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Cognitive and Behavioural Outcome of Preterm Versus Full Term Infants, at School Entry Age

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ABSTRACT

To examine the IQ, general cognitive and behavioural outcome at school age in preterm and full-term children. The present study carried out in Damietta primary schools. The target population were all children in Damietta primary schools. The study included 762 children: 206 children who were delivered at preterm (group B) and 556 children were delivered at full term (group A). All children were submitted to Binet intelligence test and self-administered questionnaires were by the parents. For completing the Binet intelligence test each student was interviewed separately in a quite suitable room by the researcher and two well-trained psychologists. There was significant increase of behaviour score (40-60 and >60) in group B (preterm) in comparison to full term group (26.2, 9.7 vs. 13.3, 4.7%, respectively). Similarly, there was significant increase of enuresis and articulation disorders in preterm group. Finally, there was significant decline of IQ in preterm in comparison to full term group. Furthermore, there was significant correlation between IQ from one site and verbal reasoning, abstract-visual reasoning, quantitative reasoning, short term memory, aggression, attention problems, somatic problems from the other side in full term group while in preterm group, this correlation was significant for verbal reasoning, abstract-visual reasoning, quantitative reasoning, short term and delinquency. Results of the present study revealed that, preterm had lower total score IQ and so, preterm are vulnerable to cognitive affection.

Key words: Intelligence quotient, cognitive, behaviour, full term, preterm

INTRODUCTION

Due to marked advances in neonatal intensive care it had been found that, survival rates of preterm infants had been improved. But improvements in survival have not been accompanied by proportional reductions in the incidence of disability in this population. Thus, survival is not an adequate measure of success in these infants who remain at high risk for neuro-developmental and behavioral morbidities. There is now increasing evidence of sustained adverse outcomes into school age and adolescence, not only for ELBW infants but for infants born late preterm (Stephens and Vohr, 2009).

Compared with their classroom peers, preterm children may have cognitive and neurological impairment at school age (Marlow *et al*., 2005). On exam, 10-11% of low birth weight infants have neurological soft signs, a twofold increased risk compared with their normal birth weight analogues.

Soft signs are defined as deviations in speech, balance, coordination, gait, tone, or fine motor or visual motor tasks that do not signify localized brain dysfunction. These soft signs are associated with an increased the risk of subnormal IQ, learning disabilities, attention deficit disorder and internalizing and externalizing behaviors at 6 and 11 years (Breslau *et al*., 2000).

Children who were born preterm are at risk for reduced cognitive test scores and their immaturity at birth is directly proportional to the mean cognitive scores at school age. Preterm-born children also show an increased incidence of ADHD and other behavior-related disorders (Bhutta *et al*., 2002).

We hypothesized that children delivered at preterm have lower IQ and affected general cognitive and behavioural functions, so this study is designed to examine the IQ, general cognitive and behavioural outcome at school age in children born at term and those who are preterm.

MATERIALS AND METHODS

This is a cross sectional, nested, case control study, carried out in Damietta primary schools. The principles and technique of randomization and selection were followed. Informed consent was obtained from every parent of the student for participation in the study. Measures to guarantee confidentiality on handling the database and questionnaire forms were arranged.

Sample size and randomization technique: The total number of schools is 80 schools: 70 public schools, 4 language school and 6 private schools. The total number of pupils in primary schools was 42824. The primary schools were divided into three categories, public school, language school and private school and randomized selection of the targeted schools were done by lottery method. Our target population was all children in Damietta primary schools. All children who were delivered at preterm were selected and systematic randomization of children who were delivered at full term (every ten) was done. The study included 766 children: 206 children who were dehvered at preterm and 560 children were delivered at full term (four children of them were excluded as they were reared in another country and the other one was excluded because he has diabetes mellitus) so full term children were 556. Students were divided into two groups: Group A: Jealthy children born at term. Group B: Healthy children born at preterm.

The study was conducted during the period from January 2010 to August; 2011. Several visits on scattered days to targeted schools were done on a period of about 14 work months. The Director of the primary school was first met to tell him about the idea of the research and to ask about a suitable quite room to apply the Binet intelligence test. During these visits the researcher moved freely in the different classrooms of the schools observing the different activities of the students. Self-administered questionnaires were given personally hand by hand to every student and after explaining the objectives of the study to the student, he/she was asked to pass the questionnaire to the parents to complete it and not to leave any item empty. About four to sex questionnaires were distributed per day. The distributed self-administered questionnaires were collected when the students returned them back on the next day. For completing the Binet intelligence test each student was interviewed separately in a quite suitable room. Nobody was allowed to enter the room in order not to interrupt the student. Mild acute illnesses were rolled out.

The team of work was consisted of the researcher and two will-trained psychologists were needed to perform, evaluate and interpret the results.

The child was comfortably seated, greeting and candies were offered in order to achieve a good relationship with him. Total testing time is 90-120 min, depending on the student's age and the

number of subtests given. All test student's took an initial vocabulary test which along with the student's age, determines the number and level of subtests to be administered. Precise data about the student was collected in short time. The basal level was assessed and used as the entrance level in the following 14 items of the test.

Test scores provide an estimate of the level at which a child is functioning based on a combination of many different subtests or measures of skills.

The numbers of correct responses on the given subtests are converted to Standard Age Score (SAS) which is based on the chronological age of the test subject. This score is similar to an I.Q. score. Based on these norms, the Area Scores and Test Composite on the Stanford-Binet Intelligence Scale each have a mean or average score of 100 and a standard deviation of 16. For this test, as with most measures of intelligence, a score of 100 is in the normal or average range. The standard deviation indicates how above or below the norm a child's score is.Standard Age Score is then converted to Standard Age Score for areas through special tables then composite overall score in other tables to obtain intelligence quotient level.

Several methods were used for data collection: Self administrated questionnaire sent to the student's parents to detect gestational age, mode of delivery, type of lactation, past medical and surgical history, socioeconomic status; complete physical and medical examination; Cognitive functions were evaluated by Stanford-Binet Intelligence Scales (SBS) Fourth Edition (Stanford-Binet IV) and behaviour was assessed by child behaviour chick list.

Data management and analysis: All collected questionnaires were revised for completeness and logical consistency. Pre-coded data was entered on the computer using Microsoft Office Excel Software program for windows, 2003 after being translated to English to facilitate data manipulation. Data was then transferred to the Statistical Package of Social Science Software program, version 16 (SPSS) to be statistically analysed. Description of quantitative variables in the form of mean, Standard Deviation (SD), range, frequency and percentage were used. Chi square and regression analysis tests were used for testing significance of observed differences between studied groups. A multivariate linear regression analysis was done to test for the significant predictors for knowledge score among students. P values equal to or less than 0.05 were considered statistically significant.

RESULTS

The study was conducted on a total number of 762 students including 72.9% children delivered at full term and 27.1% children were delivered at preterm.

In the present study, male gender represent 66.7% of full term group, compared to 65% of preterm group with no significant difference between both groups; the most prevalent age group in full term group was 9-11 years, represents 39.9% while in preterm group, the age group 7-9 years was the most common (55.3%) with significant difference between both groups; the most common birth order in full term group was the first (41.7%) and in preterm group (43.5%) with significant difference between both groups; urban residence reported in 64% in group A compared to 67% in group B with no significant difference; CS delivery was significantly increased in group B (68.9% vs. 52.5%); the most common site of delivery was hospital in both groups with significant increase in group B (83.5 vs. 71.0%, respectively); NICU admission was significantly increased in group B (21.8% vs. 5.0%); There was significant increase of NICU admission duration in group B;

Table 1: Personal and obstetric characteristics of studied students

Variable	Full term (group A) (n = 556)	Preterm (group B) (n = 206)	Test	p-value
Male gender	372 (66.9%)	134 (65.0%)	0.23	0.63
Age group				
7-9 years	198 (35.6%)	114 (55.3%)	42.98	<0.001*
9-11 years	222 (39.9%)	80 (38.8%)		
11-13 years	136 (24.4%)	12 (5.8%)		
Birth order				
First	242 (43.5%)	86 (41.7%)	22.58	<0.001*
Second	196 (35.3%)	58 (28.2%)		
Third	100 (18.0%)	38 (18.4%)		
Fourth	18 (3.2%)	20 (9.7%)		
Fifth	0 (0.0%)	4 (1.9%)		
Urban residence	356 (64.0%)	138 (67.0%)	1.02	0.31
CS mode of delivery	328 (52.5%)	142 (68.9%)	28.43	<0.001*
Site of delivery				
Hospital	389 (71.0%)	172 (83.5%)	13.34	0.001*
Clinic	120 (21.6%)	24 (11.7%)		
Home	38 (6.8%)	10 (4.8%)		
NICU admission	28 (5.0%)	45 (21.8%)	42.47	<0.001*
NICU duratiou				
<5 days	12 (2.1%)	8 (3.8%)	25.01	<0.001*
5-10 days	16 (2.9%)	7 (3.4%)		
>10 days	0 (0.0%)	30 (14.6%)		
Feeding				
Breast	474 (85.3%)	114 (55.3%)	72.11	<0.001*
Artificial	44 (7.9%)	50 (24.3%)		
Complementary	38 (6.8%)	42 (20.4%)		
Duratiou of feeding				
<6 months	54 (9.7%)	28 (13.6%)	7.45	0.02*
6-12 months	188 (33.8%)	84 (40.8%)		
>12 months	314 (56.5%)	94 (45.6%)		

there was significant decrease of breast feeding in group B (55.3% vs. 85.3%) and the duration of feeding was significantly shorter in group B (Table 1).

In the present study, there was significant increase of behaviour score (40-60 and >60) in group B (preterm) in comparison to full term group (26.2, 9.7 vs. 13.3, 4.7%, respectively). Similarly, there was significant increase of enuresis and articulation disorders in preterm group (24.3 and 13.6%) vs. (13.7 and 4.3%) in full term group respectively). In addition, there was significant decline of IQ in preterm in comparison to full term group (Table 2).

Running regression analysis between total score IQ and other parameters revealed that, there was significant correlation between IQ from one site and verbal reasoning, abstract-visual reasoning, quantitative reasoning, short term memory, aggression, attention problems, somatic problems from the other side in full term group while in preterm group, this correlation was significant for verbal reasoning, abstract-visual reasoning, quantitative reasoning, short term and delinquency (Table 3). In preterm cases, short term memory is highly correlated with IQ score so

Table 2: Comparison between studied groups as regard behavioural score, IQ score

Parameters	Full term (group A) (n = 556)	Preterm (group B) (n = 206)	Test	p-value
Behavioural score				
<40	456 (82.0%)	132 (64.1%)	27.47	<0.001%
40-63	74 (13.3%)	54 (26.2%)		
>63	26 (4.7%)	20 (9.7%)		
Behavioural problems				
Enuresis	76 (13.7%)	50 (24.3%)	12.24	<0.001%
Encorporesis	10 (1.8%)	10 (4.9%)	5.49	0.20
Sleep disorder	36 (6.5%)	16 (7.8%)	0.40	0.50
Articulation disorder	24 (4.3%)	28 (13.6%)	20.34	<0.001*
Nail pitting	110 (19.8%)	50 (24.3%)	1.83	0.18
Nail suckling	10 (1.8%)	4 (1.9%)	0.02	0.70
IQ level				
Very superior	30 (5.4%)	10 (4.9%)	34.43	<0.001*
Superior	58 (10.4%)	12 (5.8%)		
High average	130 (23.4%)	60 (29.1%)		
Average	308 (55.4%)	90 (43.7%)		
Low average	18 (3.2%)	14 (6.8%)		
Borderline	12 (2.2%)	20 (9.7%)		

Table 3: Regression analysis between total score IQ and the studied parameters in full term

	Total score IQ (Term)			Total score IQ (Preterm)		
Parameters	Coefficients	t	Significance	Coefficients	t	Significance
Verbal reasoning	0.286	16.59	S	0.306	14.83	S
Abstract-visual reasoning	0.138	10.19	S	0.277	17.67	S
Quantitative reasoning	0.393	16.06	S	0.257	12.20	S
Short term	0.359	27.52	S	0.320	18.56	S
Depression	0.166	0.748	NS	-0.398-	-1.271-	NS
Social withdrawal	-0.104-	-0.361-	NS	0.294	0.474	NS
Aggression	0.368	2.402	S	0.157	0.705	NS
Delinquency	-0.426-	-1.520-	NS	-2.702-	-4.920-	S
Attention problems	-1.244-	-3.760-	S	0.028	0.068	NS
Thinking problems	-0.567-	-1.653-	NS	0.271	0.612	NS
Social problems	-0.075-	-0.179-	NS	-0.579-	-0.991-	NS
Somatic problems	0.740	2.724	S	0.2360	0.545	NS

it is the most affected items among studied children followed by Abstract-Visual Reasoning and Delinquency more affected among preterm (Table 4).

DISCUSSION AND CONCLUSION

The present study represented a form of a cross sectional, nested, case control study. For assessment of IQ, general cognitive and behavioral outcome at school age in children born at term versus preterm in Damietta Governorate, Egypt.

Though this study gripped systematically the measuring of intelligence in children at school age that provides a reliable assessment of general cognitive functioning; It delineates that prematurity has an impact on intelligence total score, The IQ scores, although within the normal range, were lower than full term that is (108±14) in full term versus (104±16) in preterm. Our study is in mean

Table 4: Regression analysis between total score IQ and the studied parameters in preterm

	Total score IQ		
Parameters	Coefficients	t	Significance
Verbal reasoning	0.306	14.83	S
Abstract-visual reasoning	0.277	17.67	S
Quantitative reasoning	0.257	12.20	S
Short term	0.320	18.56	S
depression	-0.398-	-1.271-	NS
Social withdrawal	0.294	0.474	NS
Aggression	0.157	0.705	NS
Delinquency	-2.702-	-4.920-	S
Attention problems	0.028	0.068	NS
Thinking problems	0.271	0.612	NS
Social problems	-0.579-	-0.991-	NS
Somatic problems	0.2360	0.545	NS

accordance with a random-effects meta-analysis that showed the weighted significantly differences between the mean cognitive scores of the preterm and the full term which was 10.9 in favour of the full term (Bhutta *et al*., 2002). It also, agreed with the results of Begega *et al*. (2010) who found that preterm children, in general, display great heterogeneity in the impairment of the cognitive abilities assessed by L-M form of the Stanford-Binet Intelligence Scale and showed that total preterm score was (102±8.2) and full term (106±7.7). On the other hand Walker *et al*. (2010) exhibited fewer cognitive difficulties in preterm group than children in the control group. Compared with normal birth weight NBW children, LBW-T children in the control group had poorer selective attention and visual-spatial memory but there were no differences in IQ, language, or behaviour. We could explain such difference by the methodological tools applied and sample type.

The present study clarified that preterm birth and its complications affect all domains of cognitive and language function. An alternative possibility is that preterm birth is associated with domain-specific impairments that are dissociable from general cognitive deficits but difficult to detect because they co-occur with low IQ, Short term memory preterm score was (98.5±18.7) and full term (104±8), followed by Verbal reasoning preterm score was (99.9±14.6) and full term (102.4±11). Regression analysis between total score IQ and the studied parameters in preterm, Short term memory is highly correlated with IQ score so it is the most affected items among studied children followed by Abstract-Visual Reasoning (fluid reasoning). These results go in alignment with Taylor *et al*. (2000) and Luu *et al*. (2011), who reported that, even after exclusion of preterm subjects with significant disabilities, adolescents born preterm in the early 1990s were at increased risk of deficits in executive function and memory.

In addition it had been reported that, at neuropsychological assessment, preterm children scored significantly lower than term comparison children in all tests. After adjustment for cognitive level and maternal education, differences remained statistically significant for verbal fluency ($p<0.05$), comprehension, short-term memory and spatial abilities (Dall'oglio *et al*., 2010).

Our results reveal that the preterm had more behaviour problems (35.9%) scoring above the borderline cut-off (two folds the full term group). We found statistically significance as regards behavioural score, about one forth preterm (26.2%) and only 13.3% of full term showed positive behavioural score; about one tenth preterm (9.7%) and only one fifth full term (4.7%) have

dangerous behavioural score. So, preterm were liable to abnormal or sever behavioural problems than full term and Delinquency affection was significant among preterm with Regression analysis for male Social problems and aggression are more prominent in females depression and Delinquency are more prominent, so parents and paediatrician should take care of Preterm children who exhibit higher rates of behaviour problems early in development. Our results were in agreement with the meta-analysis of Bhutta *et al.* (2002) who found that, Children who were born preterm showed increases in externalizing or internalizing behaviours in 13 (81%) of these 16 studies. Similarly, 9 (69%) of 13 studies found a significantly higher prevalence of externalizing symptoms while 9 (75%) of 12 studies found a significantly higher prevalence of internalizing symptoms in the cases vs. the controls.

Potharst *et al.* (2011) applied SDQ behavioural score and found that normal full term (91.6%) versus preterm (61.5%), Mildly abnormal (8.4), (38.5%) for full term and preterm, respectively, severely abnormal (3.2), (18.3) for full term and preterm respectively Possible bright explanations for this discrepancy may includethe difference in tools administered and geographic distribution.

Similarly, Van Baar *et al.* (2009) found that the pretermchildren had more behavior problems (specifically internalizing problems with 27% scoring above the borderline cut-off), as well as more attention-deficit/hyperactivity disorder characteristics (specifically attention deficits).

Johnson *et al.* (2010) concluded that almost one quarter of extremely preterm children had a psychiatric disorder at 11 years of age. Behavioural score also correlates with total IQ score thus the lower IQ was associated with abnormal or sever behavioural problem, so, there is considerable difference between risk factors for different sex; the variables independently associated with emotional symptoms are female gender, high parental stress and poor general health. The factors associated with hyperactivity and inattention is male gender, the variables associated with behavioural problems are living in a non-traditional family, drug abuse in the family, higher parental stress and harsh physical punishment.

Similarly Goodman *et al.* (2007) and Spittle *et al.* (2009) found that Preterm children exhibit higher rates of behaviour problems early in development, in particular internalizing and dysregulation problems and poorer competence and lower IQ.

Other strength of the study is that its Comparison of intellectual quotient level of studied groups regarding to behavioural problems and clarification that one third preterm with enuresis and articulation disorders had lower IQ scores, other problems as, encorpoesis, sleep disorders, nail pitting and sucking had no significant difference.

Furthermore, Dai *et al.* (2007) concluded that the total intelligence level of children with Primary Nocturnal Enuresis, (PNE) was normal, but the M/C factor in the intelligence structure had some defects, suggesting that PNE may be related to the abnormity of executive function in the frontal lobe.

Barre *et al.* (2011) concluded that preterm children have significantly poorer language function compared with control children. These language difficulties are still present throughout primary school, a time when language development becomes more stable and adult-like.

In addition, Dennis *et al.* (2009) found Prematurity has a direct impact on verbal memory and linguistic processing speed which also had classified as a fluid function and found that deficits in speech articulation and prereading skills (<10th centile) were three to five times more frequent in very preterm children. More than 18% of very preterm children had cognitive deficits in more than five areas of functioning, compared with no control children. The differences between very preterm children and controls remained highly significant when only very preterm children and controls without major neuro-sensory impairment were considered.

Very preterm and/or VLBW children have moderate-to-severe deficits in academic achievement, attention problems and internalizing behavioural problems and poor EF which are adverse outcomes that were strongly correlated to their immaturity at birth. During transition to young adulthood these children continue to lag behind term-born peers (Aarnoudse-Moens *et al.*, 2009). In addition, the preterm child is at increased risk for sub-clinical behavioural problems and can most often be described as inattentive, shy or withdrawn and with poor social skills. Preterm children are more likely to have psychiatric disorders, of which ADHD is the primary abnormal outcome. The lack of co morbid hyperactivity and conduct disorders suggests a 'purer' form of attention deficit. There is also some evidence of increased risk for Autistic Spectrum Disorders in VPT children but this requires further investigation (Johnson, 2007).

In short, results of the present study revealed that, preterm had lower total score IQ so, preterm are vulnerable to cognitive affection. Preterm birth is associated with domain-specific impairments and Short term memory is highly correlated with IQ score so it is the most affected item among studied children.

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