Prevalence of hearing impairment and language and cognition delay in very low birth weight babies and their risk factors

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ABSTRACT

Background: Very low birth weight infants are at increased risk of language, cognition delay and also hearing impairment disorder. Identification is essential for early intervention. **Aims and Objectives:** To estimate the burden of language, cognition delay and hearing impairment at 24 months of corrected gestation and to test the association of examination at 6 months and 12 months with the language and cognitive outcome of very low birth weight (VLBW) infants at 24 months and to identify the perinatal and neonatal risk factors for atypical outcome. **Materials and Methods:** It is a prospective cohort study. Consecutive 120 VLBW infants were enrolled in a single centre level III neonatal unit of a teaching hospital. Hearing assessment was done before discharge and 3 monthly. Language and cognitive assessment was done by DASII Scale neu at 6 months and BSIDIII Scale at 12 months and 24 months at neurodevelopmental clinic. Language assessment was further done by REELS-3 Subscale at 24 months. All assessment ages were corrected for prematurity. **Results:** At 24 months 7.8% infants developed Language delay and 4.7% had cognition delay. Four infants developed cerebral palsy at 24 months. Shock in neonatal period had significant association with suboptimal Hearing, Language and Cognitive outcome at 12 months of corrected gestation. **Conclusion:** Early anticipation and early identification of abnormal hearing, language and cognitive outcome of VLBW infants can be used as simple and cost-effective measures for preventing long-term morbidity at resource limited countries.

Key words: Cognitive delay; Hearing assessment; Language delay; Shock; Very low birth weight infants

INTRODUCTION

The prevalence of speech and language delays ranged from 5% to 8% at the age of 2–4.5 years, while studies of only language delays reported rates of 2.3–19%. Risk factors included a family history of speech and language delays, male sex, and perinatal factors, such as prematurity and low birth weight.[1] Based on the six studies in UK, the prevalence of speech and/or language delays in children ages 2–5 years to be between 5% and 12%.[2] Language delayed children may hold lower-skilled jobs and are more likely to be unemployed than unaffected children.[3]

Approximately, 15 million babies are born very low birth weight, worldwide, each year.[4] Most of the very low birth weight babies are preterm. They have higher degree of language and social communication problems compared to full terms.[5-8]

In about 40% of very low birth weight (VLBW) infants at school age, cognitive impairment had been reported.

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Executive function and attention skills are suboptimal in most of the VLBW infants.[9] The prevalence of impaired hearing in neonates with VLBW is significantly higher than in neonates with normal birth weight because of higher rates of transient middle ear fluid accumulation and conductive hearing loss. Long-term careful monitoring for hearing loss and their audiological management VLBW babies is essential.[10]

1.5% of the VLBW cohort was found to have abnormal prolongation of ABR waveform latency despite normal auditory thresholds, suggesting that even though cochlear function may have been normal; there may have been abnormal ascending brainstem pathways.[11]

Children with hearing loss may have difficulty with hearing and understanding sounds around them and thus leading to speech and communication disorder.

Aims and objectives
1. To estimate the hearing and language and cognition delay among very low birth weight babies.
2. To identify the risk factors of language and cognition delay in VLBW babies.
3. To correlate the predictive value of language evolution at 1 year with language evolution at 2 years of age.
4. To correlate the predictive value of cognition evolution at 1 year with cognition evolution at 2 years of age.

MATERIALS AND METHODS

This is a prospective observational cohort study involving VLBW infants admitted in a level III Neonatal Intensive Care Unit (NICU) during the period of May to September 2016. All the infants discharged from NICU who were <1500 gram at birth were eligible for the study. The infants with chromosomal anomaly, major malformations and those who failed to attend for complete follow-up were excluded. Informed consent was obtained from the parents of VLBW infants eligible for the study. The study was pre-approved by the institutional ethics committee.

Birth weight was taken just after delivery. Antenatal data were collected. Natal and subsequent management were done as per standard protocol.

At 6 months of corrected gestation Developmental Assessment Scale for Indian Infants (DASII), 1 years of corrected age Bayley Scale of Infant and Toddler Development 3rd edition (BSIDIII) and 2 years of corrected age Receptive Expressive Emergent Language Test-3rd edition (REELS-3), was done by professionals who were unaware of case records (Figure 1).

Hearing assessment was done by Oto Acoustic Emission and Screening Automate Auditory Brainstem Response before discharge. Diagnostic Brainstem Evoked Auditory Brainstem Response was done at 3 months of corrected gestation. Subsequent hearing assessment was done at 6 months and 1 year and 2 years of corrected gestation.

Instruments and procedures
DASII
It is Indian adaptation of BSIDII. It is done up to 2.5 years of age. It has two scale: Mental and Motor.

BSIDIII
It is designed to assess the developing and high-risk infants and toddlers and young children aged between 1 and 42 months. It provides coverage of 5 domains: Cognitive, language, motor, adaptive, and social emotional development.

REELS-3
It is used to identify disabilities, condition, impairment that may affect language development. Procedure takes 20 min for the children up to 3 years of age.

Statistical analysis
Linear correlation among two variables was calculated using Pearson correlation and then fit linear regression model to predict the response variables for a given covariate. Chi-square test of association was used to test significance of association between two categorical variables. Statistical software R was used here.

Data had been summarised as mean and standard deviation for numerical variables and count and percentages for categorical variables and analysed by SPSS software version 24.0. Unpaired proportions were compared by Chi-square test or Fisher's exact test as appropriate. Odds ratio was calculated for relative risk with 95% confidence interval value ≤0.05 was considered statistically significant.

RESULTS

Under Linear Linear Regression Analysis, Shock, Perinatal Asphyxia, Hypoglycemia, and Culture Positive Sepsis showed significant correlation with Language development at 12 months of age (Table 1). After Multivariate Regression analysis only shock had significant correlation with language development at 12 months of corrected gestation (Table 2). Under Linear Regression Analysis Shock and Perinatal asphyxia got significant correlation with cognitive development at 12 months of corrected gestation (Table 1), but after

multivariate regression analysis none of them showed significant correlation. Under Multivariate Linear Regression analysis only Shock had significant correlation with hearing assessment at 1 years of age (Table 3).

At 24 months of corrected gestation follow-up only 5 babies had language delay and 9 babies were at risk.

Correlation of DASII mental subscale score at 6 month with BSIDIII language subscale score at 12 months of corrected gestation

We plot the scatter diagram of Mental 6 months with the language 1 year. The Pearson product moment correlation is 0.40 implying moderate linear correlation (Figure 2).

Correlation among BSIDIII language subscale at 12 months and REELS-3 language scale at 24 months

Correlation of language subscale at 1 year (assessed by BSIDIII) with 2 years language assessment done by REELS-3 is 0.59 and the scatter plot shown in Figure 3.

Correlation of cognition scale at 12 months of corrected age and cognition scale at 24 months of corrected gestation

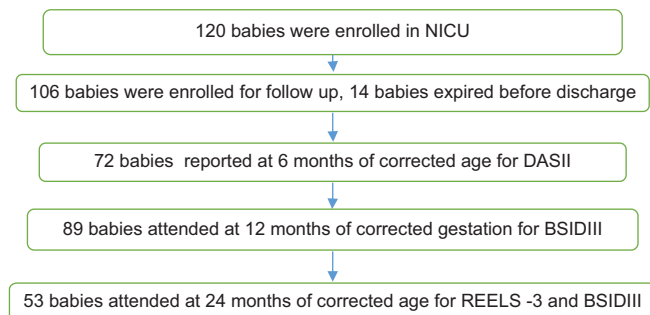Correlation between cognition 1 year and 2 year is 0.51 (Figure 4).

DISCUSSION

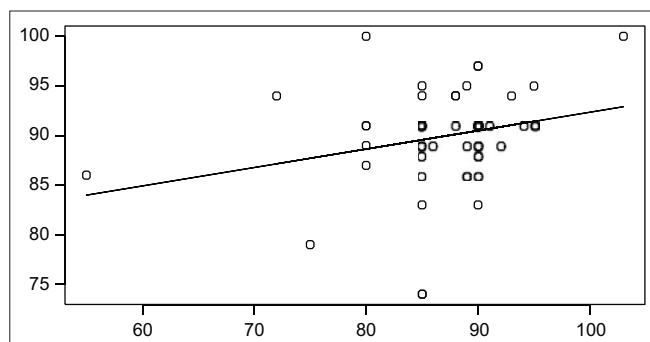3.4% of total preterm population in India are VLBW babies. Aram et al.,[12] showed that a higher proportion of VLBW than control children had subnormal language associated with IQ <85, hearing deficits, after increased survival of preterm VLBW babies, there is in need of long term follow-up for language and hearing evolution in a resource limited settings.

In a study from South Africa on neurodevelopmental outcome of preterm infants with mean birth weight and mean gestational age of 1182 grams (SD: 197.78) and 30.81 weeks (SD: 2.67), The BSID III was done at a median age of 16.48 months. Out of 106 babies, 10 babies (9.4%) had language delay, 9 babies(8.5%) had cognition delay.[13] In our study population, the mean birth weight and mean gestational age were 1169.975 grams (SD: 244.3135) and 32.2 weeks (SD: 2.85) respectively and, 5 (7.8%) had language delay and 3 babies (4.7%) had cognition delay at 2 years (corrected gestation) of follow-up.

In our study, shock had got significant and consistent correlation with language and hearing impairment in
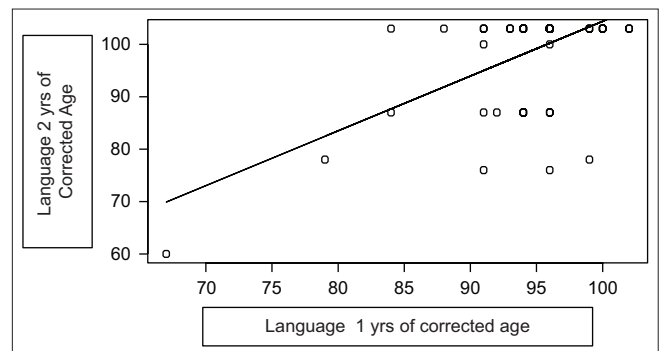

Figure 3: Fitted regression line and scattered diagram of BSIDIII Language Subscale at 12 months and REELS-3 at 24 months

120 babies were enrolled in NICU

106 babies were enrolled for follow up, 14 babies expired before discharge

72 babies reported at 6 months of corrected age for DASII

89 babies attended at 12 months of corrected gestation for BSIDIII

53 babies attended at 24 months of corrected age for REELS -3 and BSIDIII

Figure 1: Study flow chart

Figure 2: Correlation among mental subscale at 6 months and language subscale at 12 months
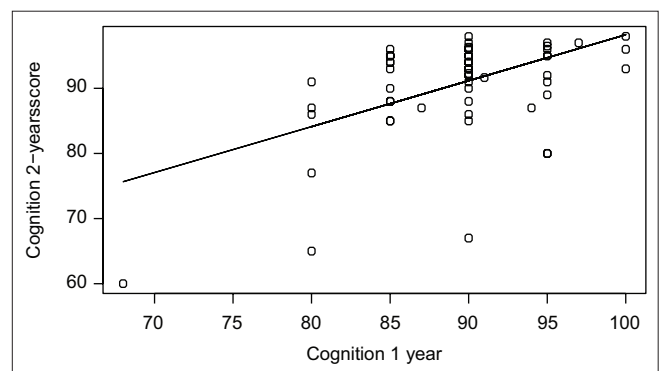
Figure 4: Fitted regression line and scattered diagram of BSIDIII cognition subscale at 12 months and BSIDIII cognition subscale at 24 months

Table 1: Overall characteristics of the VLBW babies and their association with language development

Characteristics	N=120	Correlation with DASII Mental scale at 6 months	Correlation with BSIDIII Language Subscale at 12 months	Correlation with BSIDIII Cognitive Subscale at 12 months	Correlation with Hearing assessment
Birth weight (500–1500 g)	Mean 1169.975 g (SD 244.3135)	0.4816	0.1995	0.0795	0.5396
Gestation (25–40 weeks)	Mean 32.2 weeks (SD2. 85)	0.9233	0.9741	0.9203	0.7903
Antenatal steroid	Nil (40.8%), Partial (33.3%), Full Course (25.8%)	0.2867	0.7617	0.5971	0.4654
Pregnancy Induced hypertension. Other antenatal risk factors are negligible	32 i.e., (26.6%)	0.8336	0.1866	0.0165	0.6866
Small for date	65 i.e., (54%)	0.5708	0.1674	0.3393	0.5141
Mode of delivery	NVD (51.6%), LSCS (48.3%)				
Place of delivery	Inborn (75.8%), Outborn (24.1%)				
Delivery room resuscitation	Routine care (0.083%), Initial steps (51.6%), Bag and Mask (10%), Bag and Tube (15%), Unknown (22.5%)	0.8404	0.3277	0.5499	0.7473
Perinatal asphyxia	No (75%), Yes (25%)	0.5851	0.0386	0.0044	0.4412
Shock	No (86.7%), Yes (13.3%)	0.5395	<0.0001	0.0008	0.0012
Hypoglycemia	No (89.2%), Yes (10.8%)	0.5404	0.0269	0.1742	0.2590
IVH	No (97.5%), (2.5%)				
BPD	No (74.1), Yes (25.8%)	0.6352	0.5541		0.8138
Anaemia requiring blood transfusion	No (91%), Yes (9%)	0.4639	0.1630	0.7347	0.5924
PDA	No (98.3%), Yes (9.7%)	0.6601	0.8818	0.4301	0.1859
Culture Positive Sepsis	No (98.3%), Yes (9.7%)	0.5404	0.0045	0.1219	0.1518

VLBW: Very low birth weight, BSID-III: Bayley scales of infant and toddler development (version III), DASII: Developmental assessment scale for Indian infant, IVH: Intra ventricular haemorrhage, PDA: Patent ductus arteriosus, BPD: Broncho pulmonary dysplasia

Table 2: Multivariate regresion analysis

Corrected age (12 month)	BSIDIII language subscale			BSIDIII cognition		
	St. coeff β	P value	95% CI	St. coeff β	P value	95% CI
Gestational age	−0.171	0.179	−0.052, 0.009	−0.213	0.108	−0.090, 0.009
Birth weight	0.195	0.099	0.000, 0.001	0.189	0.129	0.000, 0.001
Delivery room resuscitation	−0.038	0.742	−0.071, 0.051	−0.073	0.550	−0.127, 0.068
Perinatal asphyxia	−0.169	0.109	−0.349, 0.035	−0.099	0.375	−0.446, 0.170
Shock	0.285	0.006	−0.907, −0.158	−0.107	0.319	−0.902, 0.297

BSID-III: Bayley scales of infant and toddler development (version III)

Table 3: Mental at 6 months and language outcome at 12 months and 24 months by BayleyIII and REELS-3

Subscale	Composite Score (<70) {Abnormal}	Composite Score (70–85){At Risk}	Composite Score (>85) {Normal}	Mean Score	95% CI
Mental (6 months) {DASII}	1 (1.38%)	26 (36.11%)	45 (62.5%)	87.54	86.12–88.96
Language (12 months) {BSIDIII}	1 (1.12%)	7 (7.87%)	81 (91.00%)	89.46	88.35–90.57
Cognition 12 months	2 (2.25%)	24 (26.97%)	63 (70.79%)	89.18	87.86–90.50
Language 24 months {REELS-3}	5 (7.8%)	9 (14%)	50 (78%)	98.61	96.25–100.26
Cognition 24 months	3 (4.7%)	5 (7.8%)	56 (87.5%)	90.78	88.93–92.64

Bayley scales of infant and toddler development (version III), DASII: Developmental assessment scale for Indian infant, REELS-3: Receptive expressive emergent language test-3rd ed..ition

newborn. Goldstein RF et al., also reported significant correlation of language and cognitive outcome in BSID Scales at 24 months of corrected gestation with the duration of perinatal asphyxia and hypotension.[14]

It is observed that there is a mild linear correlation between mental 6 months (DASII) with the cognition 1 year (BSIDIII) and the Pearson product moment correlation is 0.27.

The scatter diagram of Mental 6 months (DASII) with the language 1 year (BSIDIII) showed the Pearson product moment correlation is 0.40 implying moderate linear correlation. Specific terms and words expected from a child during the language test-not familiar to the Indian child resulted in lower scores and significant discrepancy.

Tomasik showed that Preterm VLBW babies have higher chances of hearing loss that term babies. Risk is further aggravated by Shock.[15] We are also getting strong correlation with shock and hearing impairment in VLBW babies.

Limitations of the study
There was good compliance up to 12 months of corrected age but at 24 months of corrected age there was 50% lost to follow-up.

CONCLUSION

Among the all antenatal and natal and postal risk factors neonatal shock and perinatal asphyxia has got most significant correlation with language, hearing and cognition. 6 months assessment of DASII has mild correlation with cognition subscale and moderate correlation with Language Subscale of BSIDIII (assessed at 12 months of corrected gestation). However, 12 months BSIDIII assessment of both the subscale has significant correlation with 24 months assessment.

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Authors Contribution:
SC- Concept and design of the Study, Collected the antenatal histories, did the whole study prospectively, reviewed literature and manuscript preparation, interpreted the result; **SM-** Guide of SC in preparation of concept and design of study and also manuscript preparation; **TKB-** Provided early stimulation after assessment; **TRC-** Assessed the babies by BSID Scale

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