

Neurobehavioral outcomes of school-age children born preterm: a preliminary study in the Arabic community

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Abstract

Introduction: Preterm survivors from the neonatal intensive care unit (NICU) are considered as high risk group for some neurobehavioral impairments such as cognitive disabilities, developmental delays, social/emotional limitations, attention-deficit/hyperactivity disorder (ADHD), and academic difficulties.

Objective: The current study aimed to investigate the neurobehavioral outcome of premature infants in Saudi Arabia at the school age.

Methods: At the school age, preterm children (range 23-29 weeks or ≤ 1.52 kg) born from April, 2006 through September, 2008, and who were admitted following birth to a NICU, were evaluated with several neurobehavioral tools.

Results: This study includes 53 preterm children, who were followed up at the chronological age that ranged from 6.4-8.0 years. The results of the neurobehavioral assessments showed in general normal social adaptive levels and cognitive abilities, with mean total score of about 91.0 and 90.0, respectively. The prevalence of ADHD among preterm children was high, with result of 34.0% for the inattentive type and 11.3% for the hyperactive/impulsive type. None of the preterm children repeats a grade, but 22.6% utilize a form of special educational supports. Some of the preterm children showed poor school performance in reading skills, writing skills and mathematics skills, with percentages of 26.4%, 28.3% and 15.1%, respectively.

Conclusions: The present results emphasize that preterm children are a group of high-risk children who need regular follow-up to track the developmental conditions and to provide the early developmental intervention for optimal outcome.

Keywords

Neonatal, neurobehavioral, developmental, neuropsychology, preterm children, Saudi Arabia.

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Introduction

The high risk of neurobehavioral impairment following preterm birth requires long-term follow-up for early identification and early interventions. The international recommendations for neonatal services advise that routine clinical evaluation follow-up should include neurobehavioral assessment until school age [1].

It was reported in previous studies that about 17% of preterm children at 6-10 years had some form of obvious impairment, including intelligence impairment or developmental quotient below 70, and about 40% had minor impairment such as intellectual abnormalities or developmental limitations [2].

Long-term outcomes in neurobehavioral studies focused on cognitive impairment, given the risk of later learning difficulties, attention deficits, and poor school performance in this population [3-5].

Cognitive development in preterm-born children is an important factor to understand long-term outcomes. Some clinicians think that the cognitive impairment at early ages will gradually disappear with age as preterm-born children catch up with their peers intellectually [4].

It has been reported that social features or the adaptive behavior are a superior indicator of difficulties later in life [6]. Adaptive behavior is defined as the conceptual, social, and practical skills that people have learned in order to function in their everyday lives [7].

The limitations among preterm children extend to affect the school performances.

Some studies have reported limitation in school performances such as poor mathematics, poor reading [4], and some of the preterm children were attending special school at 5 years of age [8].

School performances are an important factor that needs to be assessed, as this factor is likely to be related to cognitive ability: they may reveal

additional deficits that need to be identified and treated at the early age.

Furthermore, preterm children were found to be more vulnerable to other certain types of psychological difficulties including attention-deficit/hyperactivity disorder (ADHD) [5, 9]. It was found that increased risk of ADHD was present among preterm children at age 6 years or above [10, 11].

Previous Saudi study [12] investigated the first 3 years of preterm children. That study included cognitive and social skills, but not the school behavior or the school performance.

Except that study, there are no indications of any other previous investigations in Saudi Arabia that assessed preterm children neurobehaviorally. The present study will evaluate the neurobehavioral outcome including cognitive and social skills as well as the school-performance at 7 years of age in a cohort of preterm-born children.

Method

The current sample includes a cohort of 53 preterm children whom were evaluated previously at age of 3 years, and whom were followed up at pediatric psychometric clinic at the Kingdom Hospital in Riyadh. The previous evaluation at age of 3 years has been described in detail elsewhere [12].

Preterm children were high risk babies (age ranging 23-29 weeks or born with birth weight of 1,520 g or less). The same exclusion criteria of the previous study [12] were applied here also. Exclusion criteria for this study were: dysmorphic preterm children, abnormal oropharyngeal reflexes, strabismus, abnormal tone, emotionality or abnormal reflexes, autism spectrum disorders as well as cerebral palsy which was diagnosed based on the clinical findings of abnormal posture. The neurobehavioral evaluations included: the Vineland Adaptive Behavior Scales; the Stanford-Binet Intelligence Test and the Vanderbilt ADHD diagnostic rating scale.

Each enrolled child was assessed individually in a very quiet clinic, which was designed mainly to observe and assess children psychometrically. The neurobehavioral assessments' results were interpreted according to the chronological age.

Instruments

Serial neurobehavioral follow-up evaluations were performed. Preterm children were evaluated

using standardized instruments to assess neuro-behavioral features.

The Arabic version of Stanford-Binet Intelligence Test (SBITA), the fifth edition [13], was used. In Arab countries this Intelligence test was standardized for use several years ago with good reliability and validity [14]. The SBITA produces standardized scores with a mean of 100 and standard deviation of 16 points. SBITA is intended to assess intelligence in four areas, including: Abstract and Visual Reasoning, Quantitative Reasoning, Verbal Reasoning, and Short-term Memory. Total IQ quotient was classified according to the Arabic version into: mentally retarded (≤ 67), borderline intelligence (68-78), below average (79-88), average (89-110), above average (111-120), excellent (121-131) and genius (≥ 132).

Preterm children's behaviors and ability to function adequately in the environment are measured using the Vineland Adaptive Behavior Scales, Arabic version (VABSA) [15]. Commonly, social profile and social-emotional skills are measured by VABSA.

This test includes four subdomains: Communication, Socialization, Daily Living Skills and Motor Skills. The VABSA provides the information required for the evaluation of several disabilities such as developmental delays, functional skills impairment, and learning disability. The mean total score of the VABSA, according to the Arabic version, was classified as: low adaptive behavior (≤ 69), below average (70-84), average (85-115), above average (116-130), and high adaptive behavior (≥ 131).

Vanderbilt diagnostic rating scale, the Arabic version [16, 17], was used to measure the ADHD and oppositional-defiant disorder (ODD). Recent studies support the utility of the Vanderbilt diagnostic rating scale as a diagnostic rating scale for ADHD [18]. The full Arabic version of the Vanderbilt ADHD diagnostic rating scale includes subdomain which evaluate the school behavior and performances. Teachers and parents were asked to rate on a scale of 0 (never) to 3 (very often). The score of 2 or 3 were considered to be a positive endorsement for each item. The cutoff was at least 6 positive items in at least one cluster of intention or hyperactivity impulsiveness. To consider the children's exhibited inattentive type behavior, hyperactive/impulsive type behavior or ODD type behavior, at least six positive items must be reported in both scales (i.e., teacher and parent scales). For

the ODD subdomains the cutoff were 4 positive items. Questions about school performances (3 items) were rated on a 5-point rating scale by both parents and teachers. A rating of 1 or 2 is considered to be a positive endorsement for each question. The social subscale contains descriptors of social behaviors in areas that include affective understanding, perspective taking, initiating interactions, and maintaining interactions. The respondent rates the child's ability to perform each behavior on a 5-point scale which was rated by both parents and teachers. A rating of 1 or 2 is considered to be a positive endorsement for each question. There were follow-up questions which give parents the chance to specify their detailed concerns and goals for their child's social skills [19]. All of these scales have excellent normative data, demonstrate good reliability and validity, and yield useful diagnostic information [15, 16, 20].

Results

The final sample included 53 preterm children. The demographic characteristics of the sample are presented in **Tab. 1** which summarized the birth history. There were 49 singleton children and 2 sets of twins. Means of chronological age at the neurobehavioral assessments were 7.1 with age ranging between 6.4 and 8.0 years.

The children's family characteristics mostly represented middle to upper class, with at least an undergraduate or better education, including about 11% holding a master's degree or other postgraduate degrees. The majority of the parents' ages ranged from 22 up to 30 years. Most parents (47, 88.7%) were married and in a stable relationship. Five parents (9.4%) were divorced and only 1 mother (1.9%) was widow. In general, the majority of parents who participated in this study were both mother and father together (34, 64.2%); the remaining were mothers alone (18, 34.0%), and one father alone (1.9%).

The overall scores of the Vineland scale showed normal neurobehavioral levels in general with mean total score 91.3 and range of 55-133. Means, SD and ranges of the communication, socialization, daily living skills and motor skills subscales are shown in details in **Tab. 2**. Adaptive behavior deficits and borderline scores were reported among 20.8% of the sample, with means of 59.0 and 81.5, respectively. While normal adaptive behavior levels were reported among 79.2% of the sample with mean of 94.5.

The cognitive abilities according the Stanford-Binet test showed normal IQ levels in general with mean total score 90.0 and range of 45-119. The lowest score among the IQ subscales were for the quantitative reasoning with score of 82.0 and range of 34-109. The best performance in the IQ subscales was reported for the visual reasoning with mean total score of 90.3 and range of 36-128. Mild learning disability was reported among 7 children (13.2%) and borderline IQ was reported among 11 children (20.8%).

Cross-tabulations were used between all pairs of subscales (**Tab. 3**) to obtain the prevalence of ADHD among children and according to the three criteria: teachers alone, parents alone and teachers and parents together. Surprisingly, inattentive type behavior reported by both parents and teachers was detected among 34.0%, while hyperactive/impulsive type behavior and ODD type behavior were detected among 11.3% and 3.8% of the sample, respectively.

Tab. 4 shows the results of teachers regarding the school performances among the preterm children comparing to their peers. Teachers' results show that about 19 children (35.8%) performed in general less than their peers. In details and according to their teachers, preterm children's school achievements including, reading skills, writing skills and mathematics skills were less than their peers in 26.4%, 28.3% and 15.1% of the sample, respectively.

Tab. 4 shows also the results of teachers regarding the social behavior among school. Again, teachers' results show that about 28% of the sample in general show some social behavior skills which could be ranked less than their peers. Teacher detected the limitation of social behavior skills through the subdomains of: relationships with peers, inability to following rules, disrupting behavior and inability to doing things properly, with percentages of 11.3%, 7.5%, 15.1% and 17.0%, respectively. Finally, according to both,

Table 1. Study population, characteristics of the preterm children.

Age at the current evaluation, years		Mean = 7.1 years Range = 6.4-8.0 years	
Gender, n (%)	Male	31 (58.5)	
	Female	22 (41.5)	
Premature birth history			
Gestational age, mean_SD, weeks		Mean = 27.97 weeks SD = 3.90 weeks Range = 23-29 weeks	
Birth weight, mean_SD, g		Mean= 1,322.12 g SD= 701.58 g Range = 530-1,520 g	
Brain ultrasound	Normal	40 (23.81)	
	Minor Bleeding	21 (12.50)	
	Major bleeding	19 (11.31)	
Length of stay in the NICU, days		Mean = 53.57 days SD = 37.32 days Range = 9-267 days	
		n	%
Mode of delivery	Normal	35	66.0
	Caesarian	18	34.0
Parents age, n (%)	≤ 30	28	52.8
	31-40	14	26.4
	≥ 41	11	20.8
Mother's educational level	High school or less	16	30.0
	Undergraduate or higher	37	70.0
Monthly household income	< 2,000\$	9	17.0
	2,000-4,000\$	32	60.4
	≥ 4,000\$	12	22.6

Table 2. Serial neurobehavioral results: results of the Vineland Adaptive Behavior Scales, Arabic version (VABSA), and the Stanford-Binet Intelligence Test, Arabic version (SBITA).

Age of 7 years						
Neurobehavioral scales	Mean	Range	Deficit/impaired	Borderline	Average	Above average
			n, means			
Vineland Adaptive Behavior Scales, Arabic version (VABSA)						
Subscale: Communication	88.1	55-113	4, 59.0	7, 81.5	38, 94.5	4, 122.5
Subscale: Socialization	97.1	60-114				
Subscale: Daily living skills	87.7	48-124				
Subscale: Motor skills	92.8	49-108				
Total mean score = EQ	91.3	55-133				
Stanford-Binet Intelligence Test, Arabic version (SBITA)						
Subscale: Verbal reasoning	86.6	52-112	7, 59.0	11, 71.0	32, 90.0	3, 116.0
Subscale: Abstract and visual reasoning	90.3	36-128				
Subscale: Quantitative reasoning	82.0	34-109				
Subscale: Short-term memory	89.4	48-124				
Total mean score = IQ	90.0	45-119				

Table 3. Cross-tabulations, frequencies and percentages, comparing between all pairs of subscales upon the Vanderbilt ADHD diagnostic rating scale, Arabic version.

			Teacher's' subscales					
			Attention		Hyperactive		ODD	
			Negative -	Positive +	Negative -	Positive +	Negative -	Positive +
Parents' subscales	Attention	Negative -	41 (77.4)	4 (7.5)				
		Positive +	0 (0.0)	18 (34.0)				
	Hyperactive	Negative -			44 (83.0)	1 (1.9)		
		Positive +			2 (3.8)	6 (11.3)		
	ODD	Negative -					43 (81.1)	0 (0.0)
		Positive +					8 (15.1)	2 (3.8)

Data are presented as n (%).
 ADHD: attention-deficit/hyperactivity disorder; ODD: oppositional-defiant disorder.

Table 4. Frequencies and percentages of impairment at social and academic level according to the teachers' evaluations.

Subdomains		n	%
Achievements	Less than peers in Reading	14	26.4
	Less than peers in Writing	15	28.3
	Less than peers in Mathematics	8	15.1
	One of any above	19	35.8
	Utilization special educational resources	12	22.6
	Repeat a grade	0	0.0
Social behavior	Poor relationships with peers	6	11.3
	Poor following rules	4	7.5
	Disrupting others	8	15.1
	Not doing things properly as peers	9	17.0

parents and teachers, none of this sample repeats a grade, but 22.6% utilize a form of special educational resources.

Discussion

The present study represents the first neurobehavioral study of Saudi children born prematurely evaluating them at the school ages. Based on researches, there is no previous Arabic study that investigates the preterm children at the school ages. This is a preliminary evaluation that could allow for a better understanding of the neurobehavioral profiles. And hence, these results could be employed as predictors of outcomes [21]. Therefore, this study's results will be compared with similar studies from other countries.

Long-term follow-up studies until the school ages for preterm children are rare [22, 23]. One of the explanations is the difficulty to encourage parents to take part in follow-up testing over a long period of time [24].

The sample of this study has the mean age of 7.1 years. It was recommended in previous study that the neurobehavioral assessments for preterm children should be done or repeated at the age of 4 years or older, because by assessing at an earlier age a considerable proportion of mentally retarded children could be missed [24].

In general, the neurobehavioral outcome of the current study is similar to those reported in other studies. Children born preterm show limitations at school age in social skills, cognitive abilities, attention and school performances [5, 25-27].

This study found that in school ages, about 21% up to 36% of survivors born preterm were exhibiting at least one sign of neurobehavioral impairment.

One of the major findings of this study is that the effect of preterm birth on social skills and cognitive abilities at the school age in Saudi Arabia was found to be much obvious than the effects at three years [12], where preterm children showed normal neurodevelopmental levels in general. However, this does not appear to be in agreement with literature data. Partially, this result could be explained by that limitation of applying the full neurodevelopmental assessments at the beginning for all preterm birth babies in most of the high-risk newborn programs in Arabic countries. In fact there is no clear guideline for the official evaluation of those babies. Such condition could lead to failure of early identification and early

intervention. Another explanation here could be linked to the previous point. As the outcome of the proper dynamic neurodevelopmental assessments, which seems to be absent here, should provide continuity of support for parents and for teacher in the future and within the high-risk newborn programs. The absence of such information could affect the healthy decisions to ensure that the preterm child is supported in the preschool years and into early school life [28].

Generally and through several studies at school ages, it is accepted that preterm children are at risk of developing learning and behavioral problems [4, 9, 29, 30]. In general, an important and encouraging finding was the fact that the majority of preterm children at school age appeared to have at least the minimal accepting school performance, despite that the finding showed some proportion of cognitive and neurobehavioral impairments similar to that reported in other studies and other countries.

The cognitive assessments in the current study, mainly by IQ test, showed only 7.5% with learning disability. As in previous psychometric studies [12, 31], the category of "Borderline", according to Stanford-Binet and Vineland, were considered to be normal or rather was not considered as learning disability. Borderline is defined by the DSM as an IQ range that is higher than that of mental retardation between one and two standard deviations below the mean [32]. It should be noted that these categories frequently show some sort of impairment, mainly a learning disability. These results could be explained by the fact that learning disability is often accompanied by one or more disability states such as in dysmorphic preterm children [33], consequently they were excluded from this study at the beginning. As it was seen in previous study [34], the favorable rate of low impairments in our study could be explained by this low rate of learning disability.

Attention abilities in particular and the other executive functions influence the ability to function at school and at home. In this study, teachers rated attention deficit more than parents did. Not surprisingly, given that teachers could test easily the child's attention inside the classroom comparing that with his peers. Frequently, attention deficit has been linked with prematurity [35]. In fact the prevalence of the attention deficit in this study was high, with about one-third of the sample who were reported to have attention difficulties. This result is in line with previous studies. A

recent meta-analysis study [9], which investigated 16 studies involving preterm children, reported a significant high risk of attention problems in 67% of studies.

Frequently, school achievements problems have been reported in preterm children, and many children required special educational assistance [36, 37]. In the current results, more than one third of the sample showed school achievements delayed across all subscales (reading, writing and mathematics). This delay in school achievements could not only be explained by being born prematurely, it could be associated with their lower intellectual ability and could be reported even in children who were born full-term. Furthermore we usually considered children in general to have poor school achievements if they repeat a grade, but none of this sample repeated a grade. Maybe this sample includes only those children in grade one and grade two but not from the other upper grades where school achievements could be examined with advanced level.

The current results show also that about of one-fifth of the sample utilize special educational resources. Previous study [36] showed that there were significant shift in the proportion from part-time to full-time special educational assistance between age 8 and 10 years.

Mathematic in several studies was the part in which preterm children exhibited most of their difficulty [35]. Surprisingly, children in this study showed less difficulty in the mathematic subject comparing with writing or reading skills. It is likely that mathematic at earlier grades require less skills comparing with writing or reading skills. And in the upper grades it could require more complex conceptual tasks and the change from simple oral math to written calculation [36]. Another explanation here is that Arabic subject (reading/writing) is more difficult than the other subjects such as the mathematic subject [38]. Arabic is a special language, very different from several languages. For example, the Arabic alphabet is written and read from right to left and horizontally. The letters of the alphabet can be identified on the basis of shared basic shapes, and can be distinguished from each other by the number and position of dots or the absence of dots, one, two or three, depending on the letter.

Recent studies on the neurobehavioral features of children, regardless of the type of the test used, indicate that premature children have lower scores than their full-term peers.

The present results emphasize that preterm children are a group of high-risk children who need multidisciplinary follow-up and early developmental intervention for optimal outcome [39].

Saudi Arabia's health services compares well with the West. Current evidence-based medicine and certain high technology facilities are available but there is still some area that need to be improved. Establishing neonatal care programs at our hospitals, which include major goal of making the neurobehavioral assessments, is one of the vital needs in our institutions. The attention should be paid to these children by having pediatric psychology clinic perform regular follow-ups to track the preterm children cognitive, behavioral, social and emotional conditions.

Limitations and future research

In general, the results of the present study might reflect differences in definitions for impairment and assessment tools, different study modalities, and a bias due to different treatment strategies in case of major neonatal complications.

A major limitation of our study is its relatively small sample size. This study overcomes some of the methodological limitations that are common in previous studies. The current results need to be explained with that limitation, as given that more very immature infants or less birth weights infants could survive more and have more impairment [35].

Another limitation is that this study has not established a control group of full-term children, because the goal of the study was not to test the difference in the prediction of the development in full-term and preterm children, but to accurately show the developmental outcome of children born prematurely and evaluating them at the school ages.

Finally, preterm children also appear to be at higher risk for autism spectrum disorders [40]. This very important subject is in highly need for further investigation in the future.

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Declaration of interest

The Author declares that there is no conflict of interest.

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