Results

In the present study we aimed to evaluate the effect of exclusive breastfeeding on the cognitive function as assessed by the Intelligent Quotient (IQ) test in 90 pre-school children in Aga city of Dakahlia governorate. Also to assess differences in intelligence between breastfed and formula fed children and identify other determinants that affect the child's IQ.

The 90 preschooler children aged 3 to 5 years were classified into two groups as follows:

Group 1*:* This included 57 healthy children who were exclusively breastfed. These were further subclassified in two subgroups:

- *Group 1a:* breastfed exclusively for the first 3 months only,
- *Group 1b:* breastfed exclusively for the first 6 months.

Group 2*:* This included 33 healthy children who were not breastfed exclusively and received mixed, cow's milk other foods or exclusive artificial feeding.

The results are shown in the following tables and figures ***(table 3 to table 26)*** and ***(figures 1 to figure 30).***

A description of the findings for each table and figure are shown below each table and figure as required.

Table (3): Demographic characteristic of children of the studied groups

	GROUP (1) BREASTFED N=57		**GROUP (2) ARTIFICIALLY-FED N=33**		**P**
Age (months)	***Mean ± SD*** 52.2 ± 8.1		***Mean ± SD*** 48.7 ± 9.8		**0.12**
Sex	***No***	***%***	***No***	***%***	**0.79**
Male	26	45.6	16	48.5	
Female	31	54.4	17	51.5	
Order of child	***No***	***%***	***No***	***%***	**0.26**
1st	26	45.6	11	33.4	
2nd	18	31.6	10	30.3	
3rd	9	15.8	10	30.3	
4th	4	7	1	3	
5th	0	0	1	3	
Socio-economic standard	***No***	***%***	***No***	***%***	**<0.001*** **
Low	1	1.8	1	3	
Low Average	1	1.8	23	69.7	
Average	45	78.9	7	21.2	
High Average	7	12.7	2	6.1	
Superior	3	5.3	0	0	

N = number

SD = Standard deviation

P is significant if **< or = 0.05** at confidence interval 95%.

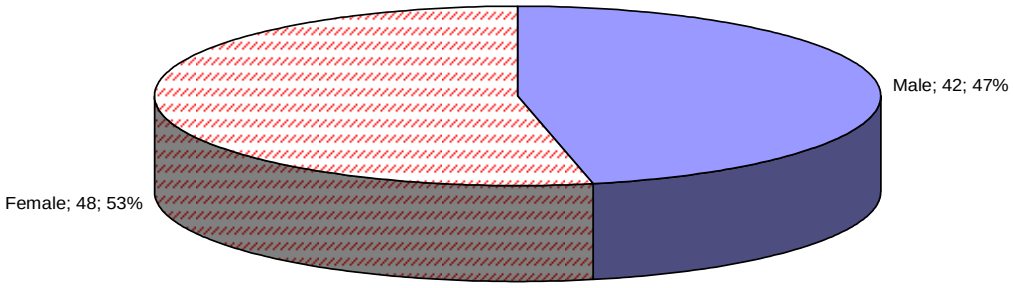


Figure (1): *Distribution of study groups by sex (males and females).*

Comment : *This fig. shows that females>males in the study groups.*

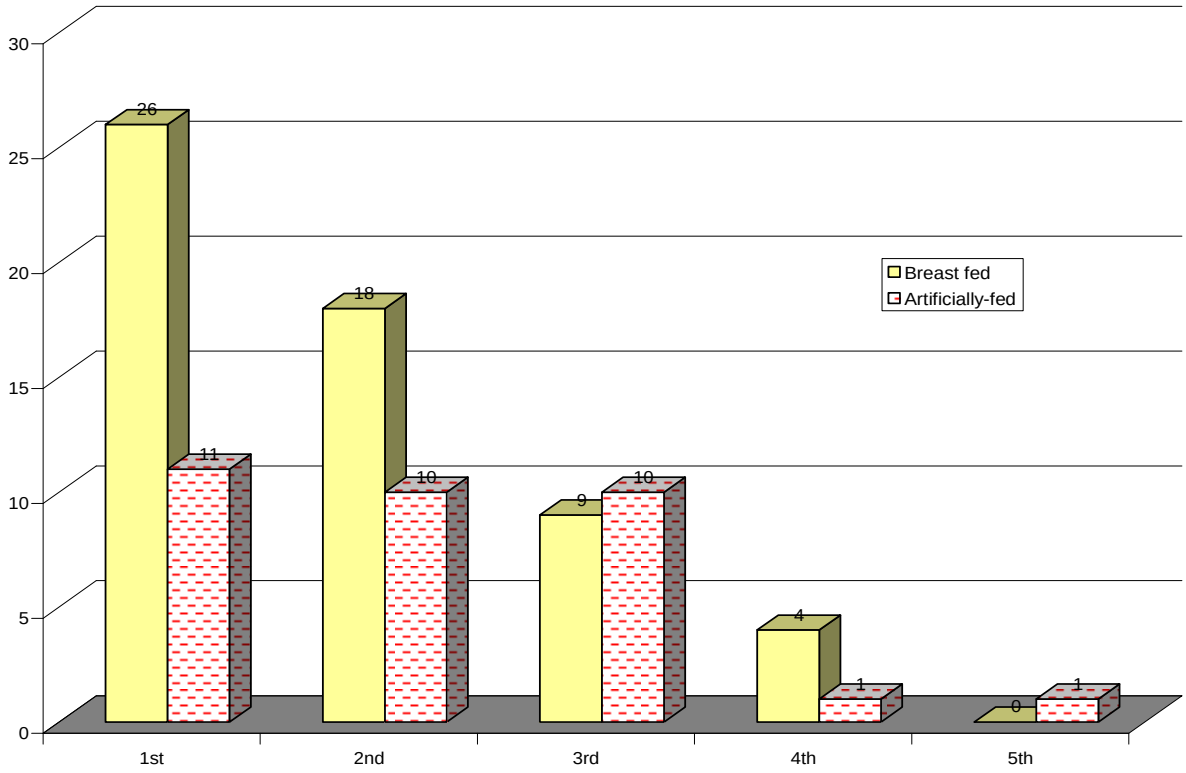


Figure (2): *Comparison of order of children in breastfed and artificially fed groups*

Table (4): Demographic characteristics of families of children in the study groups

	GROUP (1) BREASTFED N=57		**GROUP (2) ARTIFICIALLY-FED N=33**		**P**
Age of mother (years)	**Mean± SD** 25.7±2.5		**Mean± SD** 25.12±3.14		**0.34**
Number of pregnancies	2.3±0.94		2.5±1.12		**0.47**
Family size	4.3±0.92		4.4±1.1		**0.44**
Education of mother	***No***	***%***	***No***	***%***	**0.18**
• Illiterate	3	5.3	4	12.1	
• Read& write	13	22.8	11	33.3	
• 1ry	6	10.5	2	6.1	
• 2ry	22	38.6	14	42.4	
• University	13	22.8	2	6.1	
Working or not	***No***	***%***	***No***	***%***	**0.8**
• *Yes*	24	42.1	13	39.4	
• *No*	33	57.9	20	60.6	
• **Father *not present***	3	5.3	4	12.1	**0.24**
• **Father *present***	54	94.7	29	87.9	
• **Father *Smoker***	13	22.8	12	36.4	**0.16**
• ***Not Smoker***	44	77.2	21	63.6	

N = number

SD = Standard deviation

P is significant if < or = 0.05 at confidence interval 95%.

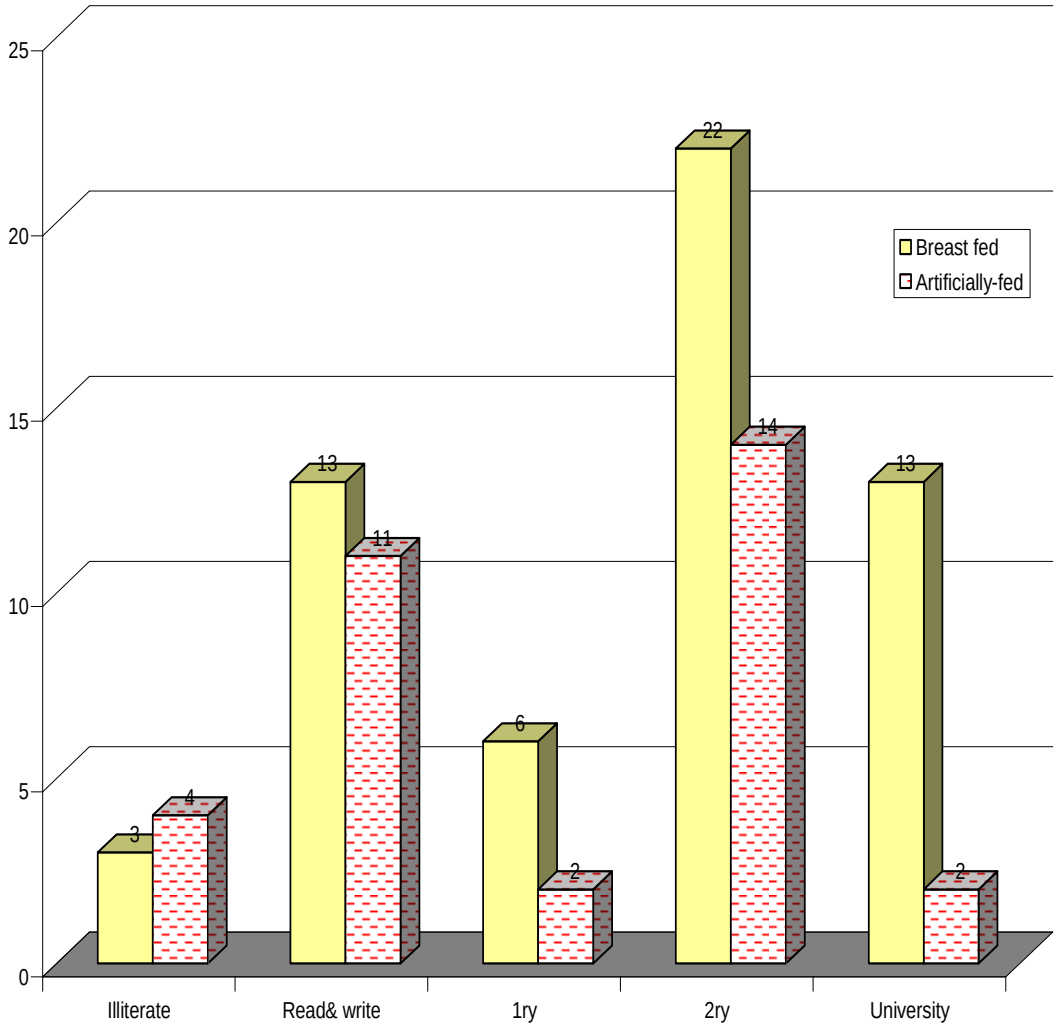


Figure (3): *Comparison of education of the mother in breastfed and artificially fed in the study groups.*

Comment : *Mothers with secondary and university education were significantly more common among the breastfed groups study,but the difference was not significant (p=0.18).*

Table (5a): Description of the history of breastfeeding practices in the breast feeding group

	GROUP (1) BREASTFED *(N=57)*	
Onset of breast feeding in hours	***No***	***Percent***
• 1st 4h	34	59.7
• 4h- 6h	13	22.8
• After 6h	10	17.5
• ***Pattern of feeding****(On demand)*	40	70.2
• *Fixed times (schedule)*	17	29.8
• ***Night Feeding*** Yes	56	98.2
• No	1	1.8
• ***Using pacifier or bottles*** Yes	14	24.6
• No	43	75.4

Comment : *This table show that there was delayed initiation of breastfeeding beyond 4hours in 40% of children, half of whom were delayed beyond 6 hrs,one third of children were feeding on schedule, one quarter of breastfed children were receive pacifier.*

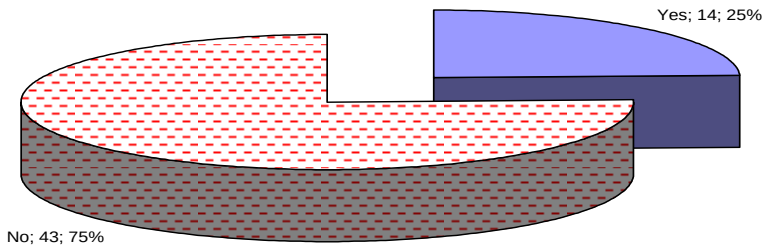


Figure (4): *Frequency distribution of pacifier or bottles offered among the breastfed group.*

Comment : *One quarter of breastfed children were receive pacifier.*

Table (5b): Duration of exclusive breastfeeding in months (Mean and SD).

Duration of exclusive feeding (months)	**MEAN** 5.01	**±SD** 1.4
Age of cessation of breastfeeding (months)	**Mean** 16.3	**±SD** 4.4

Table (6): Comparing anthropometric measurements in children who were breastfed versus those artificially fed

	BREASTFED (N=57)		**ARTIFICIAL FEEDING (N=33)**		***T***	***P***
	Mean	***± SD***	***Mean***	***± SD***		
Weight (Kg)	***16.46***	***1.64***	***16.94***	***1.74***	***-1.317***	***0.19***
wt Centile	***44.65***	***18.40***	***57.36***	***23.02***	***-2.871***	***0.01****
height(cm)	***100.89***	***4.98***	***101.03***	***6.40***	***-0.112***	***0.91***
height Centile	***37.04***	***19.20***	***41.21***	***20.65***	***-1.277***	***0.12***
HC(cm)	***50.00***	***0.86***	***49.58***	***0.93***	***1.174***	***0.13***
MAC(cm)	***14.15***	***0.26***	***14.11***	***0.34***	***0.659***	***0.51***

N = number

SD = Standard deviation

P is significant if < or = 0.05 at confidence interval 95%.

Comment : *This table shows that the artificially fed group tended to be heavier than breastfed and the difference was statistically significant p < 0.05 i.e. the artificially fed were overweight in relation to their height. There were no significant differences as regard other measurements.*

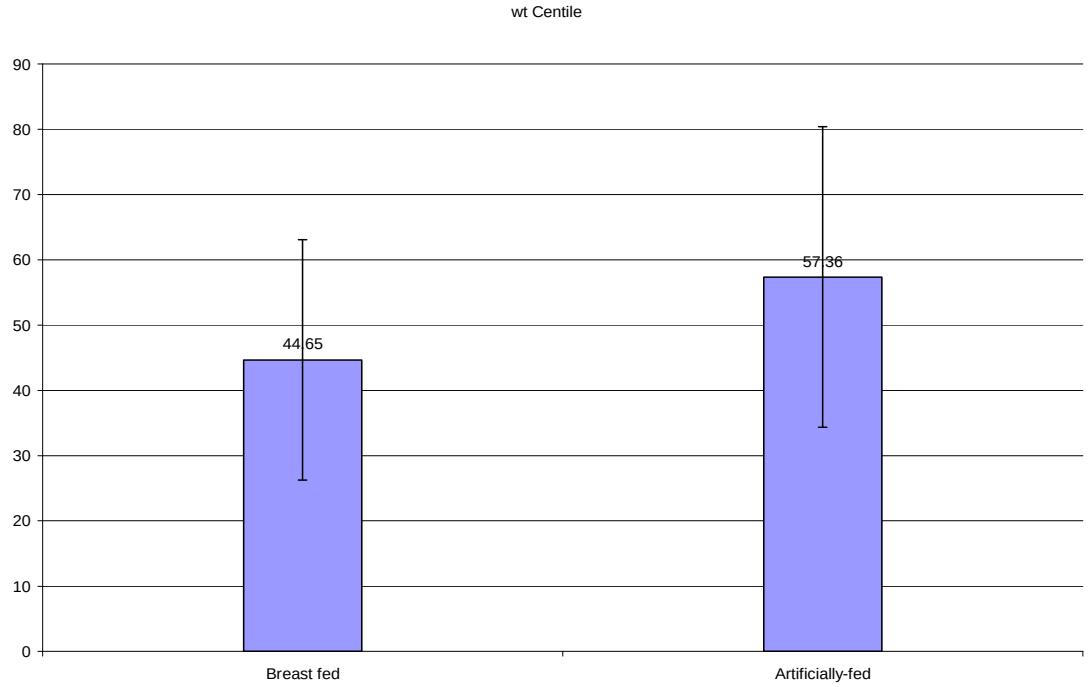


Figure (5): *Comparison of weight centile in children who were breastfed versus the artificially fed groups.*

Comment: *The Figure shows a significant increase in weight in artificially fed than breastfed groups.*

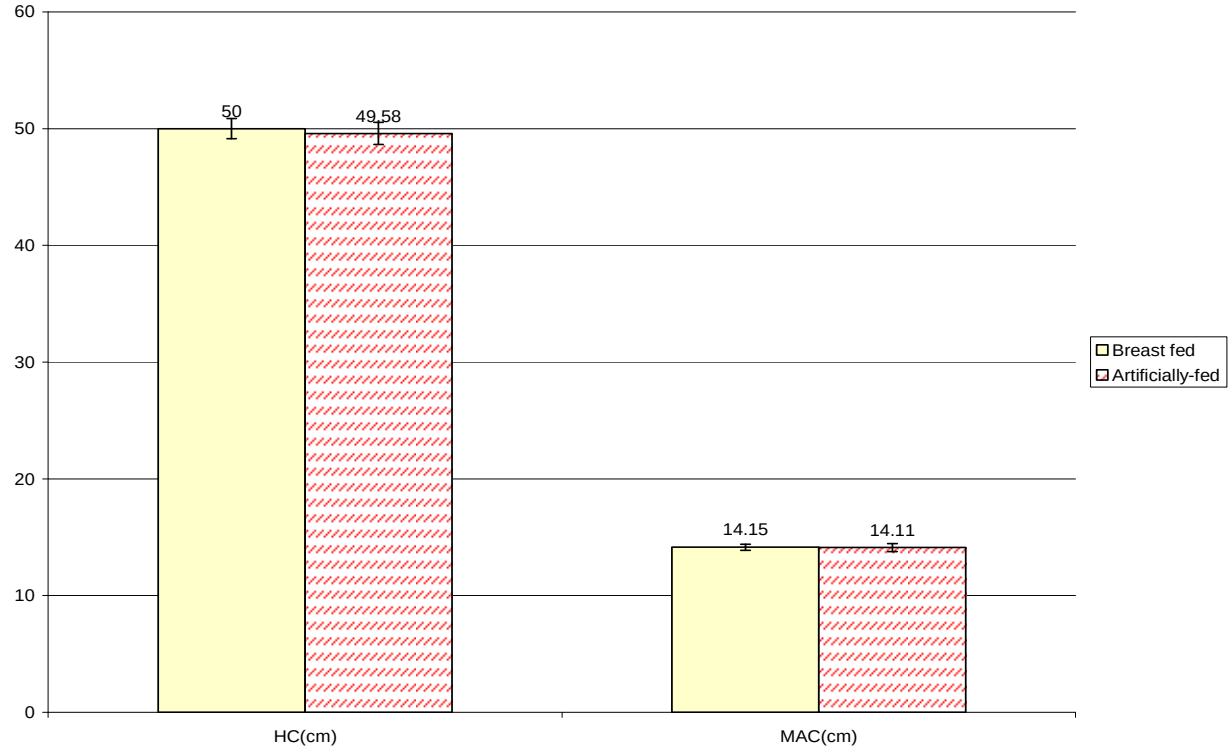


Figure (6): *Comparison of the head circumference and midarm circumference of the children who were breastfed versus the artificially fed group*

Comment: *The Figure shows no significant increase in HC and MAC in breastfed group.*

Table (7): Comparing anthropometric measurements of children breastfed for 3 months versus the 6 months subgroups

GROUP	BREASTFED 3 MONTHS (N=19)		BREASTFED 6 MONTHS (N=38)		T	P
	Mean	*± SD*	*Mean*	*± SD*		
Weight(Kg)	*16.16*	*1.83*	*16.61*	*1.53*	*-0.97*	*0.34*
Wt Centile	*35.79*	*18.20*	*49.08*	*17.15*	*-2.70*	*0.01**
Height(cm)	*101.5*	*4.77*	*100.58*	*5.12*	*0.67*	*0.50*
HC(cm)	*36.21*	*19.80*	*37.45*	*19.20*	*-0.23*	*0.82*
MAC(cm)	*50.21*	*0.78*	*49.89*	*0.89*	*1.31*	*0.20*

Comment: *This table shows significant increase in weight in breastfed for 6 months than breastfed for 3 months only* ***(p<0.05).***

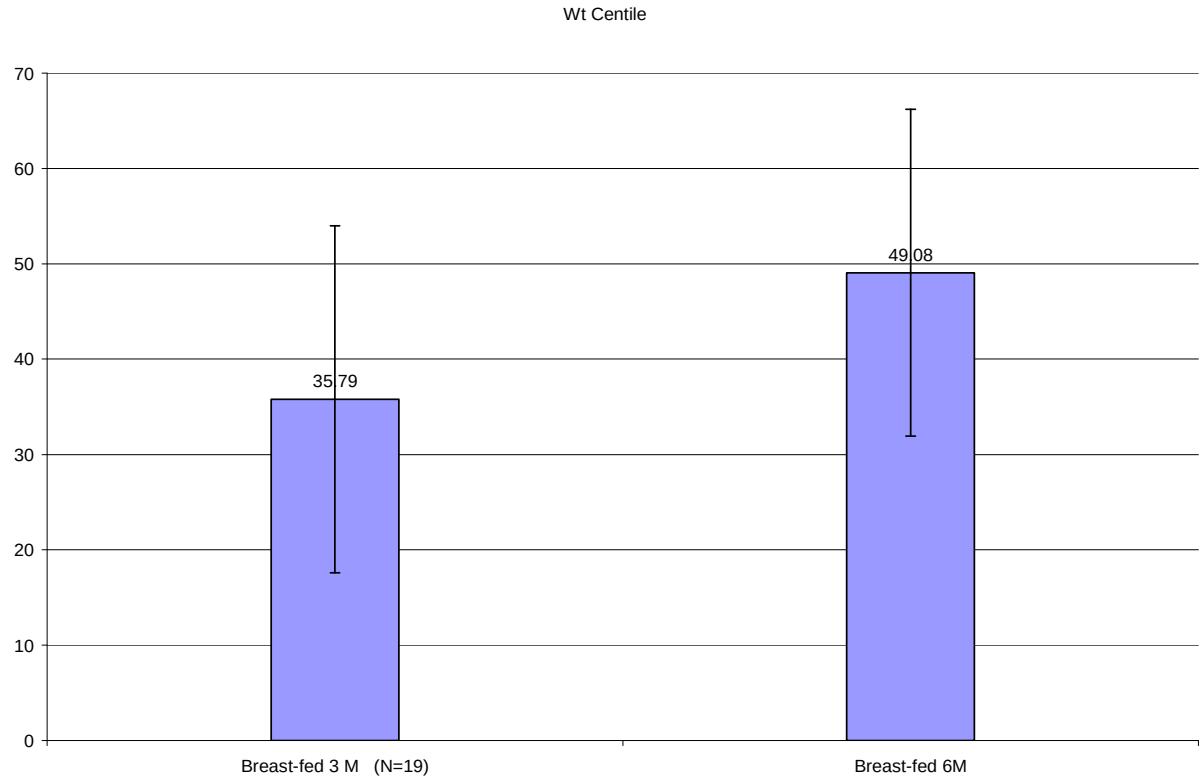


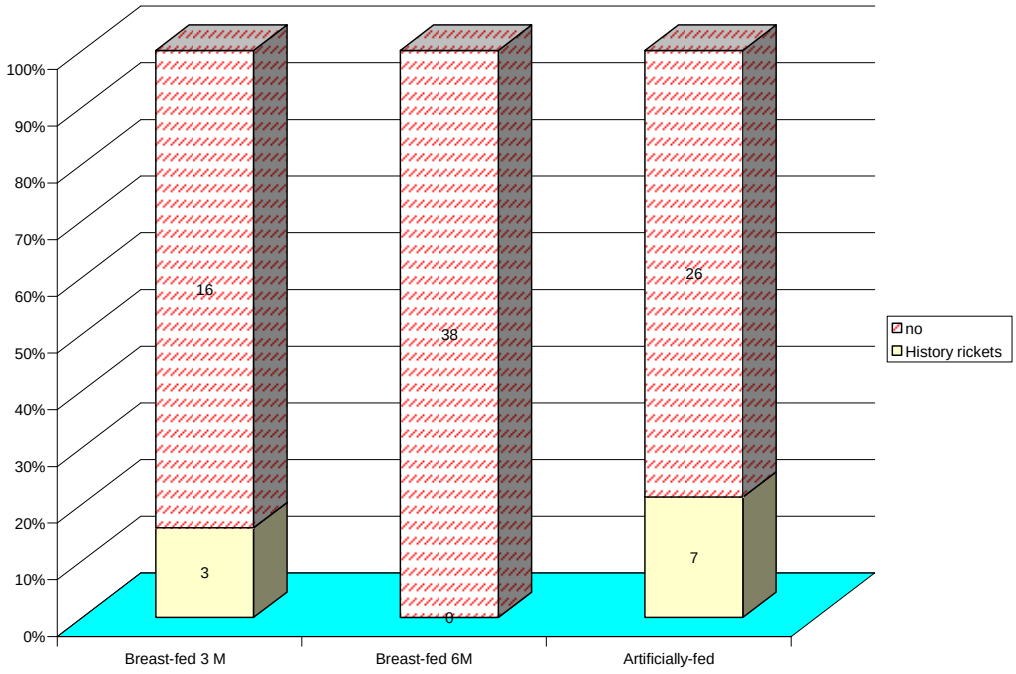
Figure (7)*: Comparison in weight centile between breastfed 3 months and 6 months subgroups.*

Comment: *The Figure shows significant increase in weight in breastfed for 6months than breastfed for 3 months only.*

Table (8): Comparison between breastfed and artificially fed groups of studied children as regard history of rickets

	BREASTFED (N=57)		**ARTIFICIALLY FED (N=33)**		***X²***	***P***
	NO.	**%**	**NO.**	**%**		
History of rickets	*3*	*(5.3%)*	*7*	*(21.2%)*	*8.1*	*0.02**

Comment: *This table shows that rickets was statistically significant higher in Artificially fed than breastfed groups.*



Figure(8): *Comparison between breastfed and artificially fed groups as regards the history of rickets.*

Comment: *The Figure shows that the history of rickets was statistically significant higher in artificially fed than breastfed groups.*

Table (9): Comparison between the subgroups of children breastfed for 3 versus 6 months as regard history of rickets

	BREASTFED (3 M) (N=19) & N%	**BREASTFED (6 M) (N=38) & N%**	**X2**	**P**
History of rickets	3(15.8%)	0 (.0%)	***6.3***	***0.012****
No (54)	16 (84.2%)	38 (100.0%)		

Comment: *This table shows that rickets was statistically significant higher in breastfed 3 months than 6 months subgroups. The difference increased with the increased duration of exclusive breastfeeding.*

Table (10): Comparing early developmental milestones of children who were breastfed versus those artificially fed.

		BREASTFED (N=57)		**ARTIFICIALLY FED (N=33)**		X^2	***P***
		NO.	**%**	**NO.**	**%**		
Developmental milestones	***Normal***	*56*	*(98.2%)*	*20*	*(90.9%)*	***22.6***	***<0.001****
	delayed motor	*1*	*(1.7%)*	*10*	*(30.3 %)*		
	delayed language	*0*	*(0%)*	*3*	*(9.1%)*		

Comment: *This table shows significant difference between breastfed and artificially fed groups as regard motor development and language. The difference was notable with increased duration of exclusive breastfeeding.*

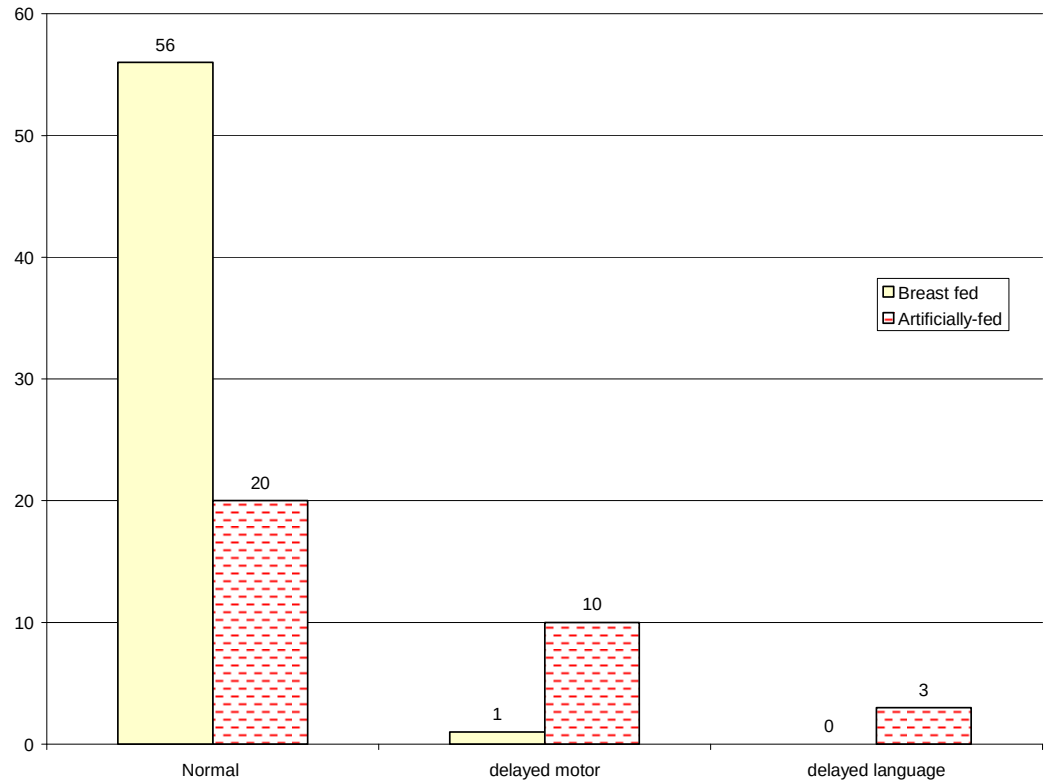


Figure (9) *Comparison in developmental milestones between breastfed group and artificially fed group*

Comment: *The Figure shows increase in number of delayed motor and language development in artificially fed group than breastfed group.*

Table (11): Comparing early developmental milestones of the subgroups of children breastfed for 3 months versus 6 months

		BREASTFED 3M (N=19)		**BREASTFED 6M (N=38)**		***X²***	***P***
		NO.	**%**	**NO.**	**%**		
Developmental milestones (*Gross motor, fine motor, social and language development*)	**Normal (56)**	*18*	*(94.7%)*	*38*	*(100.0%)*	2.04	**0.15**
	Delayed motor (1)	*1*	*(5.3%)*	*0*	*(.0%)*		
	Delayed language	*0*	*0%*	*0*	*0%*		

Comment: *This table shows no significant difference between breastfed 3 months and 6 months subgroups as regard developmental milestones in the first 2 years of life.*

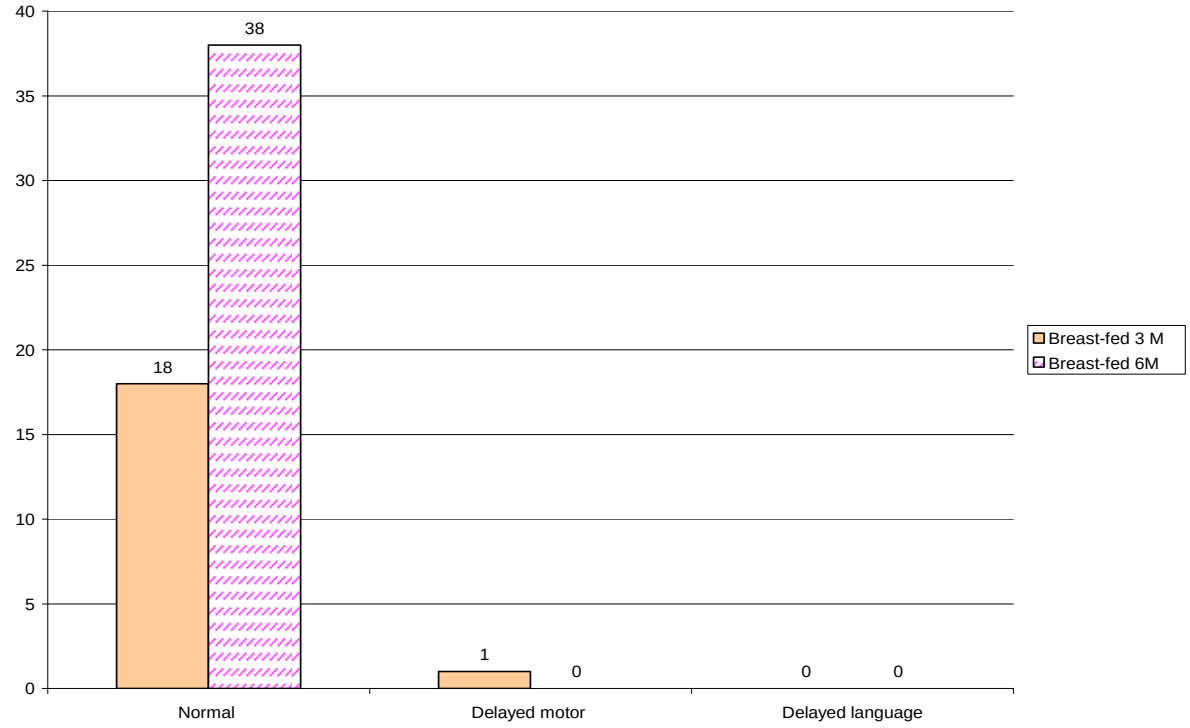


Figure (10): *Comparing early developmental milestones of the subgroups of children who were breastfed for 3 months versus those breastfed for 6 months.*

Comment: *The Figure shows no significant difference between breastfed 3 and 6 months subgroups.*

Table (12): Comparing current blood indices of the children breastfed versus those artificially fed

	BREASTFED (N=57)		**ARTIFICIALLY FED (N=33)**		***T***	***P***
	Mean	***± SD***	***Mean***	***± SD***		
RBC(×10)6	*4.57*	*0.30*	*4.40*	*0.27*	***2.67***	***0.009*****
MCV(fl)	*79.49*	*2.06*	*77.94*	*3.33*	***2.74***	***0.008*****
MCH(pg)	*24.88*	*1.14*	*24.79*	*0.99*	***0.38***	***0.71***
Hb(g/dl)	*12.33*	*0.41*	*12.07*	*0.42*	***2.82***	***0.006*****
WBC(×10)3	*7.94*	*2.25*	*6.99*	*1.73*	***2.09***	***0.04****
Platelets(×10)3	*270.63*	*56.89*	*273.48*	*52.16*	***-0.24***	***0.81***

Comment: *This table shows a significant difference in RBC, MCV ,WBC and Hb between breastfed and artificially fed groups in spite that both are at normal levels and with no significant difference as regard MCH, and platelets between breastfed and artificially fed groups.*

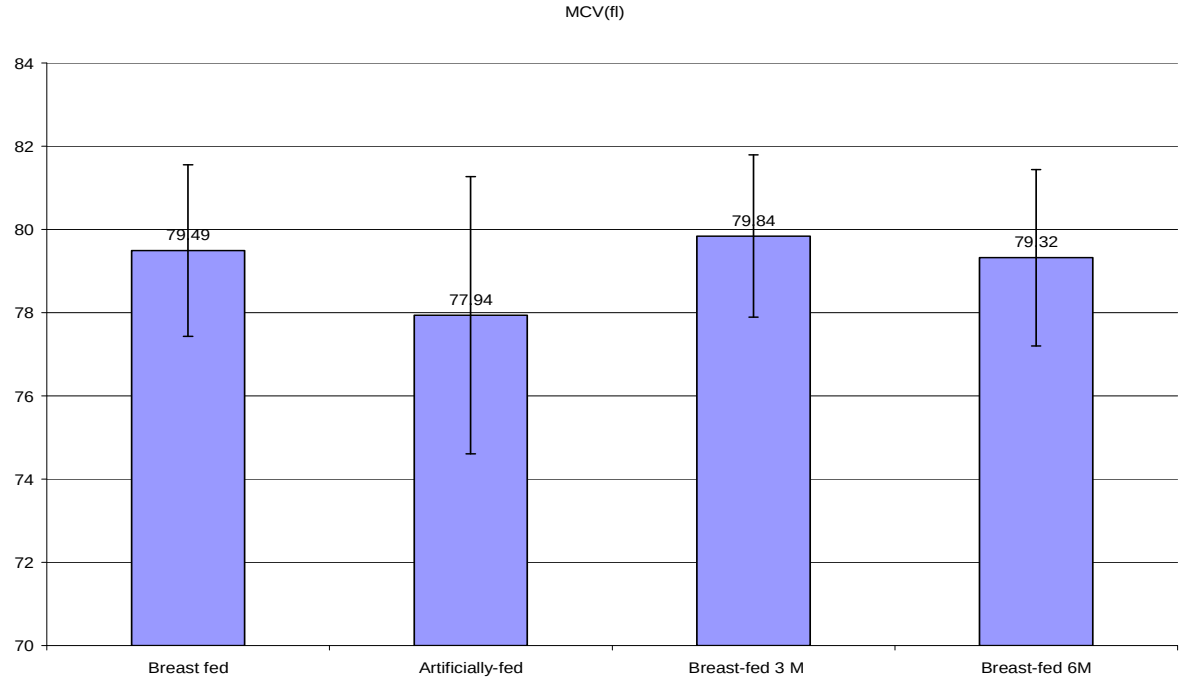


Figure (11): *Comparing the mean corpuscular volume (MCV) of the children who were breastfed group with those artificially fed.*

Comment: *The Figure shows increase of MCV in breastfed group.*

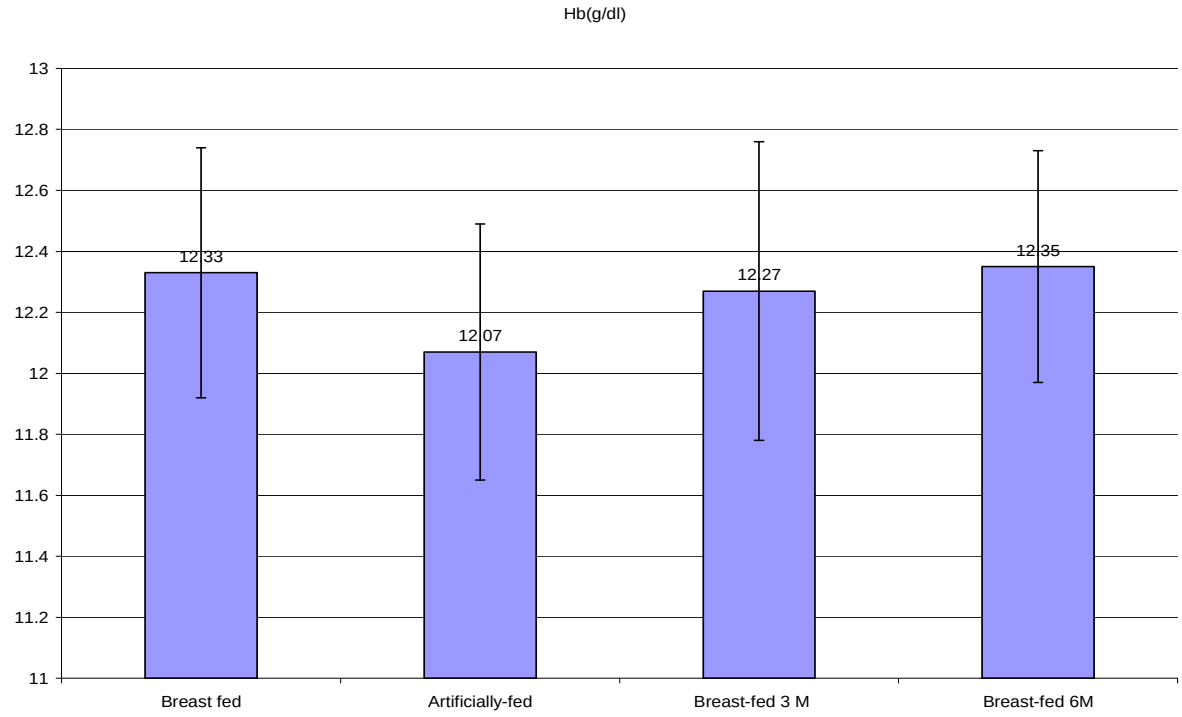


Figure (12): *Comparing hemoglobin (Hb) of children who were breastfed versus those artificially fed.*

Comment: *The Figure shows increase of Hb in breastfed group.*

Table (13): Comparing current blood indices of the subgroups of children breastfed for 3 months versus 6 months

GROUP	BREASTFED 3 MONTHS (N=19)		BREASTFED 6 MONTHS (N=38)		T	*P*
	Mean ±SD		Mean ±SD			
RBC(×10)6	4.61	0.36	4.55	0.28	0.734	0.466
MCV(fl)	79.84	1.95	79.32	2.12	0.907	0.369
MCH(pg)	24.89	1.24	24.87	1.09	0.082	0.935
Hb(g/dl)	12.27	0.49	12.35	0.38	-0.674	0.503
WBC(×10)3	8.15	2.61	7.83	2.07	0.505	0.615
Platelets(×10)3	279.68	67.29	266.11	51.31	0.847	0.4

N = number

SD = Standard deviation

P is significant if < or = 0.05 at confidence interval 95%.

Comment: *This table shows no significant statistical difference between breastfed 3 months and 6 months subgroups as regard laboratory parameters.*

Table (14): Comparing the Intelligent Quotient (IQ) of children who were breastfed versus those artificially fed

	BREASTFED (N=57)		ARTIFICIALLY FED (N=33)		*T*	*P*
	Mean	**± SD**	**Mean**	**± SD**		
IQ	99.74	10.29	88.58	8.87	**5.209**	**<0.001*** **

Comment: *This table shows a significant increase in IQ of breastfed group in comparison to artificially fed group.*

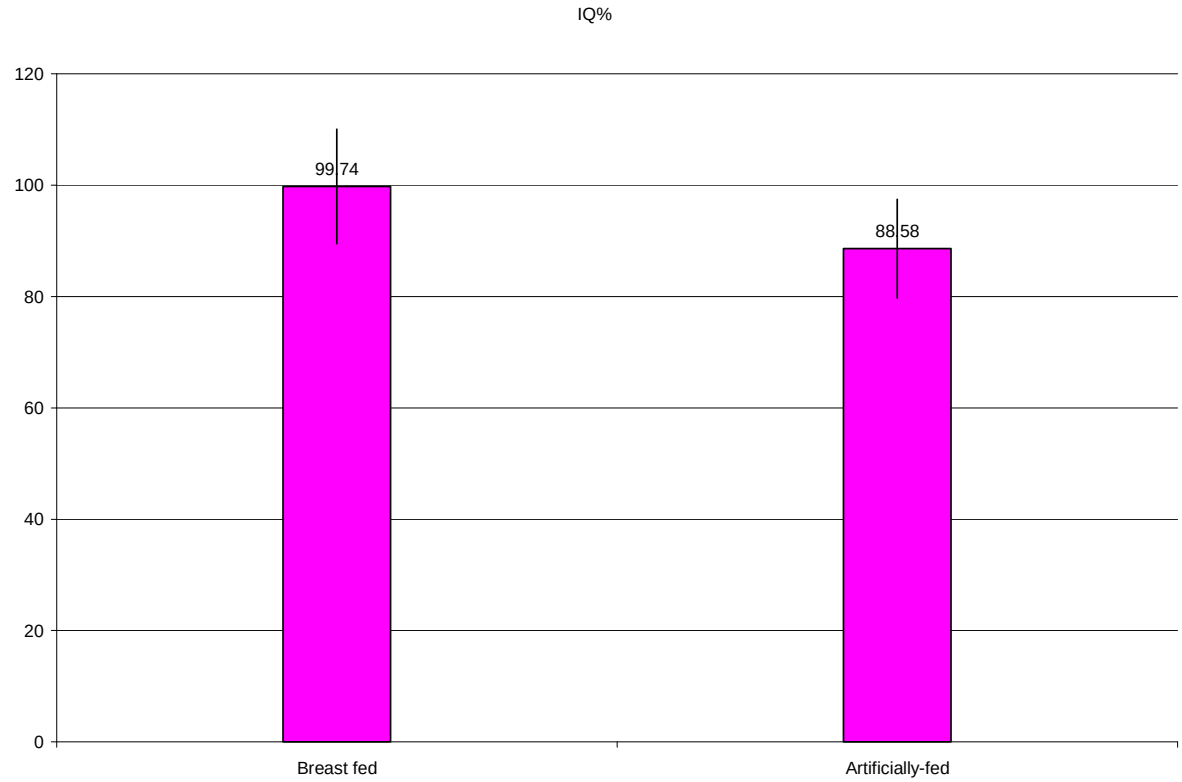


Figure (13): *Comparing Intelligent Quotient (IQ) of children who were breastfed versus those artificially fed.*

Comment: *The Figure shows increase in IQ of breastfed group.*

Table (15): Comparing the Intelligent Quotient (IQ) of the subgroups of children breastfed for 3 months versus 6 months

GROUP	BREASTFED 3M (N=19)		BREASTFED 6M (N=38)		T	*P*
IQ	92.63	5.85	103.29	10.23	**-4.199**	**<0.001*** **

Comment: *This table shows a significant increase in IQ in breastfed 6 months subgroup in comparison to breastfed 3 months subgroup.*

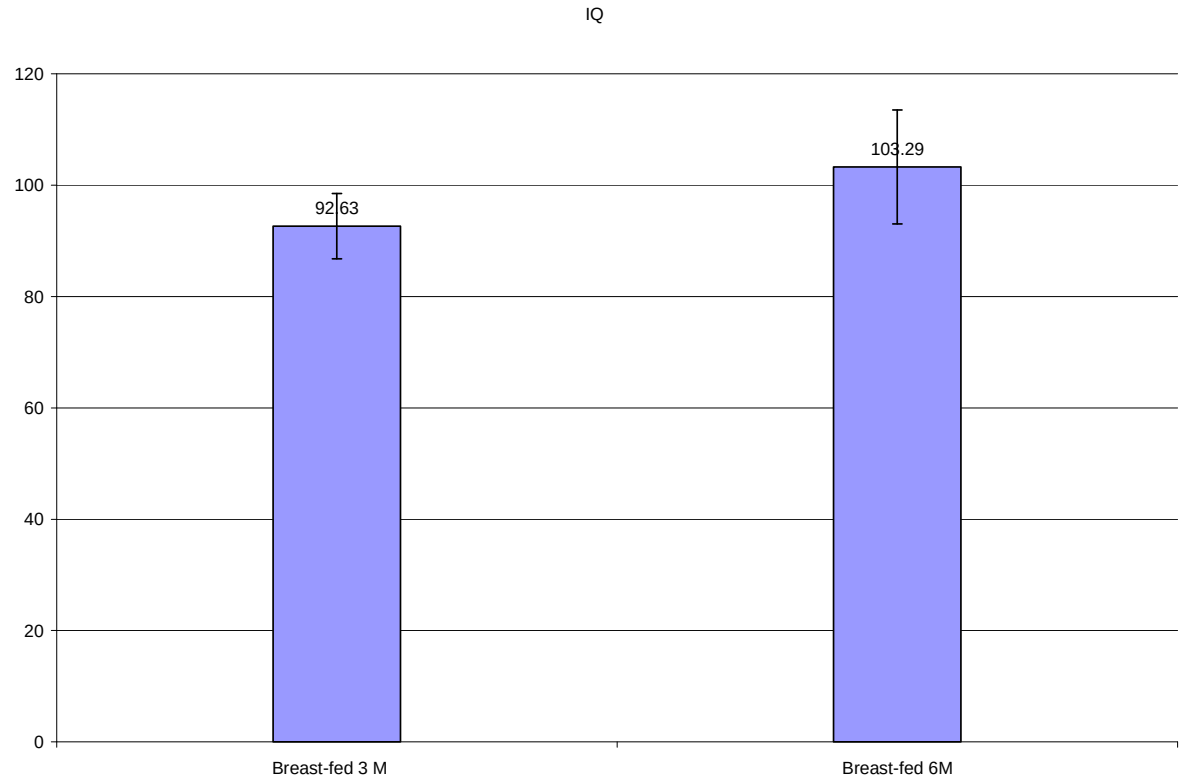


Figure (14): *Comparing Intelligent Quotient (IQ) of the subgroups of children breastfed for 3 months versus those breastfed for 6 months.*

Comment: *The Figure shows increase in IQ in breastfed (6 months) subgroup.*

Table (16): Comparing the Intelligent Quotient (IQ) of the subgroup of children breastfed for 3 months with the artificially fed group

	GROUP	N	MEAN	± SD	T	P
IQ	**breastfed 3 months**	19	92.63	5.85	**1.7**	**0.08**
	Artificially fed	33	88.58	8.87		

N = number

SD = Standard deviation

P is significant if < or = 0.05 at confidence interval 95%.

Comment: *This table shows no significant increase in IQ of breastfed 3 months group than artificially fed group.*

Table (17): Comparing the Intelligent Quotient (IQ) of the subgroup of children breastfed for 6 months with the artificially fed

	GROUP	*N*	*MEAN*	*± SD*	*T*	*P*
IQ	**breastfed 6 months**	*38*	103.29	10.23	***6.4***	**<0.001*** **
	artificially fed	*33*	88.58	8.87		

Comment: *This table shows significant increase in IQ of breast fed (6 months) subgroup than artificially fed group.*

Table (18): Effect of low socioeconomic standard on the Intelligent Quotient (IQ) of children who were breastfed and those artificially fed

	GROUP	*N*	*MEAN*	*± SD*	*T*	*P*
IQ of low socioeconomic	**Breastfed**	1	80			
	Artificially fed	1	86			
IQ of moderate socioeconomic	**Breastfed**	53	98.83	8.73	**5.1**	**.000****
	Artificially fed	32	88.66	9.00		

Comment: *This table shows significant increase in IQ of breastfed group than artificially fed group of low and moderate socioeconomic standard.*

Table (19): Effect of moderate socioeconomic standard on the Intelligent Quotient (I.Q) of children who were breastfed and those artificially fed

LEVEL	**BREASTFED (3 MONTHS) MEAN ± SD**		**BREASTFED (6 MONTHS) MEAN ± SD**		**ARTIFICIALLY FED MEAN ± SD**	
I.Q of Low	*80*				*86*	
I.Q of Moderate	93.33	5.13	101.65	8.8	88.65	8.99

Comment: *This table shows significant increase in IQ of breastfed group and subgroups than artificially fed group of low and moderate socioeconomic standard.*

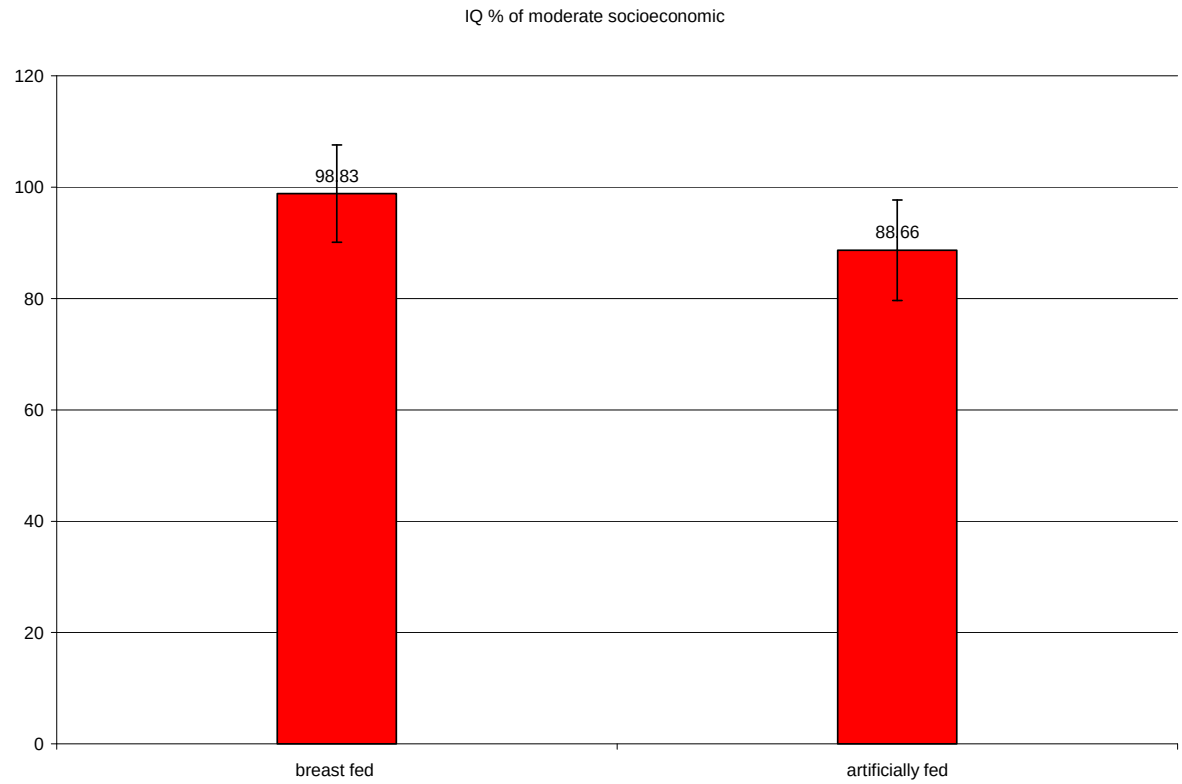


Figure (15)*: Relationship between moderate socioeconomic standard and the Intelligent Quotient (IQ) of children breastfed and artificially fed.*
Comment: *The Figure shows significant increase in IQ of breastfed group than artificially fed group of moderate socioeconomic standard.*

Table (20): Relationship between sex of the child and Intelligent Quotient (I.Q) in children who were breastfed and those artificially fed

LEVEL	BREASTFED (3-MONTHS)		BREASTFED (6-MONTHS)		ARTIFICIALLY FED	
I.Q of males	*91.17*	*3.13*	*105.15*	*10.67*	*88.06*	*8.10*
I.Q of females	*93.31*	*6.76*	*101.22*	*9.59*	*89.06*	*9.76*
P	**0.47**		**0.24**		**0.57**	

Comment: *This table shows no significant difference in IQ of the child with his sex in breastfed 3 and 6 months subgroups and artificially fed group.*

Table (21): Correlation between the order of the child and the Intelligent Quotient (IQ)

		BREASTFED (3 MONTHS)	BREASTFED (6 MONTHS)	ARTIFICIALLY FED
Order of child	***r***	*0.21*	*-0.11*	*-0.37*
	P	*0.37*	*0.58*	*0.02**

Comment: *This table shows that there is a no significant negative correlation between order of child and IQ in breastfed 3 months and 6 months subgroups and significant in artificially fed group.*

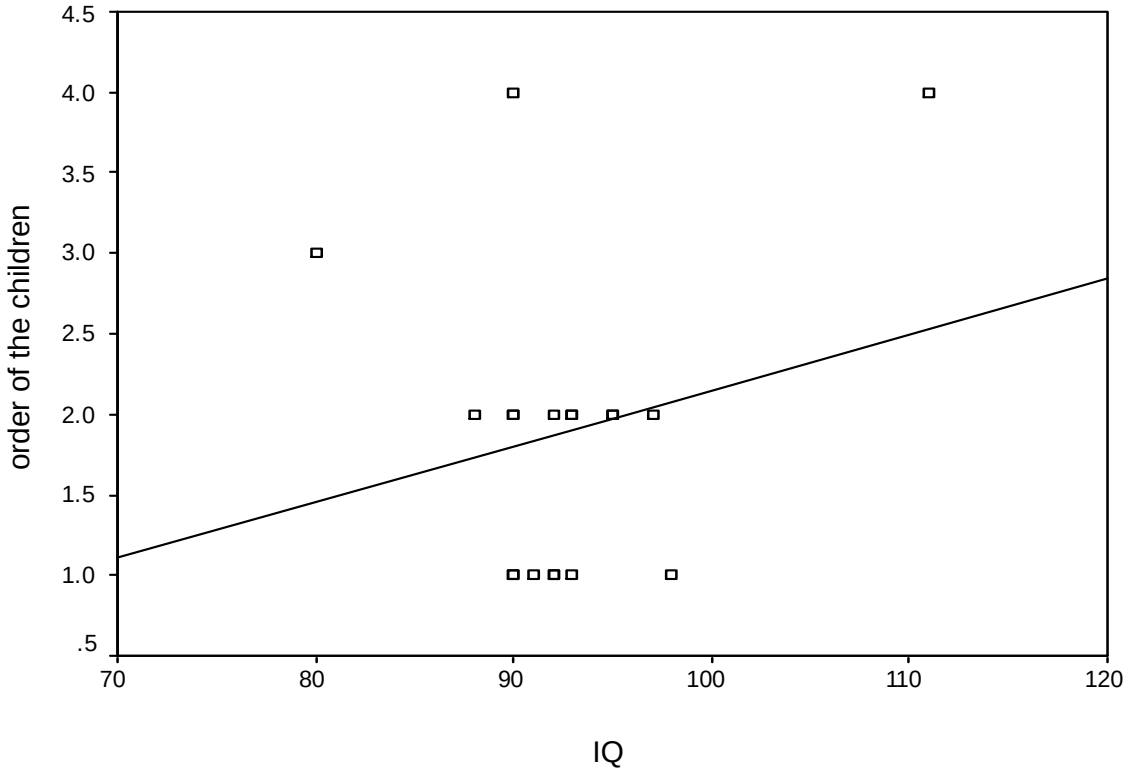


Figure (16): *Linear regression analysis showing a no significant positive correlation between order of the child and IQ in breastfed 3 months subgroup.*

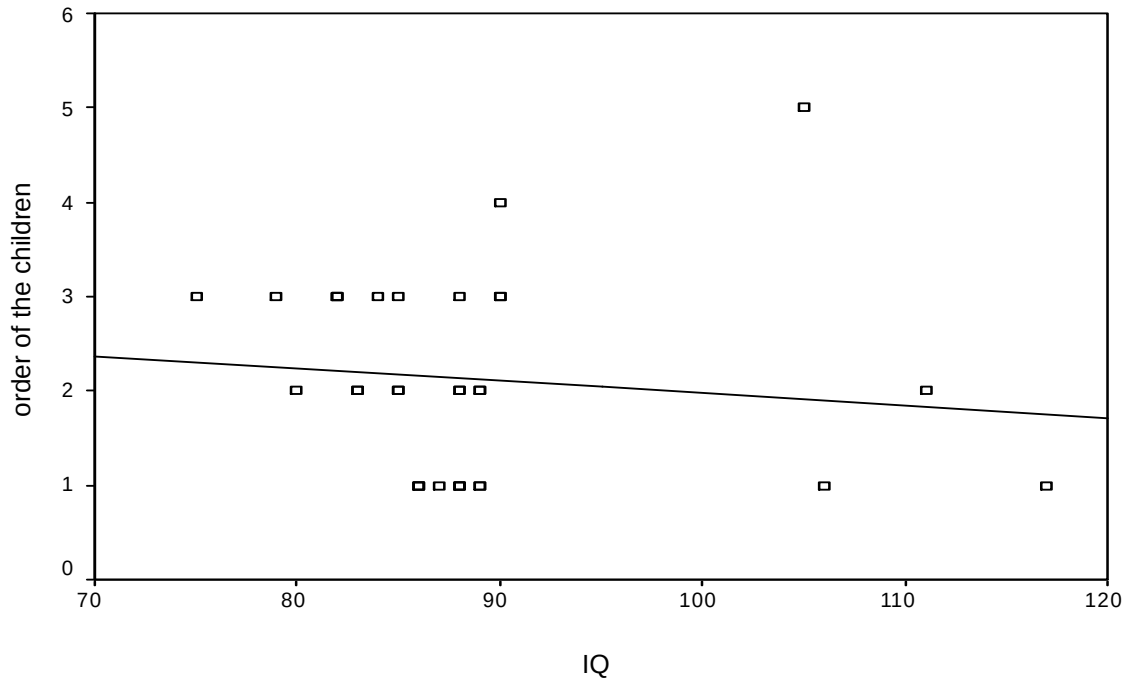


Figure (17): *Linear regression analysis showing a no significant negative correlation between order of the child and IQ in breastfed 6 months subgroup.*

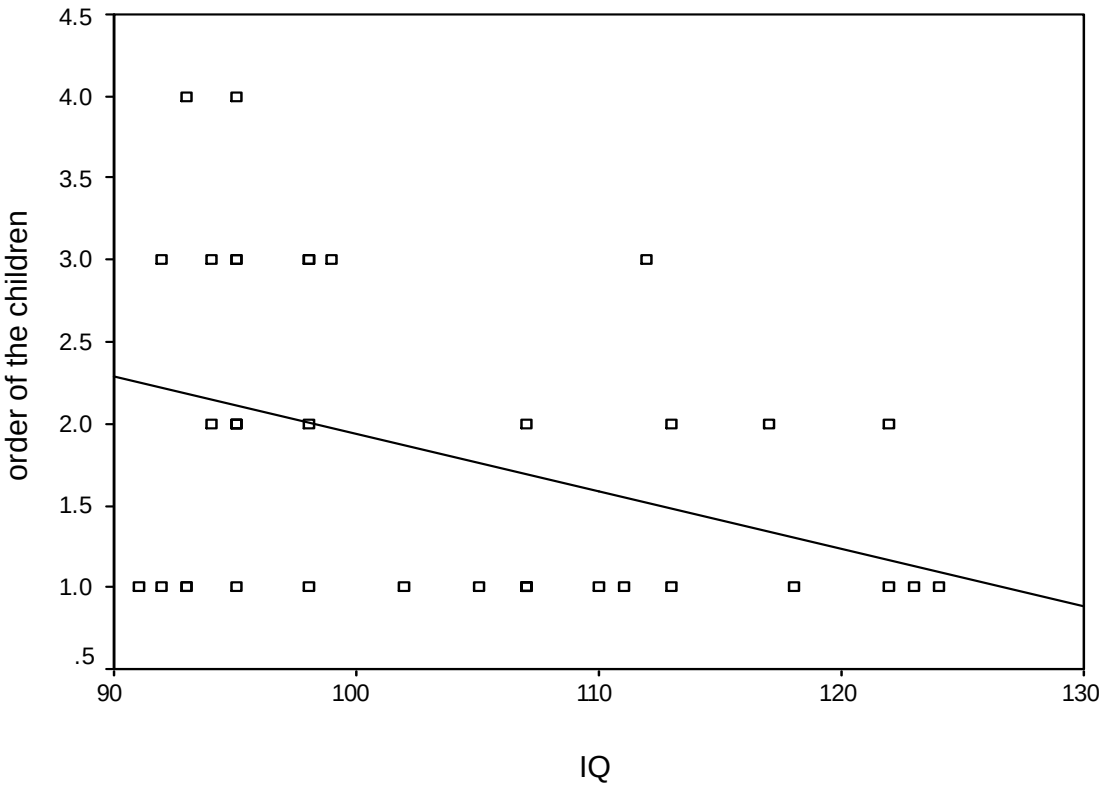


Figure (18): *Linear regression analysis showing a significant negative correlation between order of the child and IQ in artificially fed group.*

Table (22): Correlation between the level of education of the mother and her child's Intelligent Quotient (I.Q)

		BREASTFED (3 MONTHS)	**BREASTFED (6 MONTHS)**	**ARTIFICIALLY FED**
Education of the mother	**r**	*0.16*	*0.39*	*0.33*
	P	*0.51*	*0.013**	*0.057*

Comment: *This table shows that there was a positive significant correlation between Education of the mother and IQ of the child in breastfed group but with non significant positive correlation in breast fed 3months and artificial subgroups.*

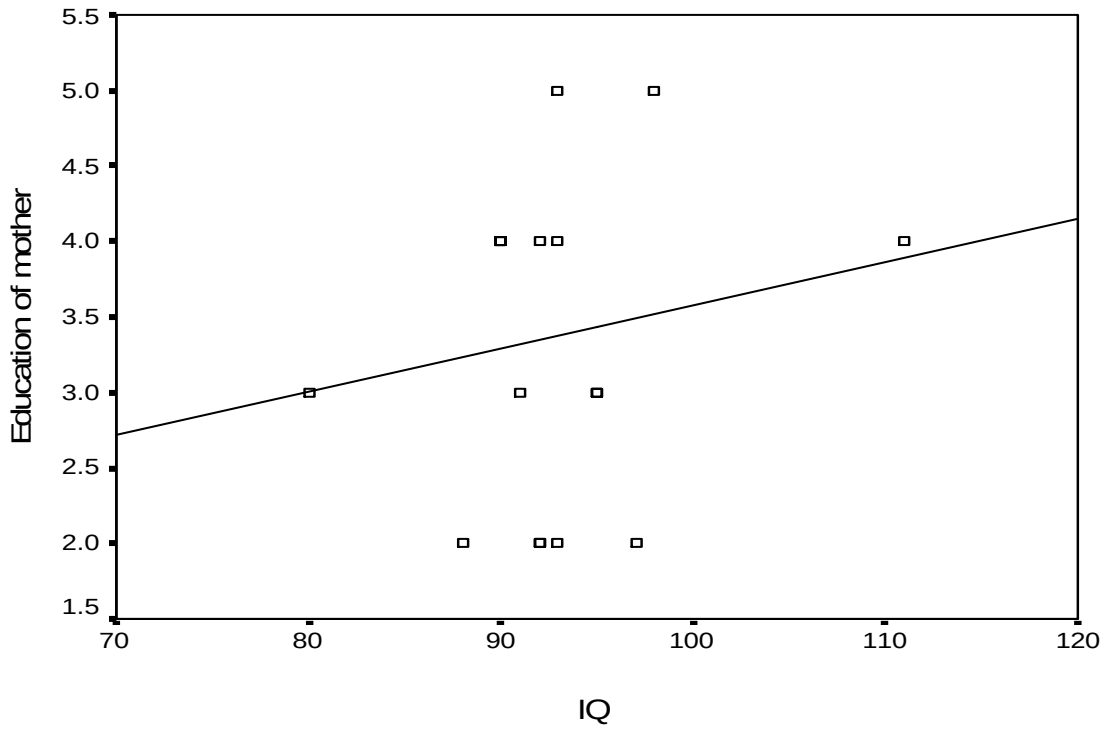


Figure (19): *A linear regression analysis showing no significant positive correlation between education of the mother and IQ of the child in breastfed 3 months subgroup.*

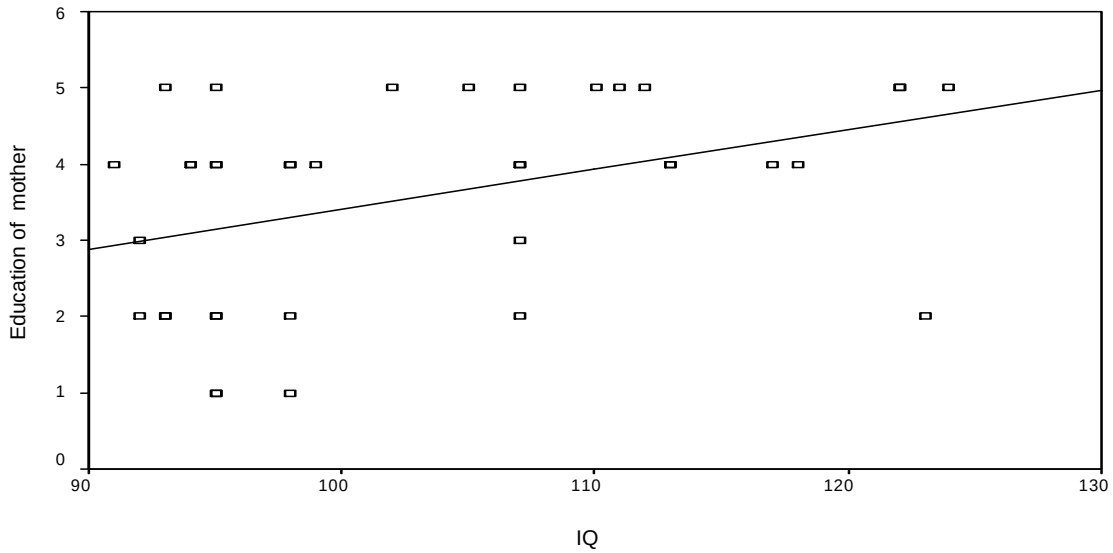


Figure (20): *Linear regression analysis showing a significant positive correlation between education of the mother and IQ of the child in breastfed 6 months subgroup.*

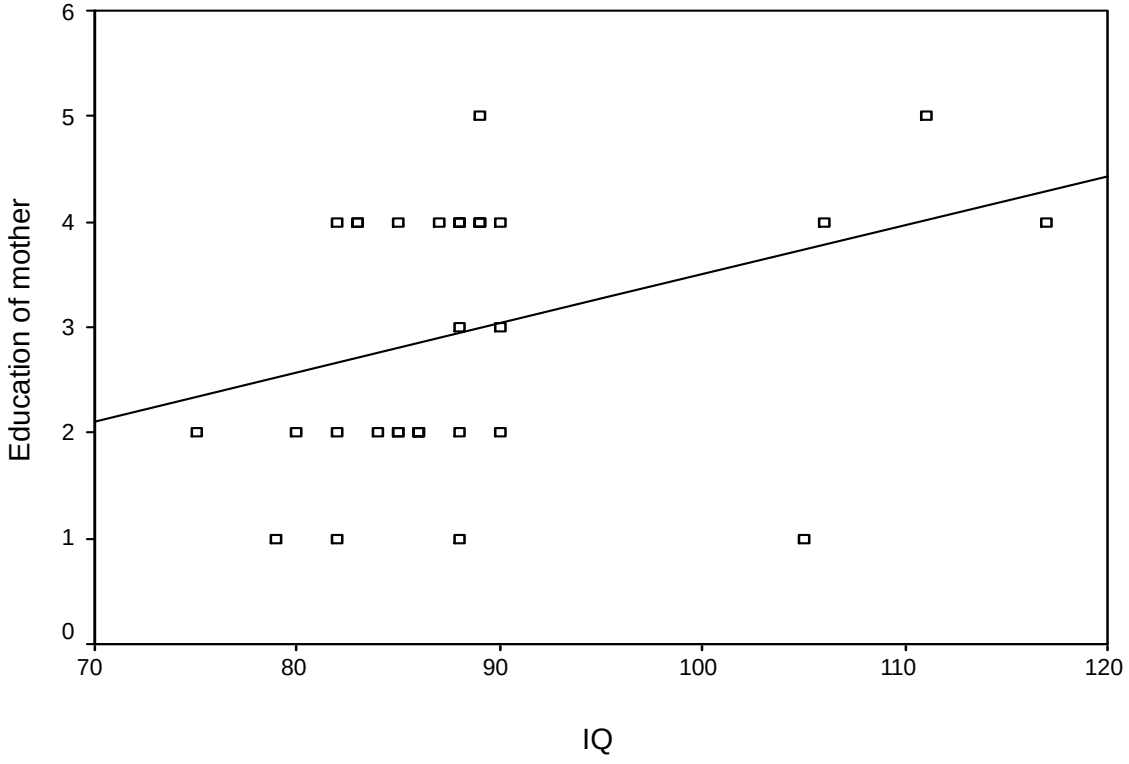


Figure (21): *Linear regression analysis showing a positive no significant correlation between education of the mother and IQ of the child in artificially fed group.*

Table (23): Correlation between age of mother and child's Intelligent Quotient (I.Q)

		BREASTFED (3M)	BREASTFED (6M)	ARTIFICIALLY FED
Age of the mother	**r**	*0.38*	*-0.14*	*-0.21*
	P	*0.09*	*0.38*	*0.22*

Comment: *This table shows that there was no significant negative correlation between age of mother and IQ of the child in breastfed 3 months subgroup and artificially fed group and no significant positive correlation in breastfed 6 months subgroup.*

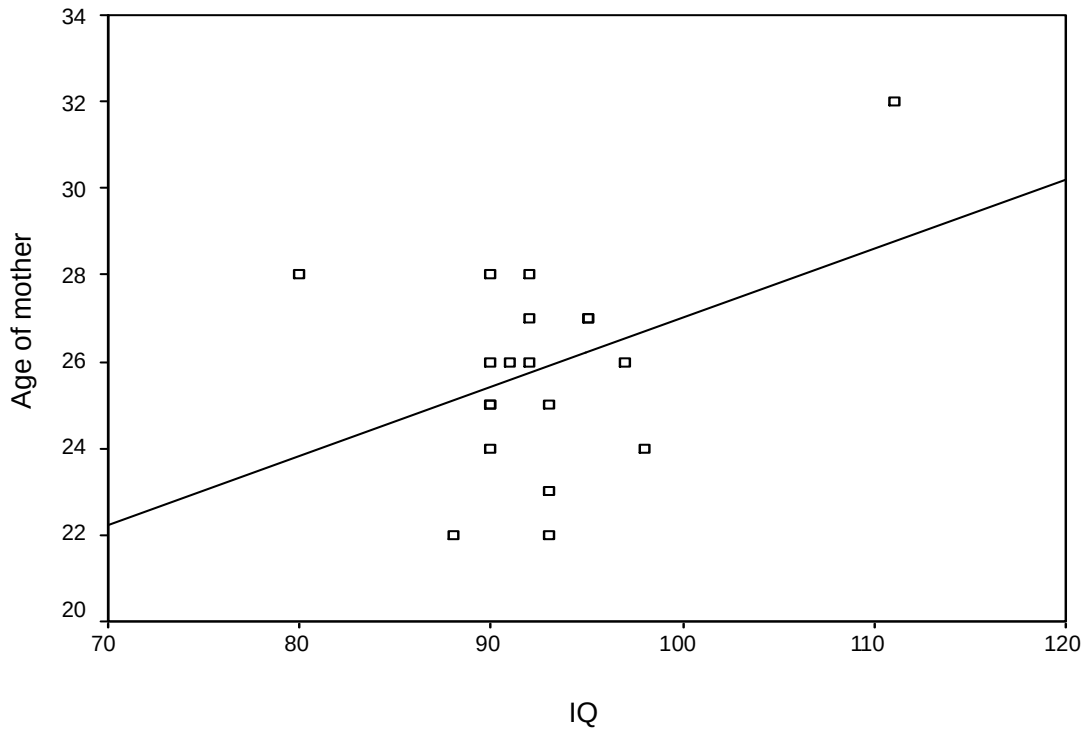


Figure (27): *Linear regression analysis showing a no significant positive correlation between age of mother and IQ of the child in breastfed 3 months subgroup.*

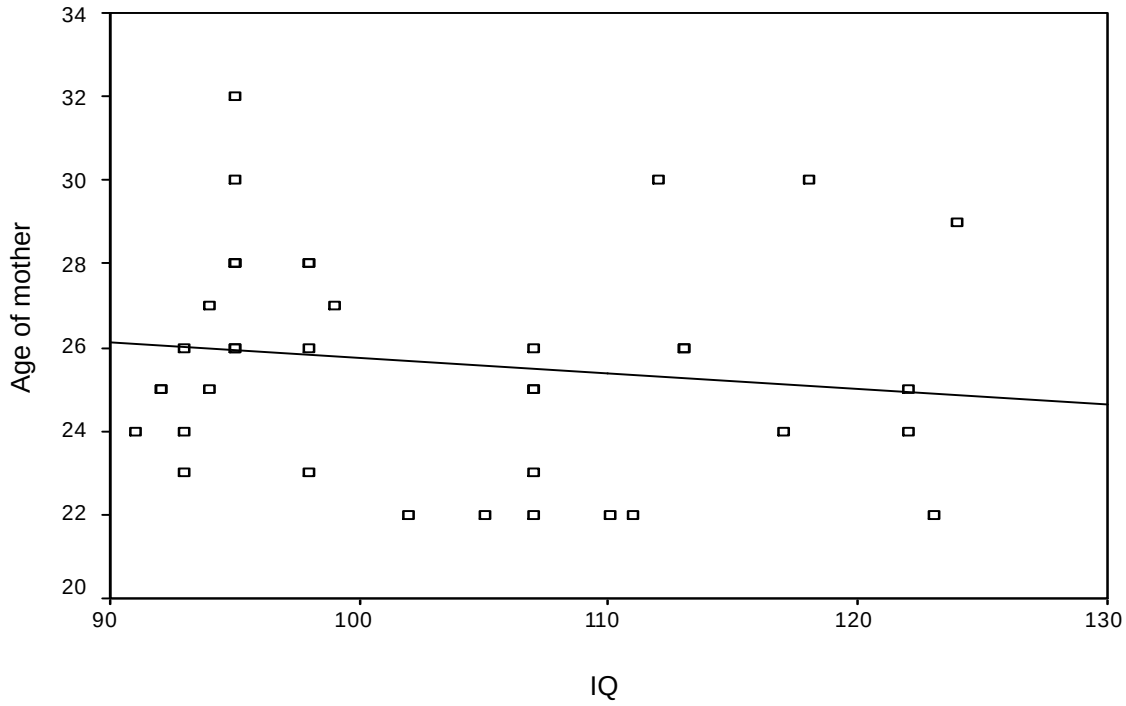


Figure (22): *Linear regression analysis showing a no significant negative correlation between age of mother and IQ of the child in breastfed 6 months subgroup.*

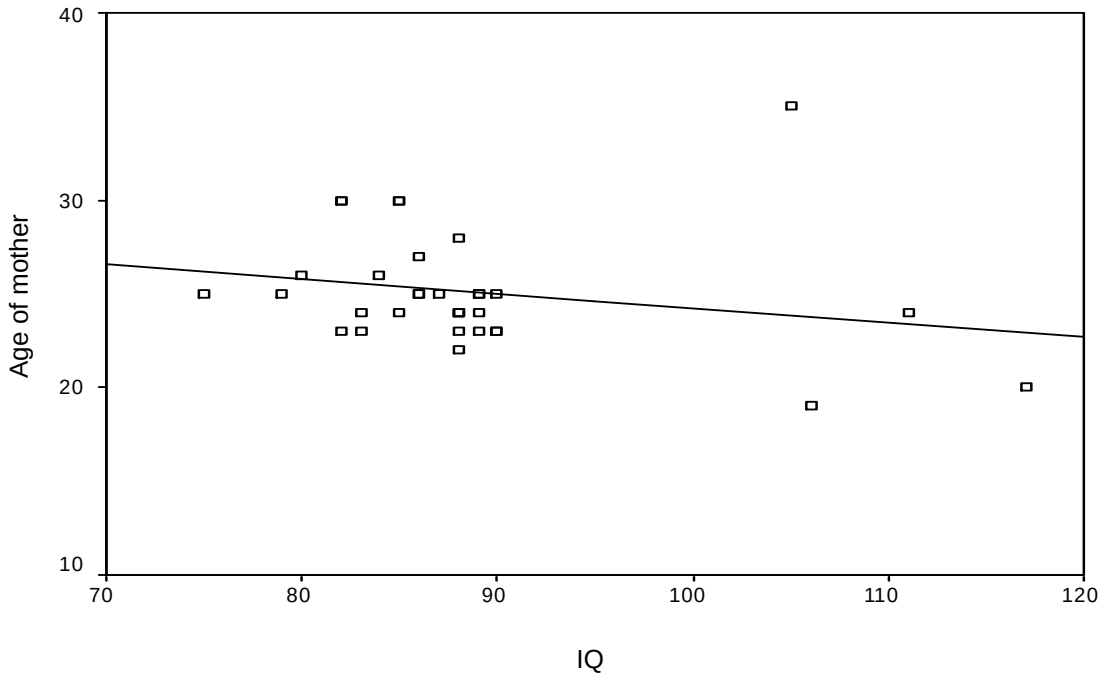


Figure (23): *Linear regression analysis showing a no significant negative correlation between age of mother and IQ of the child in artificially fed group.*

Table (24): Correlation between family size and child's Intelligent Quotient (IQ)

		BREASTFED (3 MONTHS)	BREASTFED (6 MONTHS)	ARTIFICIALLY FED
Family size	**r**	*0.15*	*-0.17*	*-0.031*
	P	*0.53*	*0.303*	*0.86*

Comment: *This table shows that there is a no significant negative correlation between family size and IQ of the child in artificially fed group, breastfed 3 and 6 months subgroups.*

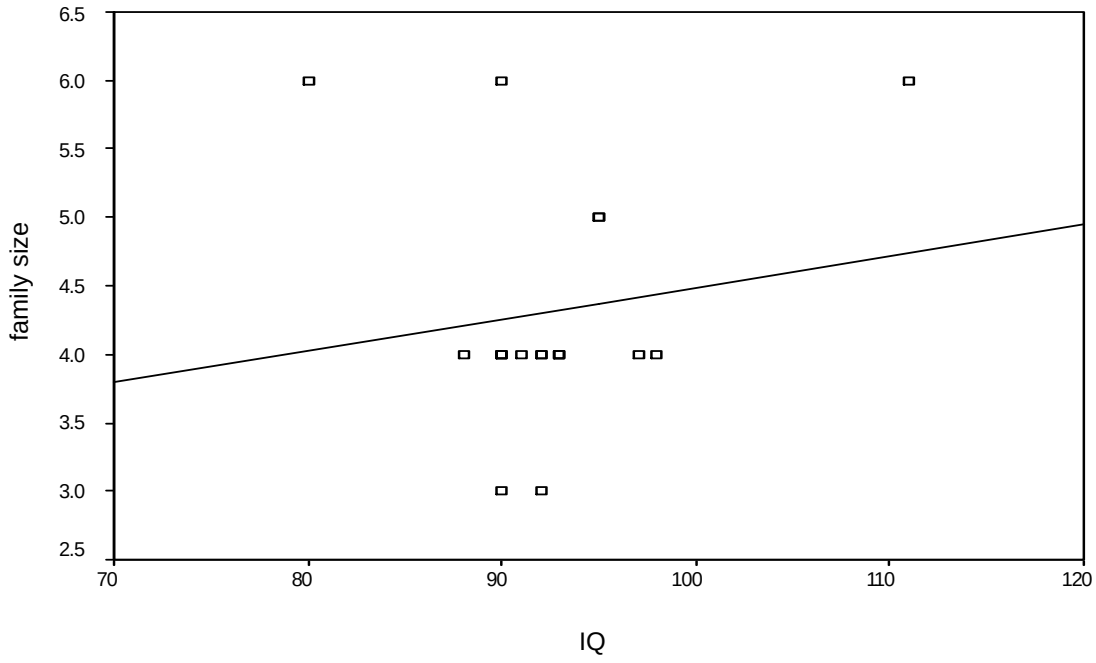


Figure (24): *A linear regression analysis showing a no significant positive correlation between family size and IQ of the child in breastfed 3 months subgroup.*

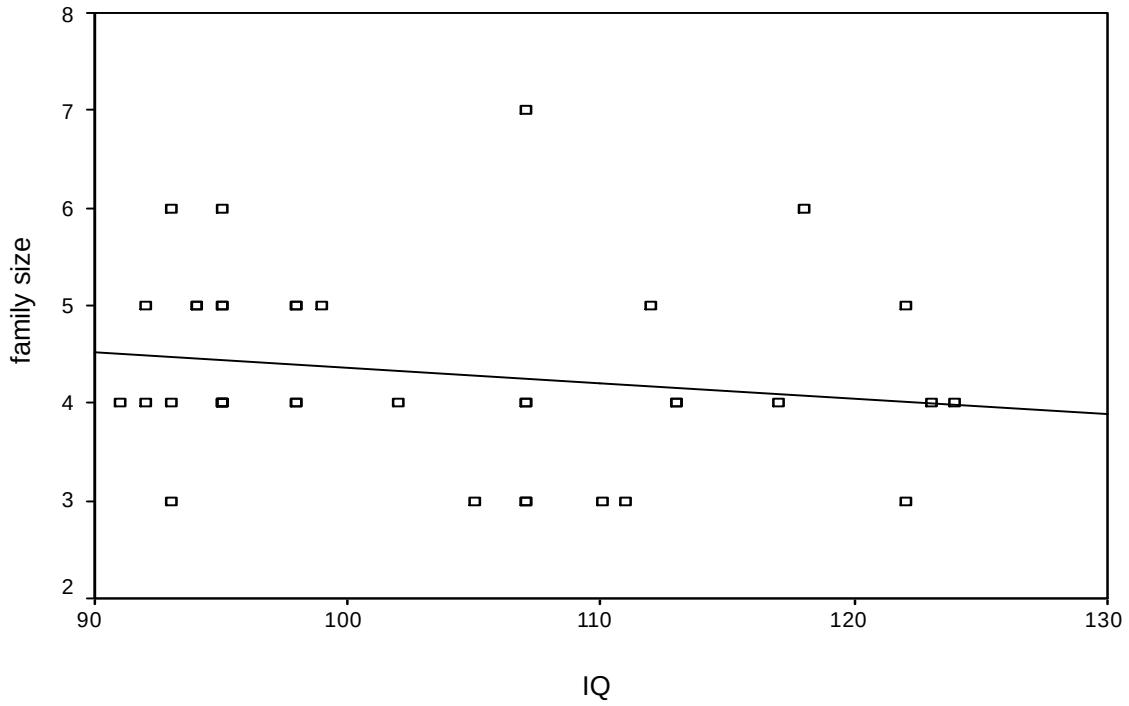


Figure (25): *Linear regression analysis showing a no significant negative correlation between family size and IQ of the child in breastfed 6 months subgroup.*

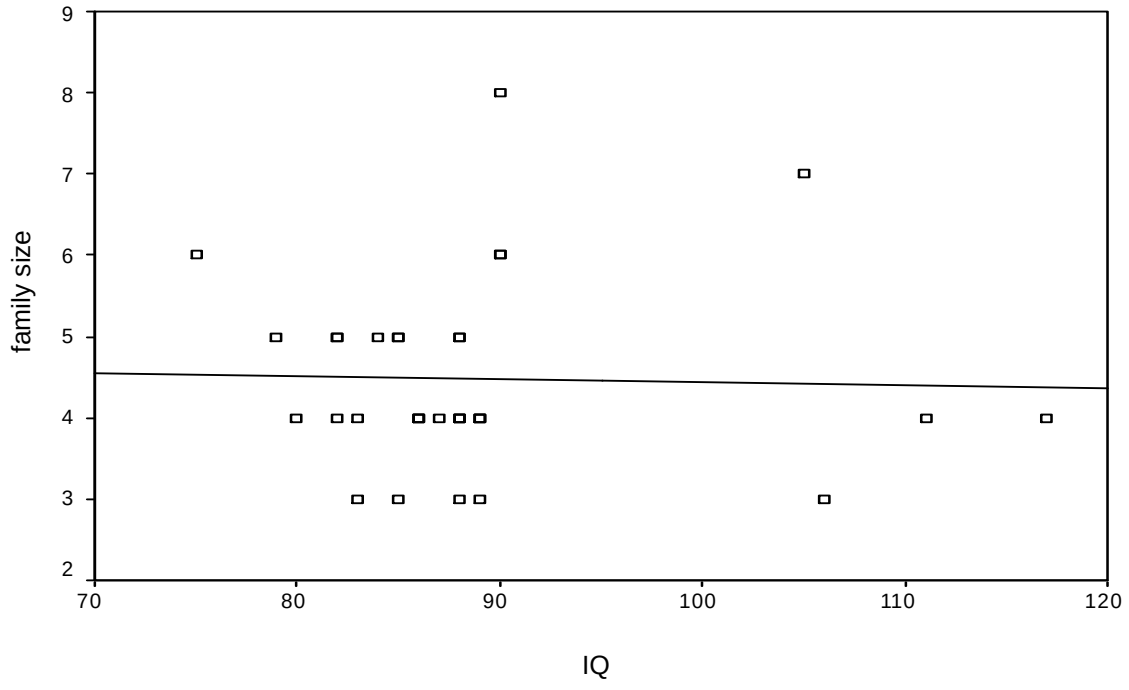


Figure (26): *Linear regression analysis showing a no significant negative correlation between family size and IQ of the child in artificially fed group.*

Table (25): Correlation between the duration of exclusive feeding and child's Intelligent Quotient (I.Q)

		BREASTFED (3 MONTHS)	BREASTFED (6 MONTHS)
Duration of feeding	**R**	*0.76*	*0.476*
	P	*<0.001***	*<0.001****

Comment: *This table shows that there is a positive significant correlation between duration of exclusive breastfeeding and IQ of the child in breastfed 3 and 6 months subgroups.*

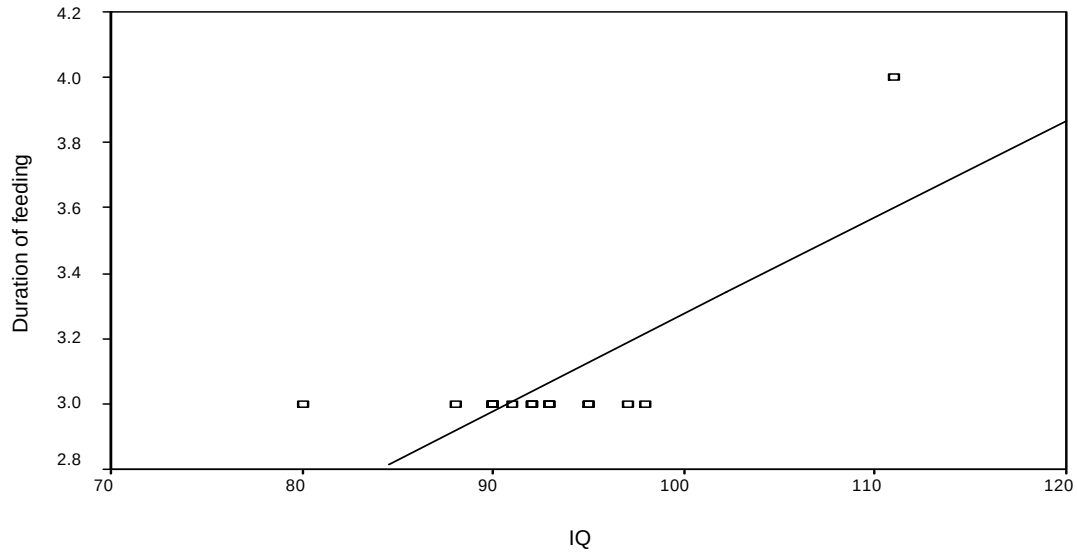


Figure (27): *A linear regression analysis showing a positive significant correlation between duration of feeding and IQ of the child in breastfed 3 months subgroup.*

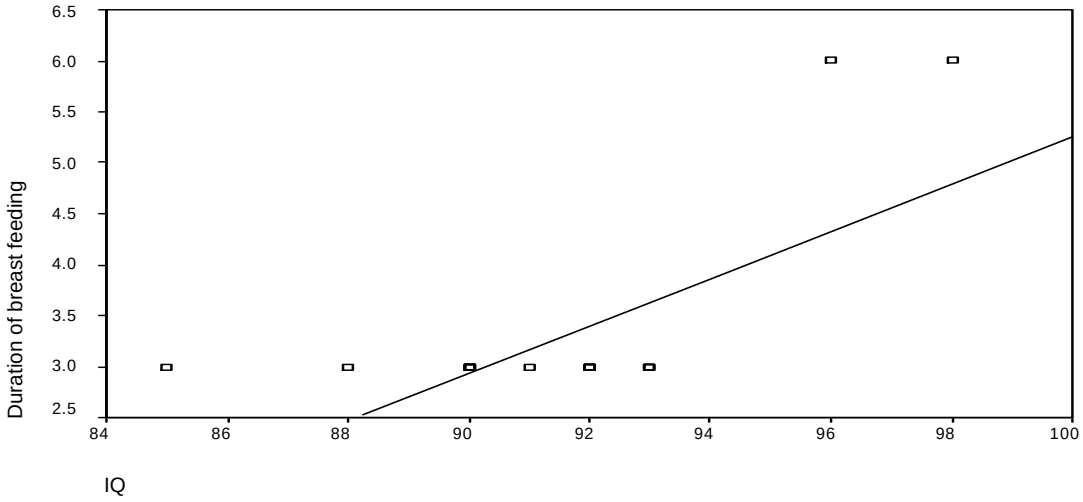


Figure (28): *Linear regression analysis showing a positive significant correlation between duration of breast feeding and IQ of the child in breastfed 6 months subgroup.*

Table (26): Correlation between age of cessation of feeding and child's Intelligent Quotient (I.Q)

		BREASTFED (3M)	**BREASTFED (6M)**
Age of cessation of breastfeeding	**r**	*0.409*	*0.159*
	P	*0.049**	*0.342*

Comment: *This table shows that there is a positive significant correlation between age of cessation of breastfeeding and IQ of the child in breastfed 3 months but with no significant positive correlation in breastfed 6 months subgroup.*

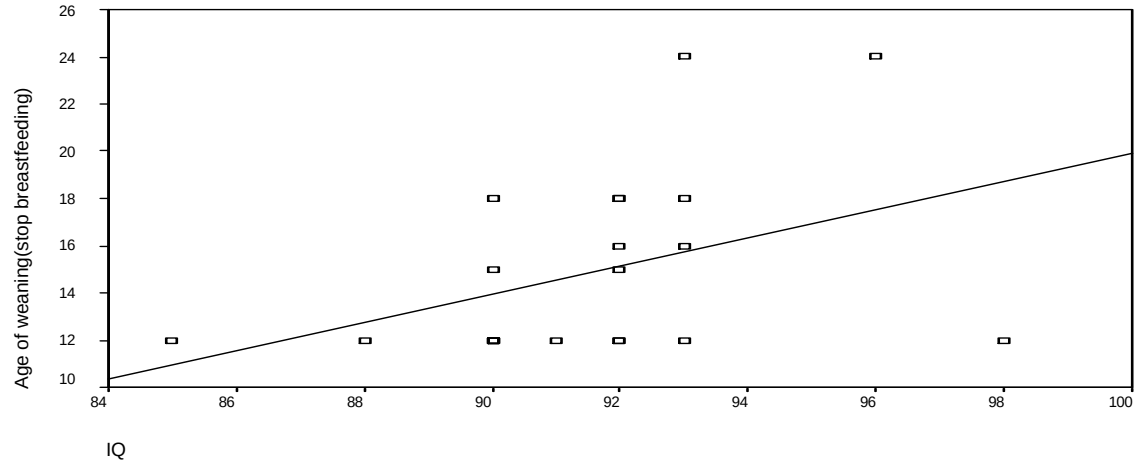


Figure (29): *Linear regression analysis showing a positive significant correlation between age of cessation of breastfeeding and IQ of the child in breastfed 3 months subgroup.*

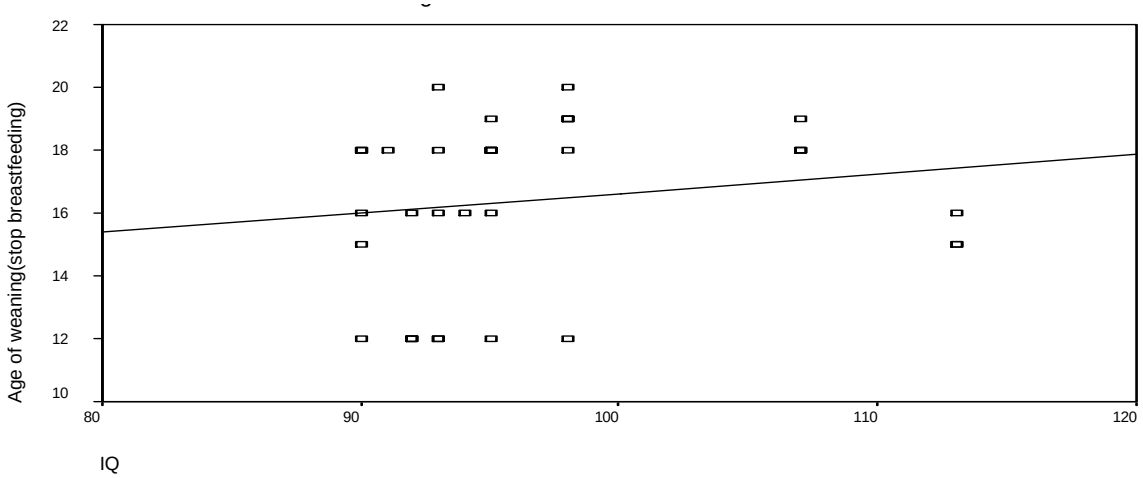


Figure (30): *Linear regression analysis showing a no significant positive correlation between age of cessation of breastfeeding and IQ of the child in breastfed 6 months subgroup.*