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The Relationship between Exclusive Breastfeeding and Mental Concentration in First and Second Grade Primary School Children of Mashhad

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ABSTRACT

Background: Breastfeeding has long-term benefits, such as reducing obesity, allergies, asthma, wheezing, inflammatory bowel disease, diabetes, cardiovascular disease and effecting on brain development. This study aimed to investigate the relationship between exclusive breastfeeding and mental concentration in first and second grade primary school children. **Methods:** In this cross-sectional study, 90 students (7-8 years old) were studied in Mashhad, Iran. The history and duration of breastfeeding were asked from children's mothers, and their mental concentration and short term memory were measured by Toulouse Pieron and Digit learning tests, respectively. **Results:** The mean of the breastfeeding period was 5.72 ± 6.89 month and the mean of total scores was 51.2 ± 32.44 for Toulouse Pieron test and 8.57 ± 6.52 for Digit learning test in all participants. The correlation between the Toulouse Pieron and Digit learning test, and breastfeeding history indicated that exclusive breast-fed children showed higher test results and therefore, better mental concentration and short term memory ($P < 0.001$). **Conclusion:** Based on the findings, exclusive breastfeeding has a positive effect on mental concentration and short term memory with respect to its duration.

Keywords: *Breastfeeding; Mental concentration; Short term memory*

Introduction

Breast milk is considered a golden standard for feeding infants and breastfeeding is recommended as a natural way to support the growth and development of the infant's health (Shamir, 2016). Despite World Health Organization (WHO) suggestions, the rate of exclusive breastfeeding in Iran at the national level was 56.8% and 27.7% in four and six months infants respectively (Olang *et al.*, 2009) and only 46.5% of exclusive breastfeeding during the first 6 months of life was observed in Tehran (Noughabi *et al.*, 2014). Breastfeeding has clear short-term benefits on child survival by reducing mortality from infectious diseases. Furthermore, it has long-term benefits, such as reducing obesity, allergies, asthma, wheezing, inflammatory bowel disease, diabetes, cardiovascular disease and effecting on brain development (Victora *et al.*,

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2015). A proposed mechanism for the effect of breastfeeding on brain development is related to the specific nutrients in breast milk that exists in small quantities in infant formulas. Brain and nervous system development affect many factors including intelligence, cognitive and behavioral functions, as well as mental concentration and a lot of learning skills (Belfort *et al.*, 2016).

Most observational studies reported that breastfeeding in children is in relation with higher IQ scores,; furthermore, the relationship between dose-response breastfeeding duration was observed in low birth weight infants (Holme *et al.*, 2010). Various studies indicated that breastfeeding is associated with advanced neurodevelopmental and cognitional tests in future (Smith *et al.*, 2003). These surveys are often questioned due to other factors associated with mothers' choice of breastfeeding (e.g. higher socioeconomic status and level of education, different child-rearing attitudes) which might improve cognitive development (Angelsen *et al.*, 2001, Der *et al.*, 2006, Mortensen *et al.*, 2002). Accordingly, the relationship between breastfeeding and some various aspects of mental development in children have been surveyed in many studies. However, this field has not been studied in Iran; therefore, it was decided to assess the effect of breastfeeding on mental concentration and short term memory.

Materials and Methods

Participants and data collection: This cross-sectional study was conducted in Mashhad city in 2016. The research population included first and second-grade elementary children. Students were participated in this study based on their desire and all them were asked to eat breakfast before the test. Exclusion criteria included: 1. History of mental illness in the family 2. Children with mental or acute infectious diseases.

Data collection lasted for three months, which included two parts: 1) Telephone interview with mothers: were their children used to eat breakfast? and for how long? 2) Taking mental concentration test (Toulouse Pieron test) and Digit learning test from children.

The calculation of the sample size conducted based on the Smith study (Smith *et al.*, 2003). 20% was considered for missing data and $\alpha = 0.05$ and 80% power of tests; furthermore, a sample size of 88 was reached. First, based on information obtained from the interview with mothers, between 81 breast-fed children and 64 formula-fed children that had our inclusion criteria, 45 cases were selected randomly in each group (totally 90 participants). Each test described by a trained technician for children in the same way and they were asked to do testing within a specified time.

Toulouse pieron test: This test consists of three phases: training for 3 minutes, resting for 2 minutes and testing phase for 3 minutes, participants were asked to start from the left top of the page, move forward line by line and cross out the squares in each row that are similar to the top patterns. We considered 1 positive point for each right and zero points and a crossed square for each missing or wrong points

Digit learning test: In this test, 6 numerical sequences contain three 8-digit sequences and three 9-digit sequences were used. Each of sequences were read for the participant and he/she was asked to repeat it immediately. We considered zero points for a wrong answer, 1 point for close to the right answer (maximum 2 wrong answers) and 2 for an absolutely correct answer.

Data analysis: The Statistical Package for Social Sciences (SPSS), version 24, (SPSS Inc., Chicago, IL, USA) was used for data analysis. Descriptive statistics (frequency, mean and standard deviation) were carried out to describe demographic data. Categorical variables were reported through frequencies (percentages) and continuous variables were presented as a mean (SD). For inferential statistical methods, Pearson correlation coefficient, independent *t-test*, and a multivariate regression model were conducted. The significancy level was P-value less than 0.05.

Ethical considerations: All participating parents provided informed consent after knowing the purpose of the study. The approval of this research was obtained from the research committee of the

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Iran University of Medical Sciences (IR.IUMS.REC 1395.95-04-193-2952).

Results

Through 90 participants, 50% of which were female. The average of the breastfeeding period was 5.72 ± 6.89 month, (range: 0 - 24) and also 51.1% of the participants were breast-fed. The mean of total scores was 51.2 ± 32.44 for Toulouse Pieron test and 8.57 ± 6.52 for Digit learning test in all participants. In order to compare the Toulouse Pieron test and Digit learning test through the breast-fed and formula-fed children and also between boys and girls, normality assumption has been checked and results have been reported in **Table 1**. The total score difference of the Toulouse Pieron test and Digit learning test in breast-fed group and the formula-fed group was 32.72 and 5.96, respectively and also independent t-test results showed significant differences between both tests score based on breastfeeding status of participants ($P < 0.001$). Evaluating the correlation between tests (Toulouse Pieron test and Digit learning test) and breastfeeding period indicated that there was a strong significant correlation between them ($P < 0.001$) and correlation coefficients were 0.48 and 0.44, respectively.

In order to assess the effect of breastfeeding duration and also participants' gender on both tests, multivariate regression model had been performed. The results showed that the duration of breastfeeding had a significant effect on the Toulouse Pieron mean and Digit learning tests ($P < 0.001$ for both). Furthermore, the Toulouse Pieron test mean score for boys was 14.73 more than girls in average. ($P = 0.019$). (**Table 2**)

Table 1. Comparison of mean ± standard deviations Toulouse Pieron test and Digit learning test total score based on sex and breastfeeding status

Tests	Sex		P-value	Breastfeeding		P-value[a]
	Girls (N = 45)	Boys (N = 45)		Yes (N = 45)	No (N = 45)	
Toulouse Pieron	44.44 ± 29.11	57.96 ± 34.46	0.04	67.20 ± 34.31	34.48 ± 19.65	< 0.001
Digit learning	9.02 ± 6.15	8.11 ± 6.90	0.51	11.48 ± 6.12	5.52 ± 5.50	< 0.001

[a]: independent *t-test*

Table 2. Multivariate Regression Model

Tests		β (SE)	95% CI for β	P-value
Toulouse Pieron	Gender(Boys)	14.73 (6.17)	2.46 – 26.99	0.019
	Duration	1.89 (0.45)	1.00 – 2.79	< 0.001
Digit learning	Gender(Boys)	-0.679 (1.28)	-3.23 – 1.87	0.598
	Duration	0.360 (0.094)	0.174 – 0.546	< 0.001

Discussion

The current study was the first analysis of mental concentration in Iran which aimed to assess the relationship between exclusive breastfeeding in infancy and long-term cognitive benefits in first and second-grade elementary school children. It was found that there is a positive significant relationship between the tests (Toulouse Pieron and Digit learning tests), and breastfeeding; In fact, breast-fed children had higher mental concentration and better digit learning score; furthermore, increasing the duration of breastfeeding was significantly accompanied by a gradual increase in Toulouse Pieron and Digit

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learning test score. The results support the evidence that breast-feeding is accompanied by more rapid or better development of neurologic function and psychological development. Human breast milk provides long-chain polyunsaturated fatty acids such as docosahexaenoic acid (DHA; 22:6n23) and arachidonic acid (AA; 20:4n26), whereas formulas do not provide, or provide little amounts of DHA or AA. Structural lipid forms 60% of the human brain, and DHA and AA are major lipid components (Anderson *et al.*, 1999, Crawford *et al.*, 1993, Farguharson J *et al.*, 1995). Meanwhile, previous studies show that DHA content of infants' brain cortex also increases significantly with duration of breast-feeding (Makrides *et al.*, 1994). Furthermore, breastfeeding may be an indicator of a safe and sound maternal attachment status, which has been shown to have a positive influence on the child's psychological development into later ages (Jansen *et al.*, 2008, Meedya *et al.*, 2010, Morley *et al.*, 1988). The amount of mutual touch, physical stimulation, and mother's gaze to the infant are significantly elevated during breastfeeding compared with bottle-feeding (Jedrychowski *et al.*, 2012).

The results are completely different from Der, et al. study (Hall, 2015) who concluded that breast-feeding has little or no effect on child's intelligence. However, this study only considered two broad categories of children who were and were not breastfed, and children who were breast-fed received lower amounts of breast milk than exclusively breast-fed children.

Most studies have suggested that the relationship between breast-feeding and cognitive development is influenced by confounders such as sex, maternal smoking history, maternal age, maternal intelligence, maternal education, maternal training, paternal education, race or ethnicity, socioeconomic status, family size, birth order, birth weight, gestational age, and childhood experiences, none of which were controlled in the present study (Girard *et al.*, 2017). In fully adjusted analyses, the advantage of breast-feeding was small and not significant (Der *et al.*, 2006).

One of the strengths of this study is that, based on authors' knowledge, it has been conducted for the first time in Iran. Adjusting the results for sex and duration of breastfeeding is another strength which helps to seek for the effect of exclusive breastfeeding on children's concentration.

The cross-sectional design of the study was one of limitations that have to be mentioned. Missing many confounders to adjust such as sex, maternal smoking history, maternal age, maternal intelligence, maternal education, maternal training, paternal education, race or ethnicity, socioeconomic status, family size, birth order, birth weight, gestational age, and childhood experiences, is another weakness of the study.

Conclusion

In summary, this study and other similar studies provide evidence that exclusive breast-feeding in the initial period of infancy brings about beneficial effects on the cognitive development of children and longer duration of breast-feeding could be even more beneficial. Yet, strong confounders such as maternal intelligence must be adequately adjusted to be able to observe the effect of exclusive breast-feeding itself on cognitive function of children. These findings can motivate mothers to breastfeed their children.

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Authors' contribution

Bahrami L conducted the study and wrote the manuscript, Sajadi Z designed the paper, Tanha K analyzed the data; all authors read and approved the final manuscript.

Conflict of Interest

The authors declare that they don't have any conflict of interest.

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