

# Breastfeeding May Protect from Developing Attention-Deficit/Hyperactivity Disorder

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## Abstract

**Introduction:** Breastfeeding has a positive influence on physical and mental development. Attention-deficit/hyperactivity disorder (ADHD) is a common neurobehavioral disorder with major social, familial, and academic influences. The present study aimed to evaluate whether ADHD is associated with a shorter duration of breastfeeding.

**Subjects and Methods:** In this retrospective matched study, children 6–12 years old diagnosed at Schneider's Children Medical Center (Petach Tikva, Israel) with ADHD between 2008 and 2009 were compared with two control groups. The first one consisted of healthy (no ADHD) siblings of ADHD children; the second control group consisted of children without ADHD who consulted at the otolaryngology clinic. A constructed questionnaire about demographic, medical, and perinatal findings, feeding history during the first year of life, and a validated adult ADHD screening questionnaire were given to both parents of every child in each group.

**Results:** In children later diagnosed as having ADHD, 43% were breastfed at 3 months of age compared with 69% in the siblings group and 73% in the control non-related group ( $p=0.002$ ). By 6 months of age 29% of ADHD children were breastfed compared with 50% in the siblings group and 57% in the control non-related group ( $p=0.011$ ). A stepwise logistic regression that included the variables found to be significant in univariate analysis demonstrated a significant association between ADHD and lack of breastfeeding at 3 months of age, maternal age at birth, male gender, and parental divorce.

**Conclusions:** Children with ADHD were less likely to breastfeed at 3 months and 6 months of age than children in the two control groups. We speculate that breastfeeding may have a protective effect from developing ADHD later in childhood.

## Introduction

**B**REASTMILK IS KNOWN TO HAVE a positive influence on the physical and mental development of the infant. The meta-analysis of Anderson et al.<sup>1</sup> concluded that breastfed infants show better cognitive development than formula-fed infants, an effect that was dependent upon the duration of breastfeeding. There appears to be definite neurological differences between 9-year-old children fed breastmilk or formula milk as babies.<sup>2,3</sup> It is unclear whether particular biochemical characteristics of human milk, the special, intimate infant–mother contact associated with breastfeeding, or both are responsible for these cognitive and neurological differences. However,

Lucas and Morley<sup>4</sup> have shown that the intelligence quotient (IQ) of children who were fed human milk by nasogastric tube was 8 points higher than that of children fed formula by nasogastric tube.

Attention-deficit/hyperactivity disorder (ADHD) is a common neurobehavioral disorder, making up to 30–50% of referrals of children to mental health services.<sup>5–7</sup> It has major influences on social, familial, and academic functioning.<sup>8,9</sup> Although the genetic predisposition to ADHD is indisputable, several modifiable environmental risk factors have been suggested, such as tobacco smoke or alcohol exposure in pregnancy or lead exposure.<sup>10</sup> In one study, the association between breastfeeding and ADHD was examined, and its

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authors concluded that a short duration of breastfeeding may be considered as an environmental factor risk factor of ADHD.<sup>11</sup> This report was limited because it did not examine whether the siblings of ADHD children were breastfed for a longer period and whether the mothers of ADHD children had ADHD themselves (possibly an important factor determining the length of the breastfeeding).

Thus, we conducted the present study in order to evaluate a possible association between breastfeeding and ADHD. Specifically, we tested the hypothesis that children diagnosed with ADHD have a lower prevalence of breastfeeding than their non-ADHD siblings or of a suitable control group of children without ADHD.

## Subjects and Methods

The parents of patients 6–12 years old attending Schneider's Children Medical Center (Petach Tikva, Israel) and diagnosed with ADHD during 2008 and 2009 were recruited consecutively on the days one of the investigators (A.K.) was working. Parents gave their informed consent for answering the study questionnaires. Parents of children with neurologic or psychiatric diagnoses such as epilepsy, mental retardation, central nervous system anomalies, brain traumatic injury, brain infections, chromosomal aberrations, depression, or pervasive developmental disorder were excluded.

Two control groups were selected for the retrospective matched design. The first group consisted of children 6–12 years old who had a sibling diagnosed with ADHD and who were not diagnosed or suspected of having ADHD themselves. This control group supposedly had a similar genetic background and a similar environment as the research group.

The second control group consisted of children 6–12 years old who consulted at the otolaryngology clinic and were not suspected of having ADHD. The study and control groups were planned as 50 patients in each group in this pilot study, in order to enable us to calculate the exact sample size of a larger study, if necessary.

## Questionnaires

Mothers were asked to fill a constructed questionnaire about their educational, psychosocial, and medical status, including relevant pregnancy and perinatal history. For the purpose of the questionnaire, parents were asked if they divorced prior to the diagnosis of ADHD. A validated ADHD screening questionnaire, the Adult ADHD Self-Report Scale (ASRS version 1.1) Symptom Checklist,<sup>12</sup> was used to define whether the mother and the father of each patient in the study group were suspected to have ADHD. For the purpose of this study, parents were classified as having ADHD when they were positive on the screening or if they had been diagnosed with ADHD or treated with methylphenidate.

The feeding history of each child was evaluated and defined as whether the mother breastfed exclusively, whether she breastfed and gave formula, or whether she exclusively gave formula. The feeding status of the infant was determined at the ages of 1 month, 2 months, 3 months, 6 months, and 1 year.

## Statistical methods

Statistical analysis was performed with BMDP statistical software.<sup>13</sup> Continuous variables were compared using analysis of variance. Discrete variables were compared using Pearson's  $\chi^2$  test or Fisher's exact test as appropriate. Non-Gaussian variables were compared using the nonparametric Kruskal–Wallis test or the Mann–Whitney U test. A *p* value of  $\leq 0.05$  was considered significant.

We also conducted a stepwise logistic regression analysis in which ADHD was the dependent variable, and the independent variables were those found to be significant in univariate analysis.

## Results

Table 1 gives the major demographic and clinical characteristics of the parents and children in all three groups. In

TABLE 1. SELECTED DEMOGRAPHIC CHARACTERISTICS OF THE STUDY POPULATION

	ADHD (n=56)	ADHD-SIB (n=52)	ADHD-control (n=51)	All groups	p value	
					ADHD-SIB	ADHD-control
Patient age (years)	10.36 ± 2.41	11.7 ± 3.50	9.5 ± 2.8	0.001	0.0271	0.1034
Male gender	41 (73.2%)	25 (48.1%)	27 (52.9%)	0.019	0.01	0.044
Maternal age at childbirth (years)	30 ± 4.5	28 ± 4.7	28 ± 4.8	0.036	0.034	0.023
Maternal education (years)	13.8 ± 2.5	13.7 ± 2.6	15.53 ± 2.2	<0.001	0.80	<0.001
Number of mothers with ADHD	8 (14.3%)	4 (7.7%)	1 (2%)	0.065	0.36	0.033
Paternal age at childbirth (years)	33.1 ± 5.7	30.6 ± 5.1	30.2 ± 4.9	0.008	0.014	0.014
Paternal education (years)	13.2 ± 2.8	13.2 ± 2.5	15.3 ± 2.5	<0.001	0.93	<0.001
Number of fathers with ADHD	6 (10.7%)	4 (7.7%)	1 (2%)	0.197	0.74	0.12
Number of divorced parents	9 (16.1%)	4 (7.7%)	1 (2%)	0.034	0.24	0.017
Cases of pregnancy-induced diabetes	5 (8.9%)	2 (3.8%)	1 (2%)	0.23	0.44	0.21
Cases of pregnancy-induced hypertension	3 (5%)	0	0	0.06	0.24	0.24
Maternal smoking during pregnancy	7 (12.5%)	3 (5.8%)	2 (3.9%)	0.21	0.32	0.165
Preterm babies	10 (17.9%)	2 (3.8%)	2 (3.9%)	0.043	0.03	0.031
Low birth weight	7 (12.5%)	4 (7.7%)	1 (2%)	0.042	0.53	0.06

ADHD, attention-deficit/hyperactivity disorder; ADHD-SIB, non-ADHD group of siblings of children diagnosed with ADHD; ADHD-control, non-related control group without ADHD.

brief, children in the ADHD group differed from the non-ADHD control groups in terms of patient age (greater in the ADHD siblings,  $p=0.001$ ) and gender (significantly more males in the ADHD group,  $p=0.019$ ), maternal age at childbirth (greater in the ADHD group,  $p=0.036$ ), maternal years of education (greater in the control group,  $p<0.001$ ), paternal age at childbirth (greater in the ADHD group,  $p=0.008$ ), paternal education (greater in the control group,  $p<0.001$ ), and rate of divorce (higher in the ADHD group,  $p=0.034$ ). There were no significant differences among the groups in terms of maternal smoking ( $p=0.21$ ). There were more preterm infants in the ADHD group ( $p=0.043$ ), and a significantly larger proportion of the ADHD children had a low birth weight compared with those in the control groups ( $p=0.042$ ). The difference in rates of maternal ADHD between groups did not reach statistical significance ( $p=0.065$ ).

There were no differences between parents in the ADHD group and in the non-ADHD control group in terms of paternal ADHD, yearly income, and pregnancy complications such as maternal diabetes, and pregnancy-induced hypertension.

At 1 month of age 63% of children later diagnosed as having ADHD were still breastfed (exclusively breastfed or not), whereas 79% of the ADHD siblings were breastfed (exclusively or not), and 86% of the non-related control children were breastfed (exclusively or not). This difference among the three groups was statistically significant ( $p=0.013$ ). At 3 months of age the difference was more pronounced: 43% of the ADHD group were still breastfeeding (exclusively or not) compared with 69% in the siblings group and 73% in the control non-related group ( $p=0.002$ ), with a post hoc calculated power of 86%. By 6 months of age all three groups had a decrease in breastfeeding rates, but the difference among groups was still statistically significant: 29% in ADHD children, 50% in the siblings group, and 57% in the non-related control group ( $p=0.011$ ).

By 1 year of age 13% of the ADHD children were still breastfed, compared with 25% in the siblings group and 33% in the non-related control group. The difference among the groups was still statistically significant ( $p=0.043$ ).

We then conducted a stepwise logistic regression that included the variables found to be significant in univariate analysis. In this analysis we used ADHD as a binary dependent variable (yes/no) with the two control groups combined. The variables found to be significantly associated with ADHD were as follows (Table 2): lack of breastfeeding at 3 months of age, maternal age at birth (for each additional year an increased risk of 10%), male gender, and parental divorce. Area

under the curve of the receiver operating characteristic plot was 0.75.

We repeated the logistic regression after exclusion of all the children whose mothers were suspected of having ADHD, and the results were similar.

## Discussion

In this study, we showed that children with ADHD tend to have a lower rate of breastfeeding at any time during the first year of life and tend to breastfeed for shorter periods than non-ADHD siblings and than a control group of non-related non-ADHD children. Specifically, fewer children in the ADHD group were still breastfeeding beyond 3 months of age compared with the infants in both control groups. However, children in the control groups and the ADHD groups differed significantly in terms of many confounding variables that could by themselves affect the rate of ADHD. For instance, older maternal age, less years of maternal education, and increased divorce rate occurred more frequently in the ADHD group than in the control groups. Although it did not reach statistical significance, smoking during pregnancy may have been influential as well. However, when we examined in logistic regression the impact of longer duration of breastfeeding (>3 months) upon the development of ADHD, breastfeeding remained significant even after taking into account the other abovementioned variables.

To the best of our knowledge, this study is the only one that involved not only a control group distinct and totally independent from the ADHD group, but also a second control group of siblings without ADHD, presumably very close genetically and environmentally from the ADHD patients. Other studies have addressed the issue of breastfeeding duration and cognitive development or ADHD but have not included such a control group of siblings. For instance, Angelsen et al.<sup>14</sup> showed that children breastfed for less than 3 months had an increased risk, compared with children breastfed for at least 6 months, of a test score below the median value of Bayley's Scales of Infant Development (Mental Index) at 13 months and of Wechsler Preschool and Primary Scales of Intelligence at 5 years. In their study, maternal age, maternal intelligence, maternal education, and smoking in pregnancy were significant confounders, but the increased risk of lower Bayley's Scales of Infant Development (Mental Index) and lower total IQ persisted after adjustment for each of these factors.<sup>14</sup> Sacker et al.<sup>15</sup> investigated whether the duration and the exclusivity of breastfeeding affect the likelihood of gross and fine motor delays in infancy. They showed that infants who had never been breastfed were 50% more likely of having gross motor delays than infants who were given some breastmilk for up to 2 months (10.7% compared with 8.4%). The odds ratio for gross motor delay was still present even after adjustment for specific biological, socioeconomic, or psychosocial factors. Infants who were never breastfed had at least a 40% greater likelihood of fine motor delay than infants who were given breastmilk for a prolonged period.<sup>15</sup> Wigg et al.<sup>16</sup> found a small statistically non-significant beneficial effect of breastfeeding on cognitive functioning at 2, 4, 7, 11, and 13 years. Paine et al.<sup>17</sup> demonstrated that the duration of breastfeeding significantly predicted mental developmental scores at 1 year of age for boys but not for girls. Quigley et al.<sup>18</sup> examined a cohort of

TABLE 2. RESULTS OF LOGISTIC REGRESSION ANALYSIS SHOWING THOSE VARIABLES SIGNIFICANTLY ASSOCIATED WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

	<i>Adjusted odds ratio</i>	<i>Confidence interval</i>	<i>p value</i>
Lack of breastfeeding at 3 months	3.08	1.46–6.50	0.001
Maternal age at birth	1.10	1.02–1.20	0.009
Male gender	2.49	1.15–5.40	0.014
Parental divorce	3.78	1.0–15.20	0.049

children 5 years old in the United Kingdom and showed that breastfeeding is associated with improved cognitive development, particularly in children born preterm.

Julvez et al.<sup>19</sup> demonstrated that long-term breastfeeding (>12–20 weeks) was associated with increased executive function scores, improvement of social competence scores, and attention deficit hyperactivity symptom scores. All three outcomes remained significant when included as covariates in the regression. Once again, the study of Julvez et al.<sup>19</sup> did not include a sibling control group.

A major limitation of our study is its retrospective design. Indeed, like in every retrospective study, there is the risk of faulty recollection, which may add some uncertainty in the exact duration of breastfeeding. Moreover, there is the risk that parents of children with ADHD asked upon breastfeeding may understand the goal of the questionnaire and might provide inaccurate information. If this were true, we would, however, expect an overestimate of the breastfeeding duration in the ADHD group.

Another limitation is that the diagnosis of no-ADHD in the patients in the control groups, as well as the diagnosis or not of ADHD in the parents, was based upon screening questionnaires and not a full, standard clinical evaluation.

Finally, the major limitation of our study resides in issues related to causality. Indeed, a shorter duration of breastfeeding in the ADHD group might be the result, rather than the cause, of ADHD. Whether feeding behavior at the breast of a child who is about to develop ADHD leads to premature weaning is an important question that our retrospective, uncontrolled design cannot answer. A “perfect” study that would aim to prove a causal relationship between breastfeeding duration and ADHD might involve a randomized clinical trial of short versus long duration of breastfeeding in infants with a strong genetic background of ADHD. Such a prospective design would not possibly be blinded and would certainly be unconceivable from an ethical standpoint.

Even if the issue of causality would be possible to study, there would still be many unanswered questions at the basic science level. It is indeed unclear whether a specific component of human milk, for instance, long-chain polyunsaturated fatty acids,<sup>20,21</sup> hormones, or neurotransmitters,<sup>22</sup> or the special mother–infant relationship involved with breastfeeding is responsible for the protective effect of breastfeeding. There are many other possible aspects by which breastfeeding might be influential. For instance, the sensory experience of a human milk-fed infant is very rich compared with that of a formula-fed infant. Indeed, human milk varies considerably in taste, smell, and composition depending upon the time of the day<sup>23</sup> and maternal food habits<sup>24</sup> and even varies from the beginning to the end of a same feed.<sup>23</sup> In contrast, the sensory stimulation of a formula-fed infant is apparently very “boring” in that industrial formula production is expected to produce formulas of very similar tastes, consistency, and smells, from one batch to another one.

We conclude that 6–12-year-old children with ADHD are more likely to have breastfed less frequently and for a shorter period than their non-ADHD siblings and than a control group of non-related non-ADHD children. Whether the lesser exposure to breastfeeding in ADHD children is causally associated with ADHD or, on the contrary, a consequence of early abnormalities of feeding behavior at the breast cannot be determined from the current study. We speculate that pre-

vention, at least partial, of ADHD may be added to the list of the multiple biological advantages of human milk feeding.

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### Disclosure Statement

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