Assessment of language disorders in low birth weight children

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Purpose
The aim of the study was to determine the size and distribution of language disorders among low birth weight (LBW) children to devise a plan for early detection, proper assessment, intervention, and prevention of these problems if possible.

Patients and methods
Eighty children were included in this study. The study group consisted of 50 children with a history of LBW, 31 boys and 19 girls, with a mean age of 4.3 ± 1.6 years. The control group consisted of 30 children with a history of normal birth weight, 13 boys and 17 girls, with a mean age of 5.1 ± 1.3 years. Children in the two groups were statistically matched in their age and sex distribution. All participant children were subjected to an interview, general examination, vocal tract examination, neurological examination, ENT examination, evaluation of various aptitudes by formal testing, psychiatric evaluation, audiological examination, and language evaluation using the Arabic Preschool Language Scale-4.

Results
The results from this study revealed that LBW in addition to poor neonatal outcome and prematurity was an important risk factor for poor language abilities in children.

Conclusion
Early consultation is recommended for LBW children with high risk factors in order to facilitate early detection and proper management of language disorders.

Keywords:
delayed language development (DLD), language assessment, low birth weight

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Introduction

Low birth weight (LBW) has been defined by the WHO as weight at birth of less than 2500 g. This is based on epidemiological observations that infants weighing less than 2500 g are ~20 times more likely to die than heavier babies [1]. Kramer [2] had reported that a baby's low weight at birth is either the result of preterm birth (before 37 weeks of gestation) or the result of restricted fetal (intrauterine) growth.

LBW is closely associated with fetal and neonatal mortality and morbidity, inhibited growth, cognitive development, and chronic diseases later in life [3]. Studies showed that the majority of survivors of perinatal complications and LBW develop, at a later stage, multiple disorders in the first stages of infancy or school age, including learning disability and language delay. Preterm LBW children may have up to four times more chances of presenting motor coordination and language acquisition delay in the third year of life than those born at a normal gestational age and weight [4]. Children born prematurely with LBW had an increased risk for language acquisition delay and lower cognitive and behavior scores when compared with normal children [5].

Even though technical and scientific advances have expressively contributed to the reduction of mortality and prematurity in LBW newborns, LBW increases the probability of mortality and neonatal morbidity, promoting a strong clinical and epidemiological impact. The aim of the current work was to determine the size and distribution of language disorders among LBW children to facilitate early detection, proper assessment, intervention, and prevention of these problems if possible.

Patients and methods

Patients

Sample size

The study group (G1) included 50 children with LBW. The results from the study group were compared with those of another group (control group), which included 30 children with normal birth weight. The children of the study and control groups were selected randomly from the pediatric clinic, Minia University Hospital. Both the study group and the control group were statistically matched with regard to age and sex distribution. All the study individual were subjected to protocol of language assessment.

The study group (G1)

This group included 50 children with LBW, 31 boys (62%) and 19 girls (38%), with a mean age of 4.3 ± 1.6 years and a range of 2 to 7 years and 4 months. According to the WHO [1], the criterion of LBW was weight at birth less than 2500 g.

The control group (G2)

This group included 30 children with normal birth weight, 13 boys (43.3%) and 17 girls (56.7%), with a mean age of 5.1 ± 1.3 years and a range of 2.5–7.5 years.

All children participated in the current study after taking written consent from their parents and following explanation of the objectives and detailed methodology of the study. All children were assessed according to the assessment protocol in the Phoniatric Unit, Minia University Hospital. This protocol is classified as follows:

Preliminary diagnostic procedures

(1) Parental interview and history, including complaints, personal data, personal history, etiological factors during pregnancy and during the natal, neonatal, and postnatal periods, developmental milestones, and illness during early childhood.
(2) Neurological and ear, nose, and throat examination.
(3) Subjective auditory perceptual assessment of both language assessment and speech.

Clinical diagnostic aids

Audiological evaluation included hearing assessment and middle ear assessment by means of immitancemetry (tympanometry and acoustic reflex threshold recording). According to the age of the child, hearing assessment was carried out through one of the following methods: field audiometry and behavioral observational audiometry, pure tone audiometry (conditioned play or conventional audiometry), and auditory brainstem response (ABR).

Immitancemetry was carried out using the Zodiac Middle ear analyzer 901 (Madsen, Denmark). Pure tone audiometry was carried out using Audiometer Amplaid 309 (Canada). For children younger than 3 years, and children in whom reliable behavioral thresholds could not be obtained, ABR was determined to estimate the hearing sensitivity. In cases showing absent or severely abnormal ABR, the cochlear (CM) was recorded to diagnose auditory neuropathy spectrum disorders (ANSD). The criterion for diagnosis of ANSD was absent or severely abnormal ABR with intact CM and absent acoustic reflex. ABR and CM were recorded using an intelligent hearing system with smart evoked potentials software version 4.5 (Intelligent Hearing system evoked potential, Miami, Florida, USA). For the ABR, the stimuli were 100 ms alternating clicks delivered through an insert earphone at an intensity level of 90 dB nHL and in 10 dB nHL decrements until cessation of the response. Repetition rate of the stimuli was 31 p/s. Electrode montage was high forehead to ipsilateral mastoid. The common electrode was placed on the contralateral mastoid. The response was filtered between 100 and 3000 Hz, amplified 100 000 times, recorded over a 10.24 ms time window, and 2000 sweeps averaged for each run.

The CM was recorded using surface electrodes. Essentially, the same ABR testing protocol described before was used to record the CM. Separate recordings were made for the three click polarities – namely, alternating, rarefaction, and condensation. The CM was recorded at 90 dB nHL. The CM was considered present if the response reversed its polarity with change of the stimulus polarity and was absent with alternating polarity. Control runs were carried out with clamping of the tube of the insert earphone. Absence of response confirms that the response is the biologic CM and not artifact. ABR and CM testing for each child was carried out under chloral hydrate sedation.

Psychometric evaluation by intelligence quotient (IQ) using the Stanford–Binet Intelligence test [6].

Language test by Arabic Preschool Language Scale-4 (APLS-4) [7]. This modified scale is used mainly to identify children who have a language disorder or delay. Eligible age for the modified PLS-4 'Arabic edition' is from 2 months to 7 years and 5 months and in older children who function developmentally at this age range. Modified PLS-4 is composed of two subscales: the Auditory Comprehension subscale (it contains 62 items) and the Expressive Communication subscale (it contains 71 items). The Auditory Comprehension subscale includes test tasks that are important precursors for language development (e.g. attention to speakers, appropriate object play) and test tasks that assess basic vocabulary, concepts, grammatical markers, understanding of complex sentences, and interferences. The Expressive Communication subscale includes items that examine the expression of vocal development, social communication, quantity, use of specific prepositions, grammatical markers, and telling a short story.

Modified PLS-4 includes two supplemental assessments: the articulation screener test (for children aged 2.5–7 years; its scores are not added to the scores

of the main test, but it is used to determine whether further articulation testing is warranted) and the parents questionnaire (its scores are not added to the score of the main test). It is used to obtain information about the behavior of the child from birth to 3 years at home.

Test components and materials

Picture manual

The picture manual contains the color picture stimuli necessary for administering many of the test items.

Record form

The record form contains abbreviated directions for administering, recording, and scoring the test.

Manipulatives

Manipulates are used to facilitate interactions with the child. Manipulates should be used for testing purposes only under strict supervision of a professional.

The items required for test administration are a ball, five blocks, a box with a lid, one small car, infant rattle, three spoons, teddy bear, keys (examiner own keys), and a towel.

Parents' questionnaire

Articulation screening: This was carried out using the Mansoura Arabic Articulatory Test [8].

A detailed assessment of articulation skills is carried out in the Phoniatric Unit of Mansoura University with the aid of a systematic articulation test that covers all Arabic sounds. This test was standardized by Abo-Elsaad *et al.* [8]. The Mansoura Arabic Articulation Test consists of 26 items containing four subitems representing each Arabic consonant appearing in the beginning, middle, end, and in two positions in familiar words, in addition to seven items representing the Arabic vowels contained within familiar words. Each word is presented to the subject in the form of a picture card, which is to be named.

Results

The children in this study were categorized into two groups:

The study group (G1): children with a history of LBW (n = 50).

The control group (G2): children with normal birth weight (n = 30) (Table 1).

Statistically significant differences were obtained between the study group and the control group as regards positive prenatal history (P < 0.05) (Table 2).

Highly statistically significant differences were obtained between the study group and the control group as regards the history of jaundice (P < 0.001).

In the study group, 31 children had neonatal jaundice and 19 were normal. In the control group, nine children had neonatal jaundice and 21 were normal. Highly statistically significant differences were obtained between the study group and the control group as regards admission in the neonatal ICU (NICU) (P < 0.001). In the study group, 24 children were admitted into the NICU, whereas in the control group none of the children were admitted into the NICU. Statistically significant differences were obtained between the study group and the control group as regards neonatal cyanosis (P < 0.05).

In the study group, seven children had neonatal cyanosis, whereas in the control group none of the children had neonatal cyanosis (Tables 3 and 4).

Statistically significant differences were found between the two groups as regards the age at sitting, age at

Table 1 Comparison between the study group and the control group as regards prenatal history

Prenatal	Cases [*n* (%)]	Control [*n* (%)]	*P*
Prenatal complication			
Irrelevant	35 (70)	28 (93.3)	0.007*
Threatened abortion	1 (2)	0	
Preterm labor	4 (8)	0	
Obstructed labor	1 (2)	0	
Postdate	7 (14)	0	
Anemia	1 (2)	0	
Twins	1 (2)	0	
Old age of mother	0	2 (6.7)	

*Nonstatistically significant differences were obtained between the two groups as regards prenatal outcomes (P < 0.05).

Table 2 Comparison between the study group and the control group as regards perinatal history

Perinatal	Cases	Control	*P*
Weight at birth	1838 ± 355.1	3006.6 ± 310.3	0.001*
Jaundice [*n* (%)]			
Negative	19 (38)	21 (70)	0.006*
Positive	31 (62)	9 (30)	
Incubation [*n* (%)]			
Negative	26 (52)	30 (100)	0.001*
Positive	24 (48)	0	
Neonatal cyanosis [*n* (%)]			
Negative	43 (86)	30 (100)	0.03*
Positive	7 (14)	0	

*Statistically significant differences were obtained between the two groups as regards weight (P < 0.05).

walking, age at utterance of first word, and age at utterance of first sentence.

The mean sitting age for the study group was 10.1 ± 4.5 months, with a range of 6–15 months, and the mean sitting age for the control group was 7.8 ± 3.4 months, with a range of 5–9 months. The mean walking age for the study group was 19.7 ± 7.1 months, with a range of 14–24 months, and the mean walking age for the control group was 13.5 ± 3. 3 months, with a range of 9–16 months.

The mean age at utterance of the first word for the study group was 22.1 ± 8.2 months, with a range of 18–24 months, and the mean age at utterance of the first word for the control group was 14.7 ± 5.1 months, with a range of 9–16 months. The mean age at utterance of the first sentence for the study group was 36.9 ± 6.9 months, with a range of 28–38 months, and the age at utterance of the first sentence for the control group was 17.1 ± 6.1 months, with a range of 18–20 months (Table 5).

A highly statistically significant difference was obtained between the two groups as regards the audiological evaluation ($P < 0.001$).

In the study group, 36 (72%) had normal hearing sensitivity, eight (16%) had sensory neural hearing impairment (SNHI), and six (12%) had slight or mild conductive hearing loss (in five children because of otitis media with effusion and in one child because of Eustachian tube dysfunction).

In the control group, 26 (86.7%) had normal hearing sensitivity, none had SNHI, and four (13.3%) had slight or mild conductive hearing loss (in two children because of otitis media with effusion and in two children because of Eustachian tube dysfunction).

The degree of SNHI in the study group was moderately severe in two children, severe in one child, and severe to profound in three children. Two children had ANSD.

The four children with conductive hearing loss (CHL) in the control group were two children with slight CHL and two children with mild CHL.

Statistically significant difference was obtained between the two groups as regards speech discrimination ($P < 0.05$) (Table 6).

A highly statistically significant difference was obtained between the two groups as regards IQ, mental age, and social age ($P < 0.01$).

The mean IQ of the children in the study group was 83.5 ± 10.6, with a range of 48–100, and the mean IQ of the children in the control group was 92.8 ± 61, with a range of 87–106. The mean mental age in the study group was 3.7 ± 1.5, with a range of 3–4 years, and the mean mental age in the control group was 4.6 ± 1.2, with a range of 4–4.9 years. The mean social age of children in the study group was 3.4 ± 1.4, with a range of 2.5–3.7 years, and the mean social age of the control group was 4.3 ± 1.3, with a range of 3.7–4.6 years (Table 7).

Table 3 Comparison between the study group and control as regards postnatal complications and fits

Postnatal	Cases [*n* (%)]	Control [*n* (%)]	*P*
Postnatal complications			
Negative	41 (82)	28 (93.3)	0.1
Positive	9 (18)	2 (6.7)	
History of fits			
Negative	28 (56)	19 (63.3)	0.5
Positive	22 (44)	11 (36.7)	

Nonstatistically significant differences were obtained between the two groups as regards postnatal outcomes and history of fits ($P < 0.05$).

Table 4 Comparison between the study group and control group as regards developmental milestones

Age (months)	Cases ($N = 50$)	Controls ($N = 30$)	*P*
Age at walking	19.7 ± 7.1	13.5 ± 3. 3	0.001*
Age at sitting	10.1 ± 4.5	7.8 ± 3.4	0.02*
Age at first word	22.1 ± 8.2	14.7 ± 5.1	0.001
Age at first sentence	36.9 ± 6.9	17.1 ± 6.1	0.001*

*Statistically significant differences were obtained between the two groups as regards walking and 1st word ($P < 0.05$).

Table 5 Comparison between the study group and control group as regards audiological evaluation

Hearing assesment	Cases ($N = 50$) [*n* (%)]	Controls ($N = 30$) [*n* (%)]	*P*
Normal hearing sensitivity	36 (72)	26 (86.7)	0.002*
SNHI	8 (16)	0	0.01*
Conductive hearing loss	6 (12)	4 (13.3)	0.1
Speech discrimination			
Excellent	12 (24)	17 (56.7)	0.02*
Good	5 (10)	1 (3.3)	0.1
Fair	3 (6)	0	0.08
Could not be assessed	30 (60)	12 (40)	0.04*

*Statistically significant differences were obtained between the two groups as regard hearing sensitivity ($P < 0.05$).

Table 6 Comparison between the study group and control group as regards intelligence quotient, mental age, and social age

IQ	Cases ($N = 50$)	Controls ($N = 30$)	*P*
IQ	83.5 ± 10.6	92.8 ± 61	0.001*
Mental age	3.7 ± 1.5	4.6 ± 1.2	0.008*
Social age	3.4 ± 1.4	4.3 ± 1.3	0.006*

IQ, intelligence quotient. *Non statistically significant differences were obtained between the two groups as regards IQ , mental and social age (P < 0.05).

Highly statistically significant differences were obtained between the study and the control group as regards the receptive language row score, expressive language row score, total language row score, standard score of receptive language, and standard score of total language ($P < 0.01$).

Nonstatistically significant differences were obtained between the study and the control group as regards the standard score of expressive language ($P > 0.05$).

The mean expressive language row score in G1 was 35.6 ± 17.5, with a range of 3–57, and the mean expressive language row score in G2 was 50.8 ± 10.1, with a range of 26–71.

The mean receptive language row score in G1 was 34.5 ± 20.8, with a range of 0–60, and the mean receptive language row score in G2 was 46.9 ± 9.7, with a range of 21–66.

The mean total language row score in G1 was 67.7 ± 34.1, with a range of 9–124, and the mean total language row score in G2 was 97.1 ± 20.2, with a range of 47–137 (Table 8).

A highly statistically significant difference was obtained between the study group and the control group as regards articulation errors ($P < 0.01$). In the study group there were 25 (50%) children with intact articulation, 18 (36%) children with multiple phonological processing, and seven (14%) children with speech sound disorders.

Among the children with speech sound disorders in the study group, two children had devoicing, three children had interdental sigmatism, and two children had rhotacism.

In the control group there were 20 (66.7%) children with intact articulation, three (10%) children with multiple phonological processing, and seven (23.3%) children with speech sound disorders.

Among the children with speech sound disorders in the control group, one child had lateral sigmatism, one child had pharyngealization of fricatives, two children had devoicing, and three children had interdental sigmatism (Table 9).

A highly statistically significant difference was obtained between the two groups as regards the children with delayed language development (DLD). Five children in the study group had normal language development and 45 children had DLD. In the control group, 17 children had normal language development and 13 children had DLD (P < 0.01).

The results of the audiological evaluation and language test revealed statistically significant difference between the two groups as regards the incidence of DLD-HL: eight (16%) children in the study group had DLD-SNHI, whereas none of the children in the control group had DLD-SNHI.

Nine children in the study group were diagnosed with DLD-specific language impairment (SLI) in comparison with eight children in the control group, with nonsignificant difference between the two groups.

Twenty-five children in the study group were diagnosed with DLD below-average mental development in comparison with five children in the control group, with significant difference between the two groups ($P < 0.05$).

Table 7 Comparison between the study group and control group as regards language

Language assesment	Cases ($N = 50$)	Controls ($N = 30$)	*P*
Receptive language row score	34.5 ± 20.8	46.9 ± 9.7	0.003*
Expressive language row score	35.6 ± 17.5	50.8 ± 10.1	0.001*
Total language row score	67.7 ± 34.1	97.1 ± 20.2	0.001*
Standard score of R	57.7 ± 16.3	69.8 ± 20.1	0.004*
Standard score of E	57.2 ± 20.1	64.6 ± 19.9	0.1
Standard score of T	55.9 ± 17.7	67.1 ± 20.1	0.01*
Language age of R	4.4 ± 7.2	4.4 ± 1.3	0.9
Language age of E	5.03 ± 7.1	4.4 ± 1.1	0.6
Language age of T	4.7 ± 6.9	4.4 ± 1.1	0.8

*Statistically significant differences were obtained between the two groups as regards language assessment ($P < 0.05$).

Table 8 Comparison between the study group and control as regards articulation

Data	Cases ($n = 50$) [n (%)]	Control ($n = 30$) [n (%)]	*P*
Intact articulation	25 (50)	20 (66.7)	0.001*
Multiple phonological processing	18 (36)	3 (10)	
Speech sound disorders	7 (14)	7 (23.3)	

*Statistically significant differences were obtained between the two groups as regards phonological process ($P < 0.05$).

Table 9 Comparison between the study group and control group as regards diagnosis

Data	Cases ($N = 50$) [n (%)]	Controls ($N = 30$) [n (%)]	*P*
Normal	5 (10)	17 (56.7)	0.004*
DLD below average mentality	25 (50)	5 (16.7)	0.03*
DLD-SLI	9 (18)	8 (26.7)	0.05
DLD-HI (SNHI)	8 (16)	0	0.01*
DLD-MR	2 (4)	0	
DLD-BDMH	1 (2)	0	

*Nonstatistically significant differences were obtained between the two groups as regards delayed language ($P < 0.05$).

Nonstatistically significant difference was obtained between the two groups as regards the incidence of DLD-SLI, DLD-BDMH, and DLD-MR. In the study group one child had DLD-BDMH and two children had DLD-MR. In the control group there were no cases with DLD-BDMH, DLD-MR, or DLD-HI (Table 10).

A significant positive correlation was obtained between the receptive language score in correlation with birth weight ($P < 0.05$).

A highly significant positive correlation was obtained between the standard score of reception in correlation with birth weight (BW) ($P < 0.01$).

A highly significant positive correlation was obtained between the standard score of expression in correlation with BW ($P < 0.01$).

Table 10 Correlation between birth weight and language in the study group

Data	*r*	*P*
Receptive language row score	0.31	0.03*
Expressive language row score	0.23	0.1
Total language row score	0.22	0.1
Standard score of R	0.42	0.002*
Standard score of E	0.36	0.01*
Standard score of T	0.36	0.009*
Language age of R	−0.27	0.05
Language age of E	−0.34	0.01*
Language age of T	−0.27	0.05

*Language and weight correlation

A highly significant positive correlation was obtained between the standard score of total language (reception and expression) and BW ($P < 0.01$).

A highly significant negative correlation was obtained between language age and BW ($P < 0.01$) (Tables 11 and 12).

On using analysis of variance (statistical test) for comparison between the language skills of four groups (normal birth weight with normal hearing, LBW with normal hearing, LBW with SNHI, and LBW with conductive hearing loss) highly significant differences were observed between overall comparative groups, but with the use of post-hoc tests (statistical tests) there were highly statistically significant differences between the control group and LBW with normal hearing and LBW with SNHI, nonsignificant differences between the control group and LBW with conductive hearing loss, highly significant differences between LBW with normal hearing and LBW with SNHI, nonsignificant differences between LBW with normal hearing and LBW with conductive hearing loss, and significant differences between LBW with SNHI and LBW with CHL.

Discussion

LBW defines a heterogeneous group of infants, some of whom are born early, some of whom are born growth

Table 11 Comparison between groups regarding language scores

Data	Normal birth weight with normal hearing (control) (*N* = 26)	LBW with normal hearing (*N* = 36)	LBW with SNHI (*N* = 8)	LBW with conductive (*N* = 6)	*P*
Row score of receptive language	46.6 ± 10.2	34.2 ± 14.9	25 ± 39.7	49.1 ± 8.7	0.004*
Row score of expressive language	50.8 ± 10.5	37.6 ± 16.3	16 ± 11.8	49.8 ± 9.4	0.001*
Row score of total language	97.1 ± 20.7	71.5 ± 30.8	27.5 ± 20.5	99 ± 17.3	0.001*
Standard score of receptive language	72.1 ± 20.6	58.7 ± 18.5	52 ± 0.5	59.1 ± 11.1	0.01*
Standard score of expressive language	67.1 ± 20.2	59.6 ± 23.1	51 ± 1.4	51 ± 6.8	0.1
Standard score of total language	69.2 ± 20.7	57.4 ± 20.7	51.1 ± 0.8	53.8 ± 3.4	0.03*

LBW, low birth weight; *Comparison of language score.

Table 12 Comparison of the *P* value between the four groups (normal birth weight with normal hearing, low birth weight with normal hearing, low birth weight with SNHI, and low birth weight with CHL

P	Receptive language	Expressive language	Total language	Standard of R	Standard of E	Standard of T
P_1	0.007	0.001	0.001	0.005	0.1	0.01
P_2	0.003	0.001	0.001	0.007	0.05	0.02
P_3	0.7	0.8	0.8	0.1	0.08	0.07
P_4	0.1	0.001	0.001	0.3	0.2	0.3
P_5	0.05	0.04	0.001	0.9	0.3	0.7
P_6	0.01	0.001	0.01	0.4	0.9	0.7

BW, birth weight; LBW, low birth weight; P_1: comparison between normal BW with normal hearing and LBW with normal hearing; P_2: comparison between normal BW with normal hearing and LBW with SNHI; P_3: comparison between normal BW with normal hearing and LBW with CHL; P_4: comparison between LBW with normal hearing and LBW with SNHI; P_5: comparison between LBW with normal hearing and LBW with CHL; P_6: comparison between LBW with SNHI and LBW with CHL.

restricted, and others are born both early and growth restricted [9]. LBW is closely associated with fetal and neonatal mortality and morbidity, inhibited growth and cognitive development, and chronic diseases later in life [3]. Worldwide there is an increasing survival rate among children born with LBW. The higher survival rates create a population with exceptional needs. Numerous studies on the follow-up of preterm and LBW infants have revealed an increased risk for BDMH, cognitive impairment, language delays, and emotional/behavioral adjustment problems [10].

This study aimed to assess language and determine language disorders in LBW children (study group) in comparison with children who had normal birth weight (control group). The two groups were matched in their demographic data (age and sex of children) to show the effect of LBW in the language abilities of children.

A statistically significant difference was obtained between the study and the control group as regards prenatal problems (30% for LBW children and 6.7% for control children). Bryan and Hindmarsh [11] reported that maternal factors can be related to insufficient substrate supply to the fetus during development because of many different causes such as reduced maternal food intake, maternal systemic diseases such as hypertension and diabetes, abnormal placental function that can lead to impaired uteroplacental blood supply or disruption of placental transfer, as well as abruption, infarction, or maldevelopment of the placenta. The majority of these factors can influence growth during the last trimester of pregnancy and result predominantly in intrauterine growth retardation (IUGR), which refers to poor growth of a baby while in the mother's uterus during pregnancy.

A statistically significant difference was obtained between the study and the control group as regards neonatal cyanosis. Fourteen percent of LBW children had neonatal cyanosis in comparison with no children in the control group. This may be explained by the fact that many of the LBW children suffered from immaturity of their lungs. This is in agreement with the findings of Hegyi *et al.* [12], who reported that LBW and immaturity are closely related to the risk for cerebral palsy and are also associated with a low Apgar score.

A highly significant statistical difference was obtained between the study and the control group as regards admission in the NICU: 48% of LBW children in comparison with no children in the control group. This result may be explained by the fact that most of the LBW babies present with increased risk for hypoglycemia, hypothermia, hypercoagulability, hyperbilirubinemia, hypotension, necrotizing enterocolitis, respiratory distress syndrome, lower Apgar scores, umbilical artery acidosis, and more incidences of intubation and more complications during delivery and ~20 times increased risk for neonatal death than do babies born at an appropriate for gestational age weight. This result is in agreement with those of Manktelow *et al.* [13]. In addition, Tyson *et al.* [14]. reported that extremely LBW infants pose a heavy resource burden to perinatal healthcare. Although it is inevitable that extremely LBW infants would have relatively long NICU length of stay, there may be opportunities for improving and standardizing care, as unexplained variation in length of stay has been reported in premature infants.

A highly statistically significant difference was obtained between the study and the control group as regards neonatal jaundice. The percentage incidence of neonatal jaundice in LBW children was 62% in comparison with 30% in the control children. This result is in agreement with that of Iranpour *et al.* [15], who reported that the premature newborn infant has an exaggerated form of physiologic jaundice with mean serum bilirubin concentrations reaching peaks of 10–12 mg/dl (171–205 mmol/l) or more with delay in reaching the maximum concentration, as compared with full-term neonates (on the fifth and sixth day of life).

A highly statistically significant difference was obtained between the two groups as regards IQ, mental age, and social age. This finding may be due to decrease in the cognitive abilities of LBW children. This result is in agreement with that of O'Keeffe *et al.* [16], who reported that children born small for gestational age seem to have modest independent effects on learning, cognition, and attention in adolescence. Several studies on the developmental outcome of premature LBW infants have highlighted a series of persistent deficits in cognitive ability across the life span [17].

The results obtained from the APLS-4 revealed highly statistically significant differences between the study and the control group as regards the row score of receptive, expressive, and total language and standard score of receptive and total language. This may be attributed to the fact that LBW children have impairment in cognition along with deficits in different language components, such as phonological processing and vocabulary and literacy skills. This agreed with the results of Schirmer *et al.* [5], who reported that children born prematurely with LBW had an increased risk for language acquisition delay and had lower cognitive and behavior scores when compared with normal language acquisition. Also Breslau and Chilcoat [18] reported

that, although very preterm adolescents continue to display deficits in general cognition and higher-level language skills compared with term peers, significant catch-up in receptive vocabulary is observed by the age of 16 years.

A positive significant correlation was obtained between the standard score of receptive language and standard score of total language in correlation with birth weight. These results show that poor neonatal outcomes, prematurity, poor cognitive abilities, and neurobehavioral deficits were more important in determining the developmental outcomes and language abilities of LBW children. Many studies are consistent with our explanation of DLD in the LBW children, such as that by Schirmer *et al.* [5], who reported that children born prematurely with LBW had an increased risk for language acquisition delay and had lower cognitive and behavior scores when compared with children with normal language acquisition. Further, Bhutta *et al.* [17] reported that several studies on the developmental outcome of premature LBW infants have highlighted a series of persistent deficits in cognitive ability across the life span.

There was a statistically highly significant difference between the study group and the control group as regards articulation errors. In the study group 50% of children had intact articulation, 36% of children had multiple phonological processing, and 14% of children had speech sound disorders. This is in agreement with the results of van Noort-van der Spek *et al.* [19], who reported poor phonological development in even healthy very low birth weight (VLBW) children, compared with term-matched children, independent of their cognitive, psychomotor, and language development, and their behavioral functioning.

There were significant differences between the two groups as regards the incidence of DLD due to below-average mental development. DLD with below-average mental development was found in 50% of LBW children and in 16.7% of control children. This may be attributed to the fact that LBW children have impairment in cognition. This study had a higher percentage of LBW children with below-average mental development than expected. This is in agreement with the results of Mervis *et al.* [20], who reported that the risk for mental retardation was higher for VLBW (< 1500 g) children than for moderately LBW (1500–2499 g) children. In addition, children with normal birth weight who were born preterm also were at increased risk for mental retardation at age 10 years. Further, Carmody *et al.* [21] reported that neuroimaging research has identified anatomical abnormalities as a result of premature birth, such as smaller hippocampus, lower gray-to-white-matter ratio, and smaller cerebellum. These structural changes in the brain are thought to be related to deficits in cognitive functioning.

There were highly significant differences between the two groups as regards the incidence of DLD due to hearing impairment, mainly SNHI. DLD with SNHI was found in 16% of LBW children and in none of the control children. Torres Valdiviieso *et al.* [22] reported the frequency of hearing loss in these children as between 5 and 6%, although it is not clear whether, in and of itself, being born at less than 1500 g or having a gestational age below 32 weeks are really risk factors or there may be other additional circumstances that make them vulnerable to hearing deficit. In addition, Kiatchoosakun *et al.* [23] reported that VLBW and prematurity are often concomitant findings and it is difficult to separate them completely. In addition, a higher incidence of hearing loss has been observed in those premature children in comparison with children born at full term. In contrast, Ari-Even Roth *et al.* [24] reported a low incidence of sensory-neural hearing loss in a cohort of VLBW infants and a relatively high incidence of conductive hearing loss. TEOAE screening was found to be an effective first-stage in-hospital hearing screening tool in this population.

The results obtained from audiological evaluation and language test revealed a statistically significant difference between the two groups as regards hearing impairment (mainly with SNHI), as 16% of the study group had DLD-SNHI in comparison with no children in the control group. This may be explained by the hyperbilirubinemia and brain damage associated with LBW. This study agreed with that of Erenberg *et al.* [25], who reported that very premature neonates (£32 weeks) and/or babies weighing less than 1500 g at birth constitute a population at higher risk for SNHI. Some studies reported an incidence of SNHI that fluctuates between 2 and 4 out of every 100 NB [25]. However, Ari-Even Roth *et al.* [24] reported a low incidence of sensory-neural hearing loss in a cohort of VLBW infants and a relatively high incidence of conductive hearing loss.

On using analysis of variance (statistical test) for comparison between the language skills of four groups (normal birth weight with normal hearing, LBW with normal hearing, LBW with SNHI, and LBW with conductive hearing loss), highly significant differences were seen between groups overall, but with the use of post-hoc tests (statistical tests) highly statistically significant differences were seen between control and LBW with normal hearing and LBW with SNHI, nonsignificant differences between the control group

and LBW with conductive hearing loss, significant differences between LBW with normal hearing and LBW with SNHI, nonsignificant difference between LBW with normal hearing and LBW with conductive hearing loss, and significant differences between LBW with SNHI and LBW with CHL. This means that LBW is a factor that affects language development and when in conjunction with hearing impairment can cause greater retardation of language skills.

Interestingly, there were nonsignificant differences between the two groups as regards the incidence of DLD-BDMH, DLD-MR, and DLD-SLI; this may be due to the small size of the sample.

The language age in this study is not representative of the language skills of the child, as the test used in our study (the APLS-4 test) was based on the standard score and not on the language age; thus, the standard score was representative of the child's language skills.

In our study two children showed epileptiform electroencephalogram and had normal brain computed tomography. Also one child of the study group had decreased visual acuity and another child had complete blindness. This is in agreement with the finding of Kuban *et al.* [26], who reported that major motor, cognitive, visual, and hearing impairments appear to account for more than half of the positive autism children screened among extremely low gestational age newborns. Even after eliminating those with such impairments, 10% of children, or nearly double the expected rate, screened positive.

Conclusion

LBW is an important risk factor for poor language abilities in children. Therefore, early consultation is recommended for LBW children with high risk factors to facilitate early detection and proper management of language disorders.

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Conflicts of interest

There are no conflicts of interest.

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