Paediatrica Indonesiana

VOLUME 48 September • 2008 NUMBER 5

Original Article

Cognitive development in babies with exclusive breastfeeding using Mullen Scale test

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Abstract

Background Breast milk is the best nutrition for babies' growth and development. There are many reasons for discontinuation of exclusive breastfeeding (BF).

Objective To evaluate the impact of exclusive breastfeeding on babies' cognitive development.

Methods A cohort study was conducted for full term newborn babies. They were evaluated for cognitive development using Mullen scale test at of 6 and 9 months; *t* test was used to obtain mean difference of cognitive values. Logistic regression analysis was performed to distinguish factors associated with the cognitive development.

Results One hundred and forty babies were enrolled to this study (70 babies with exclusive BF and 70 babies with non-exclusive BF). There were 34 boys (49%) in exclusive and 37 boys (53%) in non-exclusive BF group. Mean cognitive score at age six months was 1.41 points higher for exclusive BF group, mean rate 174.31 (SD 4.89) and 172.90 (SD 4.19) for exclusive and non-exclusive BF, respectively. Mean cognitive score at nine months was 1.49 point higher in exclusive BF group with mean rate 175.28 (SD 4.39) and 173.82 (SD 3.80) for exclusive and non-exclusive BF respectively. Logistic regression analysis showed that exclusively breastfed babies had higher mean Mullen cognitive score of 4.761 (95% CI 1.341; 16.907) and 4.431 (95% CI 1.313; 14.949) times at sixth and ninth month respectively than non-exclusive BF.

Conclusion Exclusively breastfed babies may have higher mean score of Mullen cognitive score at sixth and ninth months when compared with those who are non exclusively breastfed. **[Paediatr Indones 2008;48:278-83]**.

Keywords: *cognitive, Mullen test, breastfeeding*

Breastfeeding (BF) is the primary food for babies, which is natural and specific for babies to fulfill their growth and development needs.[1-4] In the United States in 2001, National Immunization Survey found that there were 65.1% mothers who breastfeed after delivering their babies in the hospital. Among them, only 27.0% that continued to breastfeed exclusively for six months and only 12.3% that continued to breastfeed until one year.[5] In Australia the total average of babies who had breastfeeding exclusively until six months was 18.6%.[6.] In Indonesia, according to Indonesian Health Demographic Survey (Survey Demografi Kesehatan Indonesia) in 1997, 96.3% babies were breastfed, but only 52% babies were exclusively breastfed at 0–4 months, while exclusive breastfeed duration average was 1.7 months.[7] Survey at outpatient Clinic Department of Child Health, Medical School, Udayana University, Sanglah Hospital, Denpasar, Bali found that there were 80% mothers who breastfeed but only

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for 48% mothers exclusively breastfed.[8] Studies on the benefits of breast milk in comparison to formula milk with cognitive development showed variations between children age.[9-12] On full term babies, long follow-up study by Horwood and Ferguson,[11] found that there were significant differences on children of 10–13 years of age in their intelligence quotient (IQ). Meta analysis by Anderson *et al*[10] found that babies with exclusive breastfeeding had 2.66 points higher for cognitive score compared with babies with formula.

This study aimed to find out whether babies with exclusive breast feeding had higher cognitive development compared to those with non-exclusive breast feeding.

Methods

This study was conducted from August 1st, 2003 to September 30th, 2004. Subjects were all babies who were born at *Balai Kesehatan Ibu dan Anak (BKIA)* Pekambingan outpatient clinic, Dauh Puri, West Denpasar Primary Health Care. Inclusion criteria were full term baby (37–42 gestational weeks), birth weight of 2500–4000 grams, and born at *Balai Kesehatan Ibu dan Anak (BKIA)* Pekambingan outpatient clinic, Dauh Puri, West Denpasar. Exclusion criteria were baby with severe congenital anomaly, severe asphyxia, hearing defect, and vision defect. Reason for dropping-out were sepsis, brain infection (meningitis, encephalitis, brain abscess), non-

Tabel 1. Baselines characteristics of study subjects

	Exclusive BF (n=70)	Non-exclusive BF (n=70)
Sex, (%)		
Male	34 (48)	37 (52)
Female	36 (51)	33 (47)
Mother education (%)		
Low	8 (11)	5 (7)
Moderate	42 (60)	32 (45)
High	20 (28)	33 (47.1)
Father education (%)		
Low	0	1 (1)
Moderate	22 (31)	29 (41)
High	48 (68)	40 (57)
Mother occupational (%)		
Housewife	51 (72)	11 (15)
Government employee	14 (20)	12 (17)
Public employee	5 (7)	47 (67)
Father occupational (%)		
Jobless	4 (5)	3 (4.3)
Government employee	31 (44)	28 (40)
Public employee	35 (50)	39 (55.7)
Parity (%)		
Primipara	19 (27)	40 (57)
Multipara	20 (28)	19 (27)
Grandemultipara	31 (44)	11 (15)
Birth weight, mean (SD) grams	3139.3 (0.38)	3219.3 (0.36)
Sixth month body weight, mean (SD) grams	7454 (0.58)	7374 (0.47)
Ninth month body weight, mean (SD) grams	8413 (0.49)	8311 (0.40)
Head circumference, mean (SD) cm	34.6 (1.01)	34.8 (0.81)
Six month head circumference, mean (SD) cm	41.9 (1.63)	41.9 (1.32)
Nine month head circumference, mean (SD) cm	44.8(1.26)	44.6(1.21)

infection brain anomaly (brain tumor, epilepsy, long seizure, intracranial hemorrhage), hyperbilirubinemia, chronic disease (chronic diarrhea, tuberculosis, etc), and refusal to join study.

Sample size was calculated to obtain 80% power and 5% significance level ($P<0.05$) and 1.5 clinical differences. There were 70 babies for each group, exclusive and non-exclusive breastfeeding babies. Babies who had formula milk since birth were categorized as non-exclusive breastfeeding babies, and follow up measurement was performed every month at *Balai Kesehatan Ibu dan Anak (BKIA)* Pekambingan outpatient clinic. Babies who just had breast milk since birth and continued to be given breast milk every month during follow up until four months of age defined as exclusive breast feeding babies. Author was blind about babies status, whether exclusive or non-exclusive breastfed during study period.

Mullen cognitive development test was measured as primary outcomes at six and nine months old during follow up at clinic and parents were contacted to have appointment time at clinic. If parents did not come on the appointment time, author conducted home visitation seven days after the appointment time. If baby was ill at follow-up time, follow-up will be continued until day 7. Measurement performed using The Mullen Scales of Early Learning, American Guidance Service (AGS) Edition. Secondary outcome was measured based on five categories: gross motor development, fine motor development, expressive language, receptive language, and visual reception. Babies were then grouped into age group and row score found for each category and adjusted for age. Raw score then converted into C3 table to get cognitive T score.

Data were presented as mean and proportion for each study group. Independent *t* test was applied in order to determine independent and dependent variable association. General linear model analysis was performed to determine cognitive development for both groups at six and nine months. Relation between independent variable (numerical and nominal) with dependent variable (nominal dichotomous) was determined using multiple logistic regression

On multivariate logistic regression analysis, we changed cognitive score to dichotomous variables such as upper mean score and lower mean score. P score and confidence interval was obtained for each statistic. Statistical significance was set at $P<0.05$. Intention to treat analysis was performed when drop out subjects were more than 20%.

Results

During the study period, there were 176 babies born, and only 140 were enrolled in the study. Thirty-six babies were excluded because of asphyxia (21), congenital anomaly (2), low birth weight (4), and parents refused to join study (9). After consecutive sample collection, we allocated 70 babies for each group.

During six months follow up, there were no drop outs, while during nine months follow-up 3 and 6 babies dropped out from exclusive and non-exclusive groups, respectively. From exclusive breast feeding group, drop-out occurred due to their parents moved to another region. Drop out in non exclusive breast feeding was caused by their parents moved to another region (4); having febrile seizure (1); having intracranial hemorrhage (1) (**Figure 1**). **Table 1** showed subjects' characteristics for each group.

Cognitive score at six months inn exclusive breast feeding group was 174.31 and in non-exclusive breast feeding group was 172.9 ($P=0.11$). The same results were also found at nine months of age; the cognitive score in exclusive and in non-exclusive breast feeding was 175.28 and 173.82 respectively, ($P=0.07$) (**Table 2**).

On multivariate logistic regression analysis (**Table 3**), we found that the babies who had exclusive BF probably had higher mean score of Mullen cognitive score 4.761 (95% CI 1.341 to 16.907) and 4.431 (95% CI 1.313 to 14.949) times at six and nine months old respectively rather than non exclusive BF.

Discussion

Child cognitive development is influenced by genetic and environmental factors. The child has a genetically determined potential for cognitive development. However environmental factors, such as adequate nutrition and the parents' ability to create a good and stimulating home environment may also have a positive influence on the child's cognitive development.[2-4]

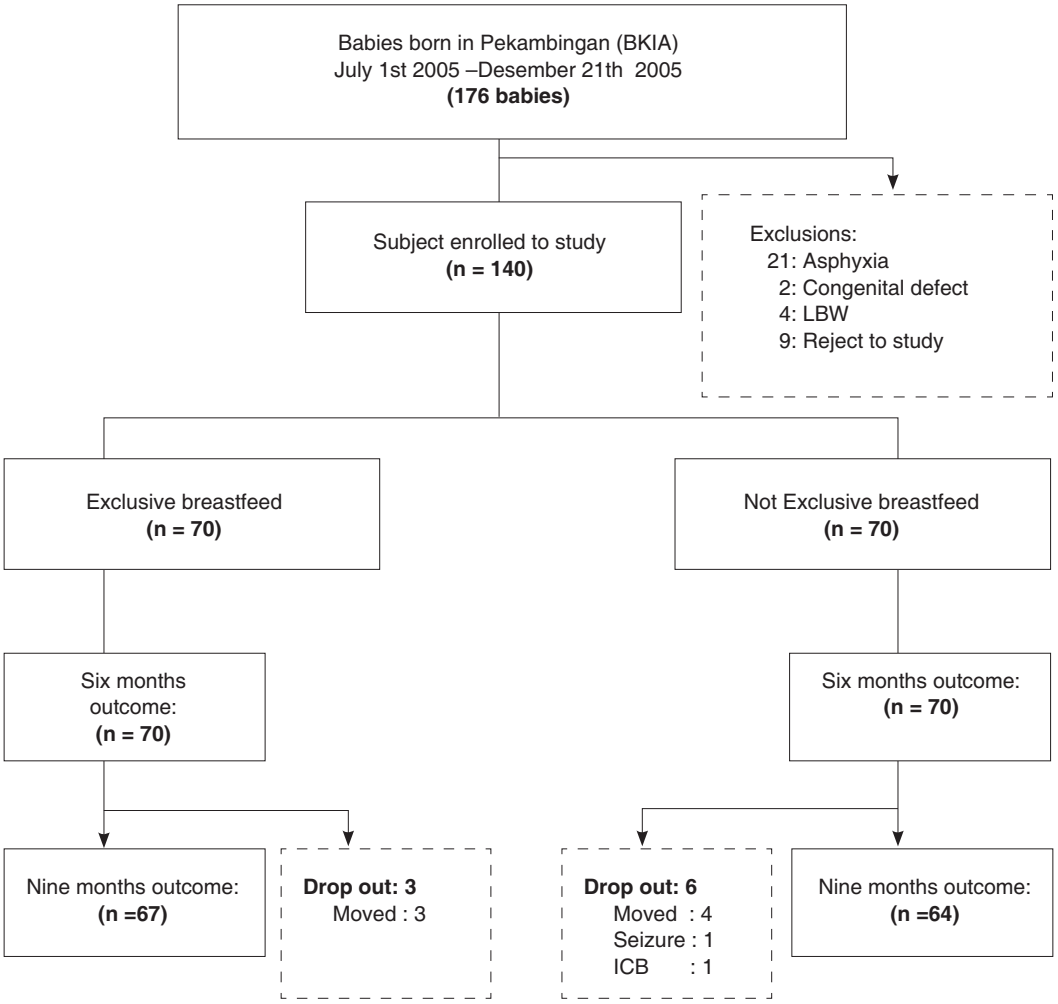

Figure 1. Diagram of study flow

Table 2. T score description from Mullen Test

	Group		P	95% CI
	Exclusive BF	Non-excl BF		
Sixth months	(n = 70)	(n =70)		
Gross motor	42.30 (2.39)	41.69 (3.34)	0.21	-0.36 to 1.59
Fine motor	40.51 (1.98)	40.09 (1.61)	0.16	-0.17 to 1.03
Visual reception	45.40 (2.89)	44.57 (2.31)	0.06	-0.05 to 1.70
Receptive language	45.20 (2.91)	44.90 (2.36)	0.50	-0.58 to 1.19
Expressive language	43.20 (2.41)	43.34 (2.99)	0.76	-1.05 to 0.77
Ninth months	(n = 67)	(n = 64)		
Gross motor	42.75 (2.70)	42.36 (2.94)	0.44	-0.63 to 1.29
Fine motor	43,84 (2,84)	43.61 (2.86)	0.65	-0.69 to 1.26
Visual reception	44.33 (2.58)	43.72 (1.96)	0.13	-0.07 to 1.75
Receptive language	43.07 (2.54)	43.22 (2.43)	0.74	-0.92 to 0.77
Expressive language	43.60 (2.22)	43.55 (2.38)	0.90	-0.65 to 0.93

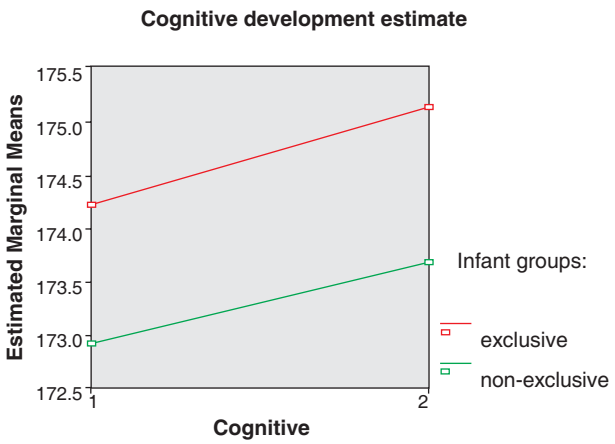

Figure 2. Mullen's cognitive score development estimation on sixth and ninth month

The actual mechanisms of improved cognitive development with breastfeeding remain unknown; however, breast milk contains a complex array of nutrients, tropics factors, and other bioactive ingredients. Docosahexaenoic acid is found abundant in human milk and rapidly incorporated into the central nervous system during the first three months of life. Milk levels of Choline and possibly Taurine may have an effect, as may numerous other peptides and oligosaccharide components. The act of BF may also favor infant's intellectual development through increased mother-infant positive interaction resulting in better long-term relationships. BF is also thought to elicit beneficial hormonal responses in mothers, reducing stress and depression and resulting in improved care quality.[3,4]

In this study, we found that mean cognitive scores were higher for exclusive breastfeeding babies, 1.41 point higher at six months of age and 1.49 point higher at nine months of age (Table 1 and Figure 1). Similar result was also found by Anderson *et al*[10] that showed that full term babies with exclusive breastfeeding for four months had 2.66 points higher cognitive development score. John Horwood and Ferguson[11] showed significant Intelligence Quotient (IQ) differences on their long follow up study that performed until 10 – 13 years of age. They also found that reading capability was also significantly higher for exclusive breastfeeding group.

Nancy *et al*[13] performed study that compared full term babies who were given breast milk, formula, and ARA and DHA supplementation. She also showed that there were differences on IQ, receptive and expressive language, motor function, and visual function after 39 months of age evaluation. But in this study, on exclusive breastfeeding group, Mullen cognitive score was higher, but this was not statistically significant. Mean rate differences were 1.44 and 1.49 with P = 0.11 and P= 0.07 at age six and nine months.

We evaluated cognitive development score at six and nine months of age due to limited time only. We performed six month of age evaluation associated to brain development acceleration and nine month of age due to measles immunization, so it will be easier to meet them.

On logistic regression multivariate analysis we found the babies who were exclusive BF probably have higher mean score of Mullen cognitive score 4.761 (95% CI 1.341; 16.907) and 4.431 (95% CI 1.313; 14.949) times at sixth and ninth month respectively

Table 3. Multivariate analysis for factors that associated to cognitive development on sixth and ninth month

	Sixth month				Ninth month			
	B	P	Exp(B)	95% CI	B	P	Exp(B)	95% CI
Intercept	-1.364	0.233			-2.026	0.074		
Mother education	-1.510	0.201	0.221	0.022 to 2.232	0.613	0.432	1.847	0.400 to 8.521
Mother occupation	0.415	0.518	1.515	0.430 to 5.336	0.628	0.315	1.874	0.550 to 6.387
Parity	0.688	0.248	1.989	0.619 to 6.395	0.209	0.718	1.233	0.396 to 3.839
Group BF	1.560	0.072	4.761	1.341 to16.907	1.489	0.066	4.431	1.313 to 14.949

P= significant level, Exp (B) = Odd Ratio, CI = Confident Interval

rather than non exclusive BF. Similar study by Gomez and Sanchiz *et al*[14] found that the mental development index were 4.6 points higher in babies who were breastfed for longer than 4 months than in those with less breast-fed period.

Limitations on this study include short time follow up, grouping, and other factors like stimulation that were given to babies, raising pattern, and anemia, genetic and other factors that were not evaluated in this study. It will be necessary to improve study design in the future, so exclusive breastfeeding impact on babies' cognitive development is better understood.

We concluded that babies who were exclusively breastfed tended to have higher mean score of Mullen cognitive score at six and nine months of age than those who were non-exclusively breakfast.

Acknowledgments

We indebted to I Gde Raka Widiana, MD and IB Subanada, MD for their help in constructing methodology and statistical analysis in this study.

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