

## Prevalence of ADHD in children born by mothers consuming *Frankincense* during pregnancy

**Running Title:** *Frankincense* consumption during pregnancy and ADHD

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### Abstract

**Aims:** In Iranian culture, due to some narratives from the prophet Mohammad about the use of frankincense during pregnancy for increasing IQ in children, some women consume frankincense during expectancy. This study's goal is to evaluate the relationship between frankincense used during pregnancy and the incidence of ADHD.

**Methods:** In this study, the case group comprised children 4-17 years old referring to Shahid Chamran Pharmacy in Yazd from summer to winter 2018 for receiving Methylphenidate, those with whom a psychologist had identified ADHD based on DSM-V factors. The control group included children of the same age group but without ADHD. For data gathering, a checklist was used with some questions on smoking, family history of ADHD, presence/absence of a specific disease during pregnancy, frankincense used during pregnancy, and a chemical medication consumed during pregnancy.

**Results:** The main result demonstrated that the children whose mothers used frankincense during pregnancy were 0.67 times less likely to be affected by ADHD than those whose mothers did not use this substance. However, the difference failed to be statistically significant ( $P > 0.05$ ).

**Conclusion:** Some studies report that frankincense can bear a positive effect on the development of the brain and possibly adequate formation of dendrites trees, axons and induce proper communication between them, so the impact of frankincense on the brain may be justified by its protective effect against the hyperactive child.

**Keywords:** Attention deficit hyperactivity disorder; ADHD; *Boswellia carterri*; *Frankincense*

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## Introduction

Optimal development of the central nervous system requires adequate minerals and vitamins during gestation, perinatal and childhood periods. Some mothers try to use some herbal drugs to increase their children's Intelligence Quotient (IQ) (1).

Attention Deficit Hyperactivity Disorder (ADHD) is a neurobehavioral syndrome characterized by inattention, irritability, hyperactivity, anxiety, and restlessness, especially in boys (2). The cause of ADHD in children is not yet clearly known, and its etiology is multi-factorial. One of the critical factors linked to ADHD incidence is the diet of women during pregnancy. Chronic deficiency of some minerals such as zinc, iron, magnesium, and iodine and insufficient dietary intake of long-chain polyunsaturated fatty acids may have a significant impact on the development of the symptoms of ADHD in children (3).

Like many disorders, ADHD treatment bears some shortcomings, including adverse effects and high treatment costs. The Iranian culture linked, in part, to some narratives from the prophet Mohammad about the use of frankincense during pregnancy for increasing the children's IQ has induced some women in Iran to have a try of it during pregnancy (4).

Several studies have reported anti-inflammatory and antitumor activity of *Boswellia serrata*. Boswellic acid is one of the main compounds of frankincense which is responsible for its therapeutic effects (5). This substance bears an antimicrobial effect on gram-negative and gram-positive bacteria (6). In some countries, several

species of *Boswellia*, such as *Boswellia serrata* and *Boswellia carterii*, have been deployed to treat inflammatory diseases like Rheumatoid arthritis, Crohn's disease, ulcerative colitis, and osteoarthritis (7). Some studies have also investigated the effect of frankincense on cognitive capabilities hence detecting that the aqueous extract of *B.serrata* during gestation in rats can enhance the power of learning, post-learning stage, short-term and long-term memory (8).

This study aimed to investigate the prevalence of ADHD in children whose mothers used frankincense during pregnancy.

## Methods

In this study, the case group included 4-17-year-old children whose parents had referred to Shahid Chamran Pharmacy in Yazd from summer to winter 2018 for receiving Methylphenidate as a psychologist had identified ADHD with them based on DSM-V criteria. The control group also comprised children of the same age group who did not show any signs of ADHD; they were selected from elementary and high schools of Yazd. And the two groups were matched for all demographic dimensions.

For sampling, the simple randomized method was utilized, and a checklist was used to gather the relevant data.

The checklist questions were around smoking, family history of ADHD, any specific disease during pregnancy, frankincense used during pregnancy (either at their own discretion or on the

advice of others), and a chemical medication consumed during pregnancy.

### **Ethical issues**

The study protocol was approved by the Medical Ethics Committee of Shahid Sadoughi University of Medical Sciences with the reference number: IR.SSU.MEDICINE.REC.1396.329. The subjects who participated in this project were not charged, and their information was kept confidential. The patients chose voluntarily whether to continue with or withdraw from the study.

### **Inclusion and exclusion criteria**

Children aged 4-17 years old with ADHD as diagnosed by a psychiatrist, who had been referred to Shahid Chamran Pharmacy of Yazd (Iran) for receiving Ritalin, were included in the study.

Inability to communicate, inability to answer the questions of the checklist, failure to recall the requested information, chronic diseases such as kidney failure, liver disorders, anemia, and any disease that could trigger long-term use of the drug were considered the exclusion criteria.

### **Outcome measures**

Data were garnered by a data collection form completed in the form of face-to-face or telephone interviews with the mothers. (The checklist is attached to the end of the article.)

### **Randomization and blinding**

Sampling was performed by simple random method. Each patient who had been referred to Shahid Chamran Pharmacy to receive Ritalin was

included in the study, and the inclusion criteria were then evaluated.

### **Sample size**

By assuming the level of significance of 5% and test power of 80% and also by considering the prevalence of ADHD in ordinary people of the community, which is about 5%, and assuming that consumption of frankincense escalates the prevalence of hyperactivity by about 10%, that is, the odds ratio of 2 150 people in each group, the sample size was examined.

### **Statistical analysis**

Data were analyzed through SPSS18 software using Chi-square test, Fisher's exact test, Logistic Regression, and Independent T-test. For qualitative variables, Fisher's exact test and Chi-squared test were used. And based on the occurrence of interfering variables in the incidence of ADHD, Logistic Regression was also applied. In all cases, the significance level was considered less than 0.05.

### **Results**

In this study, 300 children were studied, 14 of whom were excluded from the control group for their age being under four years; data analysis was thus performed based on the information of 286 subjects. On the basis of the inclusion criteria, the age group of the participants was determined to be 4 to 17 years, with an average of 8.5 years. The highest age frequency in both case and control groups belonged to those aged 4 to 9 years (**Table 1, Figure 1, Table. 2**).

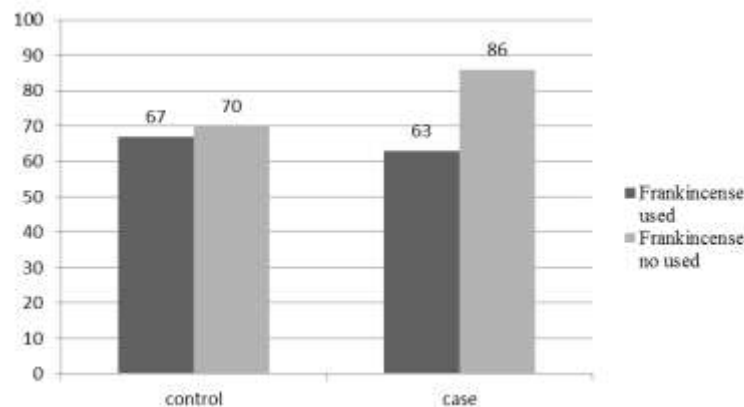
**Table.1** Sex distribution in the ADHD and control groups,

Groups Sex	ADHD		Control	Total	P-value
	N (%)		N (%)	N (%)	
Boys	106 (71.1)		80(58)	186(65.1)	<0.05
Girls	43 (28.85)		57(41.9)	100(34.9)	
Total	149 (100)	137(100)	286(100)		

ADHD: Attention deficit hyperactivity disorder, N: number

**Table. 2** The results of logistic regression

Variables	P-value	Exp	Confidence interval for odds ratio	
			Upper limit	Low limit
Age	0.524	1.032	1.136	0.937
Sex	0.039	0.585	0.975	0.352
Inheritance	0.000	3.682	6.858	1.977
Frankincense consumption	0.114	0.672	1.100	0.410



**Figure .1** Frequency of Frankincense used during pregnancy

The Chi-square test assessed the difference between gender and group. Due to heterogeneity of gender ratio in the two groups and the fact that Children whose mothers used frankincense during pregnancy tended 0.67 times less likely to develop

gender is assumed to be one of the risk factors for ADHD, logistic regression was used to analyze the data on frankincense consumption (**Table.3**).

ADHD than those born from mothers who had used frankincense; however, this difference was

not statistically significant ( $P>0.05$ ).

**Table. 3** Frequency of tobacco use during pregnancy in the two groups

	Frequency (%)	Frequency (%)	P-value
Tobacco use	38(25.5)	27(19.7)	>0.05
No tobacco use	111(74.5)	110(80.3)	
Total	149(100)	137(100)	

The chance of ADHD in girls born from mothers consuming frankincense during pregnancy turned out to be 0.58 times lower than boys, and the difference was statistically significant ( $P<0.05$ ).

Children whose mothers had used frankincense during pregnancy and had a child with ADHD in the family or other relatives were 3.6 times more likely to develop ADHD ( $P<0.05$ ).

The mothers' average age in the case group appeared to be 35 years, but in the control group 33, the difference was significant ( $P<0.05$ ).

The average age of the children in the case and control groups turned out to be 8.68 and 8.48 years, respectively, but the difference was not statistically significant ( $P>0.05$ ).

In the case and control groups, respectively, 83% and 45.6% of mothers were housewives, but the difference failed to be statistically significant ( $P>0.05$ ).

As evidenced by **Table.3**, in 25.5% of children in the case group, one of their parents smoked or consumed hookah during pregnancy, while in the control group, this figure turned out to be 19.7%. This difference, however, was not statistically significant ( $P>0.05$ ).

As presented in **Table.4**, 33.3% of children with a history of ADHD in their family suffered from the disease. This number showed to be 12.4% in the healthy group, thus being significantly different ( $P<0.05$ ).

**Table. 4** Frequency of Inheritance in groups

Groups	Case (%)	Control(%)
Relatives with a history of hyperactivity	49(33.3)	17(12.4)
Relatives without a history of hyperactivity	98(66.7)	120(87.6)
Total	147(100)	137(100)

## Discussion

Predicated on the results of this study, the chance of developing ADHD in children born by mothers who had consumed frankincense during pregnancy proved to be 0.67 times lower than those whose mothers failed to use frankincense; this difference was not, however, statistically significant ( $P > 0.05$ ). Moreover, in terms of sex, girls whose mothers consumed frankincense were 0.58 times less likely to be affected by ADHD compared with boys, and this difference was statistically significant ( $P < 0.05$ ).

One of the essential effects of frankincense is strengthening memory. There are even several narratives from the prophet of Islam and Imams concerning other benefits of frankincense (9).

As Beheshti et al. detected, consumption of frankincense in mice during lactation increases the power of memory and learning in their babies. These researchers found that administration of frankincense, especially at a dose of 0.05 g/kg during the critical development of the fetal and neonatal nervous system, triggers learning abilities, particularly causing a significant increase in memory enhancement and its maintenance. It follows that frankincense can positively affect the development of the brain and possibly adequate formation of dendrites trees, axons, and proper communication between them so that this effect of frankincense on the brain may be justified by its protective effect against the child who is hyperactive (10).

Monoterpenes, diterpenes, pentacyclic triterpenes or buswellic acids, and tetracyclic triterpenes are essential constituents of frankincense. Boswellic

acid inhibits the synthesis of the pro-inflammatory enzyme 5-lipoxygenase. This enzyme itself produces inflammatory leukotrienes (10, 11). Given the role of inflammation in ADHD, probably one of the mechanisms to reduce the incidence of ADHD in children, as indicated by this study, is reducing inflammation by frankincense (12).

The researchers have also demonstrated that administration of frankincense, especially at a dose of 0.05 g / kg during the critical development of the fetal and neonatal nervous system, can induce learning in individuals, especially causing a significant increase in

strengthening and maintenance of memory. Therefore, it seems that frankincense can positively impact the development of the brain and possibly the proper formation of dendritic axons on trees and adequate communication between them. (13). Contact monoterpene, detergent, pentacyclic triterpene acid, boswellic acid, and tetracyclic triterpene acids are important constituents of frankincense. Boswellic acid inhibits the synthesis of the pro-inflammatory enzyme 5-lipoxygenase. This enzyme itself produces inflammatory leukotrienes (10).

The present study identified 33.3% of children with ADHD having another child with ADHD in their family or other relatives. This number was 12.4% in the healthy group, thus showing a significant difference between the two groups ( $P < 0.05$ ). The logistic model also showed the chance of ADHD among children whose mothers consumed frankincense during pregnancy and had a history of hyperactivity in their family and

relatives being 3.6 times higher than those who did not have a family history of the like. In a study conducted at the University of Welfare and Rehabilitation, Khoshabi et al. examined the risk factors for ADHD. They reported ADHD in children with an account of the disorder in their parents and relatives higher than those devoid of such a history in their parents and relatives. They also reported that boys show a more elevated incidence of ADHD than girls. In the present study, the incidence of ADHD in children with a family history of ADHD was higher than those without a family history of the disease (14).

Another study detected 45 to 90% of children with parental ADHD showing this complication (15). Studies on inmates and twins also project the role of genes in the development of this disorder. For most diseases, including ADHD, genetic and non-genetic factors may play a role in the disease etiology (16).

An essential indicator of genetic heterogeneity in ADHD is high behavioral disorders, anxiety, and depression. Gender differences can also be vital in addressing heterogeneity in ADHD. Also, the ratio of boys to girls is four to one in the community sample but not one in the clinic referral sample. The Gender model of family burden indicates that girls need more burden of familial etiological factors to manifest ADHD than boys. If ADHD is a single gene disorder, girls probably need two copies of the gene, whereas boys need only one copy to be involved in the disorder; this can justify the lower prevalence of the disorder in girls. Since mothers with ADHD always bear two copies of the gene,

the probability of passing it onto their children is 100%. Although the study of Hebrani et al. at Mashhad University of Medical Sciences showed that gender fails to be a risk factor for family genetics concerning ADHD and familial ADHD accumulation, their research may have become confounded by the possibility of parental involvement bias (17).

In Sweden, a study by Rodriguez et al. revealed that maternal lifestyle and stress and smoking during pregnancy could directly be related to hyperactivity in children, especially boys (18). The incidence of hyperactivity is associated with many environmental factors, although it is difficult to determine precisely which factor contributed to its occurrence. Some factors can heighten the likelihood of ADHD in case a mother encounters them during pregnancy. These factors include alcohol, nicotine, glucocorticoids, toxins such as hexachlorobenzene, poor maternal diet, and stress during pregnancy (19). Prenatal risk factors comprise prematurity, low birth weight, and difficult delivery. It has been found that the incidence of hyperactivity is also associated with childhood diseases such as meningitis, encephalopathy, heart disease, thyroid disorders, epilepsy, head trauma, as well as autoimmune and metabolic disorders. A high level of lead in the blood is also associated with hyperactivity but is not as important as the abovementioned factors. Moreover, psychosocial conditions such as poverty, childhood violence, and family disputes have been proved to be associated with ADHD. Furthermore, experiencing smoking and hookah by parents can stimulate the effect of nicotine on the incidence of hyperactivity (20).

In the present study, smoking and hookah used by parents in the patient group was higher than the healthy group but was not statistically significant. An inadequate sample size may fail to account for such a relationship ( $P < 0.05$ ). For this is a retrospective study, there is the likelihood of an error in the mother's recall in answering the questions. The principles of correct randomization are not well observed. Therefore, it is recommended that prospective studies be performed to investigate the effects of frankincense on ADHD further.

### Conclusion

The present study showed that girls whose mothers consumed frankincense during pregnancy were less likely to be affected by ADHD. Consumption of frankincense in pregnancy fails to increase the incidence of hyperactivity in children and bears a protective role.

**Conflict of interests:** There are no conflicts of interest.

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