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The Effect of Breastfeeding on the Cognitive and Language Development of Children Under 3 Years of Age: Results of ‘Balochistan-Early Childhood Development Project’

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Abstract

Background: Breastfeeding is known to be an important factor in the overall growth and development of children. Breastfeeding is thought to lead to enhance cognitive and language development of a child. However, this association has not yet been scientifically and statistically established. This study aimed to explore this association in children under 3 years of age.

Methods: This was a secondary data-analysis of the baseline data of “Balochistan – Early Childhood Development Project”. The final sample comprised of 604 children less than 3 years of age. The children were selected by three-stage stratified random sampling from three districts of Balochistan province; Gwadar, Quetta and Qilla Saifullah. The data for the duration of breastfeeding was categorized as less than 6 months, from 6 months to 12 months and greater than 12 months. The age appropriate language and cognitive development of children was assessed through the CDA (Care for development Appraisal) tool. We applied multivariate logistic regression model for the analysis.

Results: In unadjusted analysis, children breastfed for more than 12 months were at an advantage for cognitive and language development (cOR=2.91, cOR=2.8; $p<0.05$; respectively). After adjusting for a range of co-variables this developmental advantage decreased to aOR=2.42 for cognition and aOR=2.44 for language respectively ($p<0.05$).

Conclusions: The duration for which the child is breast-fed is integral for his language and cognitive development. Based on our findings we recommend that breastfeeding should be promoted for more than 12 months to bring out the maximum benefit in the language and cognitive development of a child.

Keywords: Feeding breast; Cognitive function; Language developments

Background

Breastfeeding for long has been known to have a beneficial effect on the overall growth and development of children [1]. The effect of breastfeeding on the cognitive and language development of children has been widely studied. However, we still lack conclusive evidence to the actual benefit, if any, on these domains of child development. Some studies give an encouraging effect of breastfeeding whereas others point out that the positive impact is solely due to the effect of confounding factors.

According to the work by James et al. [2] breast-feeding was associated with significantly higher scores for cognitive development in children even after adjustment for appropriate key cofactors. His findings were contradicted by Asnat et al. [3] he found that much of the reported effect of breastfeeding on child neurodevelopment was due to confounding; maternal intelligence and socio-economic status being the noteworthy of the list.

As compared to cognitive development, little work has been done to see the link between breastfeeding and language development of children. Vasiliki et al. [4] pointed out that longer duration of breast feeding was associated with increased scores in cognitive, language and motor development at 18 months of age, independently from a wide range of parental and infant characteristics.

The notion of exclusive breastfeeding has been promoted for the last two decades. Most of the studies recommend exclusive breastfeeding for six months for optimal growth of the child [5]. However, there is dearth of data regarding the dose-response relationship of breastfeeding with cognitive and language development of children. Thus, we sought to investigate the effect of increasing the duration of breastfeeding on the language and cognitive development of children less than 3 years of age.

Methods

Sampling

This paper uses cross-sectional data collected from 604 children participating in the baseline survey of “Baluchistan-Early Childhood

Development Project”, a quasi-experimental study [6]. This study was initiated to enhance the access, equity and quality of education in class Katchi, one and two of 75 government primary schools in three districts; Gwadar, Quetta and Qilla Saifullah; of Baluchistan province. The sample was selected through three stage stratified random sampling. In the first stage, number of children studying in nearest project focus schools to FRC (Family Resource Centre) was found in each district. In the second stage, selected households in the FRC catchment areas were visited and in the third stage, family having a 0-8 year old child was selected. All stages of the project were subject to rigorous ethical review by the Ethical Review Committee of Aga Khan University. The details of the parent study are mentioned elsewhere [6].

Statistical methods

Ideally, the causal effect of breastfeeding on the cognitive and language development of children would be assessed by a randomized control trial. Research ethics does not allow such randomization in which one group of children does not get breastfeeding, thus we are forced to use observational methods and statistical analysis to identify the effect of breastfeeding on outcome- language and cognitive development. We controlled for a large range of potentially confounding factors drawn from the “Balochistan – Early Childhood Development Project”. Chi-square and Independent sample t- test were applied for initial analysis. Uni-variate logistic regression was done to assess the effect of independent factors on outcomes. All variables with p-value<0.25 were taken for the multivariate analysis. Multicollinearity was checked between the independent variables through Pearson and Spearman correlation. For none of the variables the correlation coefficient was beyond 50%. The adjusted odds ratios were calculated in the multivariate regression by selecting the model with the smallest value of -2 log likelihood. The analysis was done using SPSS version 22 (Figure 1).

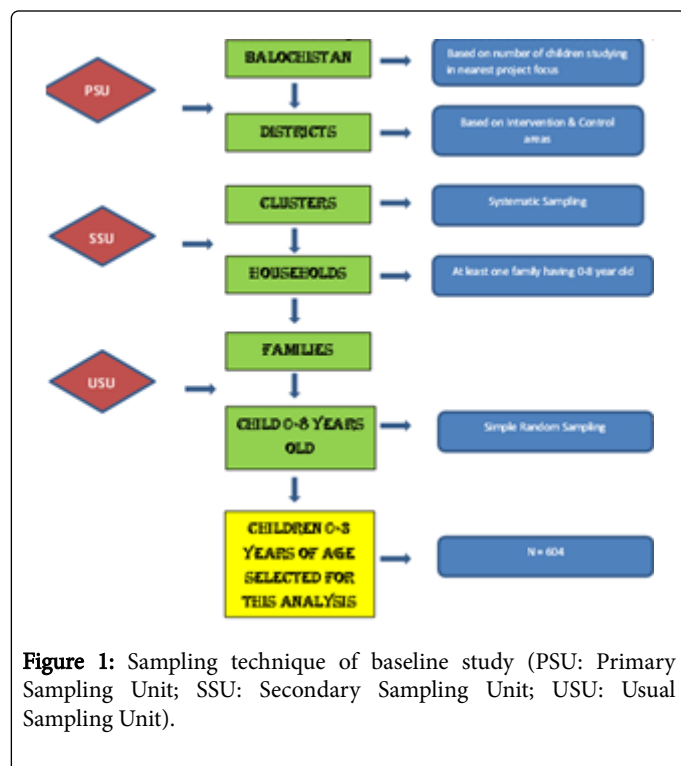


Figure 1: Sampling technique of baseline study (PSU: Primary Sampling Unit; SSU: Secondary Sampling Unit; USU: Usual Sampling Unit).

Measures

Breastfeeding measure

Information regarding the breastfeeding initiation and duration of exposure was obtained retrospectively from the child's mother. The mother was asked whether the study child was ever breastfed and the duration of exposure to breastfeeding was recorded in months and weeks. The duration of breastfeeding was treated as a categorical variable i-e breastfeeding duration less than 6 months, breastfeeding duration greater than 6 and less than 12 months and lastly breastfeeding duration greater than 12 months. The reason for this categorization was to determine the cut-off level of the duration of breastfeeding which leads to improvement in cognition and language.

Language and cognitive outcome measure

To measure the language and cognitive development of children, CDA (Care for Development Appraisal) tool was applied. It assesses the development of children in five domains; gross motor, fine motor, language, cognitive and social-emotional development [7]. For each domain it assesses whether or not age appropriate indicator for the child has been achieved. Thus it gave a binary outcome for the cognitive and language development of children.

Co-variables

Parenteral nurturance is considered an important factor in a child's developmental trajectory. We used the HOME (Home Observation for Measurement of the Environment) inventory to assess the quality and quantity of support and stimulation provided for children at home [8]. The HOME scale is further distributed over six subscales. Each subscale has a set of questions with a binary outcome. No cut-off points are specified in the HOME manual and the scores falling into the lowest quarter, middle half and upper quarter are reported. High scores, falling in the upper quarter category, indicate a safer and stimulating home environment for healthy child development whereas home scores falling into the lowest quarter are considered as a risk for development [8]. Frequency distributions of all responses and mean and standard deviation for all subscales were calculated. Each sub-scale was adjusted for the multivariate regression. We also included the monthly income of the family, the type of construction of the house and house ownership as proxy indicators for capturing the socio-economic status of the participants. The data for joint vs. nuclear family was also taken as it was our hypothesis that children living in joint families receive more stimulation as compared to those living solely with the parents. We also adjusted for stunting and immunization coverage as indicators of a child's medical health.

Results

The Table 1 shows that 64.4% of the children were breastfed for more than a year. Children having age appropriate cognitive and language development were 93.4% and 94.5% respectively. 98.8% of the children belonged to Islamic families. 30% of our sample was taken from Gwadar, 36% from Quetta and 34% from Muslim Bagh. 50.5% children were boys and the rest were girls. Most of the children belonged to poor families, 50.8% having family income less than Rs.10,000/month. 36.9% of the children lived in a “Kacha” house and 25.8%, 37.3% lived in a “Semi-Pakka” and “Pakka” house respectively.

Variables	Frequencies (percentages)
Duration of Breastfeeding	
Less than 6 months	88 (14.6)
Greater than 6, less than 12 months	127 (21.0)
Greater than 12 months	389 (64.4)
Cognitive Development	
Yes	564 (93.4)
No	40 (6.6)
Language Development	
Yes	571 (94.5)
No	33 (5.5)
Gender	
Male	305 (50.5)
Female	299 (49.5)
Monthly income of the family	
Income less than Rs.10000	307 (50.8)
Income>Rs.10000 and <Rs.15000	153 (25.3)
Income greater than Rs.15000	144 (23.8)
House Ownership	
Owns the house	488 (80.8)
Does not own the house	116 (19.2)
Construction of house	
Pakka	225 (37.3)
Semi pakka	156 (25.8)
Kacha	223 (36.9)
Stunting	
Present	240 (40.5)
Not Present	352 (59.5)
Immunization	
Completely Immunized	431 (71.4)
Not immunized	173 (28.6)
Nuclear/Joint Family	
Nuclear family	256 (42.4)
Joint family	348 (57.6)
Home Inventory (Mean+SD)	
Responsivity (11)	8.95 (1.95)

Acceptance (8)	5.34 (2.16)
Organization (6)	4.25 (1.32)
Learning material (9)	1.89 (2.57)
Involvement (6)	3.54 (1.74)
Variety (5)	2.93 (0.89)

Table 1: Descriptive statistics of the sample population.

The data regarding birth weight of the child and the gestational age at the time of delivery were taken through maternal recall. 98% of the children were full term at birth. For 92% of the participants, the birth weight was not known by the mother. Only 2.3% of the participants had birth weight below 2.5 kg. For 71.4% of the children, the mothers reported that they were completely immunized according to EPI schedule. When asked about the age of weaning, 35% children were started on semi-solid food before 6 months and 50% were first given semi-solid food at 6 months. 57.6% children lived in a joint family. Height and weight of the children were measured at the time of the interview. Stunting was determined using the WHO standard z-score charts. It was seen that 40.5% of the children were stunted (Table 1).

Table 2 shows that 94.9% and 95.6% of the children who were breastfed for more than 12 months had age appropriate cognitive and language development as compared to 86.4% and 88.6% of children breastfed less than 6 months respectively (p-value<0.05) (Table 2).

Table 3 shows the results of uni-variate and multi-variate logistic regression for cognition. It shows that after adjusting for co-variables, the odds of cognitive development were 2.42 times more in children

who were breastfed for more than 12 months as compared to those who were breastfed for less than 6 months (p<0.05). Cognitive development was 53% more in girls as compared to boys (p=0.039). The odds of cognitive development improved with greater household income, having a "pakka" residence vs. a "kacha". The cognitive development was also more in children who were immunized (aOR=1.90) and were not stunted (aOR=1.71). However these results were not statistically significant (p>0.05) (Table 3).

Table 4 shows the crude and adjusted ORs for Language development in children. It was determined that after adjusting for other possible factors, the odds of language development were 2.44 times more in children breastfed more than 12 months as compare to children breastfed less than 6 months (p <0.05). The children who were completely immunized also were at an advantage for language development (aOR=2.91, p=0.006). Surprisingly, our study did not reveal any positive impact of parenteral nurturance on cognitive or language development of children as measured by the HOME inventory (Table 4).

Characteristics	Breastfeeding less than 6 months	Breastfeeding greater than 6, less than 12 months	Breastfeeding greater than 12 months	P value*
	N (%)	N (%)	N (%)	
Cognitive development				
Yes	76 (86.4)	119 (93.7)	369 (94.9)	<0.05
No	12 (13.6)	8 (6.3)	20 (5.1)	
Language Development				
Yes	78 (88.6)	121 (95.3)	372 (95.6)	<0.05
No	10 (11.4)	6 (4.7)	17 (4.4)	
Gender				
Male	46 (52.3)	51 (40.2)	208 (53.5)	<0.05
Female	42 (47.7)	76 (59.8)	181 (46.5)	
Monthly income of the family				
Income less than Rs.10000	38 (43.2)	75 (59.1)	194 (49.9)	0.199
Income >Rs.10000 and <Rs.15000	27 (30.7)	28 (22)	98 (25.2)	
Income greater than Rs.15000	23 (26.1)	24 (18.9)	97 (24.9)	

House ownership				
owns the house	72 (81.8)	103 (81.1)	313 (80.5)	0.954
does not own the house	16 (18.2)	24 (18.9)	76 (19.5)	
Construction of house				
Kacha	24 (27.3)	80 (63.0)	119 (30.6)	<0.05
Semi pakka	21 (23.9)	18 (14.2)	117 (30.1)	
Pakka	43 (48.9)	29 (22.8)	153 (39.3)	
Stunting				
Yes	42 (50.0)	37 (29.6)	161 (42.0)	<0.05
No	42 (50.0)	88 (70.4)	222 (58.0)	
Immunization				
Immunized	59 (67.0)	79 (62.2)	293 (75.3)	<0.05
Not immunized	29 (33.0)	48 (37.8)	96 (24.7)	
Nuclear/Joint Family				
Nuclear family	39 (44.3)	60 (47.2)	157 (40.4)	0.365
Joint family	49 (55.7)	67 (52.8)	232 (59.6)	
*P value has been calculated using chi-square test.				

Table 2: Descriptive statistics of children according to the duration of breastfeeding.

Variables	Unadjusted OR (95%CI)	Adjusted OR (95%CI)*	P value
Duration of Breastfeeding			
Less than 6 months	1	1	<0.05
Greater than 6, less than 12 months	2.34 (0.91-6.01)	1.91 (0.67-5.47)	
Greater than 12 months	2.91 (1.36-6.21)	2.42 (1.05-5.57)	
Gender			
Male	0.52 (0.27-1.03)	0.47 (0.23-0.96)	<0.05
Monthly income of the family			
Income less than Rs.10000	1	1	0.206
Income > Rs.10000 and <Rs.15000	0.64 (0.31-1.29)	0.61 (0.29-1.30)	
Income greater than Rs. 15000	1.93 (0.71-5.27)	1.58 (0.55-4.51)	
House Ownership			
Owns the house	0.58(0.22-1.52)		
Construction of house			
Kacha	1	1	0.087
Semi pakka	1.30 (0.64-2.63)	2.43 (0.87-6.72)	
Pakka	2.32 (0.90-5.97)	1.72 (0.73-4.03)	
			0.211

Stunting			
Not Present	1.77 (0.92-3.41)	1.71 (0.85-3.44)	0.128
Immunization			
Completely Immunized	1.72 (0.89-3.34)	1.90 (0.88-4.09)	0.098
Nuclear/Joint Family			
Nuclear family	1.39 (0.71-2.73)		
Home Inventory			
Responsivity (11)	1.17 (0.98-1.14)	1.16 (0.98-1.37)	0.082
Acceptance (8)	0.90 (0.77-1.06)	0.89 (0.75-1.06)	0.205
Organization (6)	1.04 (0.77-1.40)		
Learning material (9)	0.88 (0.76-1.01)	0.87 (0.75-1.00)	0.051
Involvement (6)	0.91 (0.73-1.14)		
Variety (5)	1.17 (0.75-1.81)		
*All variables Adjusted with each other			

Table 3: Results of multiple logistic regressions for cognition.

Variables	Unadjusted OR (95%CI)	Adjusted OR (95%CI)*	P value
Duration of Breastfeeding			
Less than 6 months	1	1	<0.05
Greater than 6,less than 12 months	2.58 (0.90-7.39)	2.20 (0.73-6.55)	
Greater than 12 months	2.80 (1.23-6.35)	2.44 (1.05-5.70)	
Gender			
Male	0.56 (0.27-1.17)	0.49 (0.23-1.05)	0.067
Monthly income of the family			
Income less than Rs.10000	1		
Income > Rs.10000 and <Rs.15000	1.22 (0.49-3.01)		
Income greater than Rs. 15000	0.87 (0.38-2.02)		
House Ownership			
Owens the house	1.35 (0.51-3.57)		
Construction of house			
Kacha	1		
Semi pakka	1.42 (0.56-3.61)		
Pakka	1.18 (0.53-2.63)		
Stunting			
Present	1.50 (0.73-3.06)		
Immunization			

Completely Immunized	2.48 (1.22-5.03)	2.91 (1.36-6.22)	0.006
Nuclear/Joint Family			
Nuclear family	1.74 (0.81-3.72)	1.77 (0.82-3.85)	0.145
Home Inventory			
Responsivity (11)	1.07 (0.88-1.30)		
Acceptance (8)	0.94 (0.79-1.11)		
Organization (6)	1.01 (0.73-1.39)		
Learning material (9)	0.88 (0.76-1.03)	0.91 (0.79-1.04)	0.192
Involvement (6)	1.06 (0.83-1.36)		
Variety (5)	1.11 (0.69-1.80)		
*All the variables were adjusted with each other in the final model			

Table 4: Results of multivariate logistic regression for language.

Discussion

The results of the current study indicate that increasing the duration of breastfeeding (>12 months) during infancy was significantly associated with improvement in the cognitive and language development of children even after adjusting for a range of child and socio-economic and socio-environmental factors (aOR=2.42, aOR=2.44 respectively). The biologic plausibility for this association lies in the hypothesis that the breast milk has long chain polyunsaturated fatty acids (PUFAs) which are not present in the cow's milk. These bio-active compounds are found in high concentrations in the brain and the retina. It is thought that these compounds have a beneficial effect on the visual and neuro-cognitive development during the early years of neuro-maturation thus leading to significantly improved cognitive and language development in infants [9].

Similar findings have been reported by other studies that the language and cognitive outcomes are better in breastfed children as compared to bottle fed children. Also, increasing the dose (duration) of breastfeeding leads to protection against delays in children's language development [10,11].

Immunization played an important role in the language development of children under 3 years of age. Children who were completely immunized were 2.91 times more likely to achieve age appropriate language development as compared to non-immunized children (p=0.006). A possible explanation for this association could be that non-immunized children suffer more from childhood diseases. During episodes of disease, the child is lethargic and less susceptible to human stimulation, thus losing the time for further development. Chronic diseases also result in stunting which is a proven risk factor for developmental delays in children [12].

Limited data is available in the context of Pakistan regarding the association between breastfeeding and language and cognitive development of children. 94% of children of Pakistan are reported to have been breastfed at some-time [13]. A major strength of our study was to reveal this association. We also utilized HOME, which is a validated tool for measuring the effect of the home environment on the child. We would further argue that robust techniques of analysis were applied and a wide range of co-variables were adjusted. An obvious

limitation of our study is that we did not have data regarding the maternal IQ to be adjusted in our analysis. Some studies suggest that the difference in IQ of children is solely based on maternal IQ and when that is adjusted the difference vanishes [3]. Some studies take maternal education as a proxy indicator for maternal IQ, but we did not think that to be appropriate [14]. We also could not account for several other factors which play an important role in the development of children. Lastly, we cannot exclude the possibility of recall bias affecting the data regarding the duration of breastfeeding. Eaton et al. [15] found out that for children under 3 years of age, 79% of the mothers were able to accurately recall the duration of breastfeeding within a month and 95% to within 2 months.

Conclusion

Based on our findings, we recommend that breastfeeding should be promoted for greater than 12 months. It leads to improved child's language and cognitive development and also helps to build a bond between the mother and the child. However, we need more robust studies, including trials to establish the causal association between the duration of breastfeeding and a child's language and cognitive development.

Declarations

Ethics approval and consent to participate: Before starting the project, clearance was obtained from the Ethical Review Committee of Aga Khan University, Pakistan. Prior to administering the questionnaire to the participants, an informed consent was obtained from the mothers of the children.

Consent for publication: Written informed consent for publication was obtained from all the mothers of the participants.

Availability of data and material: The datasets analyzed for this paper are available from the corresponding author on reasonable request.

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AusAID. This agency was involved in setting up the Family Resource Centres, FRCs in the districts of Balochistan.

Authors' contributions

MI came up with the conception and design of the study. She analyzed and interpreted the data. She was a major contributor in writing the manuscript. GR critically revised the content of the manuscript and gave final approval of the manuscript to be published. SA analyzed and interpreted the data.

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