson SN (2008) Differences in executive functioning in children with heavy prenatal alcohol exposure or attention-deficit/hyperactivity disorder. J Int Neuropsychol Soc 14:119-129. DOI: 10.1017/S1355617708080144.Differences

Wasserman RC, Kelleher KJ, Bocian A, Baker A, Childs GE, Indacochea F (1999) Identification of Attentional and Hyperactivity Problems in Primary Care: A Report from Pediatric Research in Office Settings and the Ambulatory Sentinel Practice Network. Pediatrics 103:1-7

Yao S, Kuja-halkola R, Martin J, Lu Y, Lichtenstein P, Norring C (2019) Associations Between Attention-De fi cit / Hyperactivity Disorder and Various Eating Disorders: A Swedish Nationwide Population Study Using Multiple Genetically Informative Approaches. Biol Psychiatry 86:577-86.

Yu Z, Han S, Zhu J, Sun X, Ji C, Guo X (2013) Pre-Pregnancy Body Mass Index in Relation to Infant Birth Weight and Offspring Overweight / Obesity: A Systematic Review and Meta-Analysis. PLoS One 8:1627-38.