



COGNITIVE ABILITIES OF LOW BIRTH WEIGHT AND NORMAL BIRTH WEIGHT SCHOOL CHILDREN: A COMPARATIVE STUDY

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ABSTRACT

Low birth weight is a global public health problem, predominantly prevalent in the least developed and developing countries. As the single most important factor, it determines mortality and morbidity of neonates, infants and children along with restrained growth and development. Low birth weight children have varying degrees of social, medical and environmental risks that negatively affect the outcomes across the continuum of low birth weight and it is apparently noticed during school age and adolescence. The study was aimed to assess the cognitive ability of school children born with low birth weight and normal birth weight. A total of five hundred and ninety one (591) school children of 6+ and 7+ years of age living in Mysore city were recruited as subjects using the purposive sampling technique. Both schools and households visit was carried out to recruit the subjects born during 2010 to 2012 year. A self-developed questionnaire was administered to the parents to collect the data on socio-demographic conditions and birth history of children. The intelligence quotient of children was assessed by using Wechsler's intelligence scale for children –IV. The findings of the study indicates that a highly considerable percentage of low birth weight children 13.8% of borderline Full Scale IQ and 51.5% of low average level of Full scale IQ was found. Whereas 29.6% of normal birthweight children were found under low average level of Full scale IQ and Majority (70.4%) of normal birth weight and 34.7% of low birthweight children were noticed under average level of full scale IQ. There was a high significant association ($\chi^2 = 77.66$ at $P < 0.001$) found between birth weight group concerning with full-scale intelligence quotient. Overall, the study concluded that birth weight determines the cognitive outcomes of children in later years i.e. at school-age period. Significant association between birthweight groups and the levels of FSIQ within the groups of gender, age, class/education, and family income was noticed. The study suggests the implementation of Intervention programs/early stimulating programs to reduce the long-term consequences for infants who are born low birth weight is needed.

Index terms: Low birth weight, normal birth weight, cognitive ability, Full scale Intelligence Quotient.

INTRODUCTION

Low birthweight (LBW) is a sensitive indicator of socio-economic conditions and indirectly measures the health of the mother and the child. The World Health Organization (WHO) has defined the term low birthweight as a birth weight of less than 2500gms, irrespective of the duration of the gestational period. In lower-middle-income countries, around 18 million infants are born with low birth weight (LBW) (i.e. birth weight < 2500 g), of which one-fourth (26%) are in south Asia alone (Lee et.al. 2013). Advances in neonatal care during the past few decades resulted in increased survival of infants born preterm or with LBW (Fanaroff et al., 2007; Stoll et al., 2010). Survival comes at a cost as these children are at high risk for a variety of developmental problems including cognitive deficits, poor academic achievement, and behavior disorders (Anderson, Doyle, et.al., 2003; Taylor, 2010). The average intelligence quotient (IQ) of a child with LBW is lower than a child with adequate birthweight. In addition to the reduced IQ, they are also having greater learning difficulties. There is a greater need for special education for Small-for-Gestational Ages (SGAs) and preterm infants. Cognitive deficits, school difficulties, and behavioral problems are often reported by children born with LBW or extremely preterm infants.

As intellectual, social and emotional skills are required to effective functioning in school, deficits in development become particularly evident when children reach preschool age. Studies indicate that low birthweight preterm children show a significantly poorer school performance when compared to normal birth weight (NBW) children of the same age. Low birthweight preterm infants have deficits in cognitive and motor performance, and these aspects impact their education and quality of life. As it has been reported before in a population of southern Brazil, prematurity and LBW are considered risk factors for developmental delay (Julia et.al, 2009). Eickman et.al.(2002) showed that LBW infants had a poorer motor and cognitive development than NBW term infants and birthweight is considered a risk factor for outcome. Children born preterm or with LBW often show impairments in both the motor and the cognitive domains at a young age and this co-occurrence of difficulties lasts into childhood. However, while co-occurrence of difficulties is common, motor difficulties do also occur independently of cognitive or behavioral difficulties. (Foulder, et.al, 2014). The impaired motor and cognitive outcome is a significant long-term complication associated with LBW or malnutrition. The risk of impairment increases as the weight lowers (Radaelli et.al, 2020). Studies have shown that both preterm and full-term children with a reduced birth weight have more problems than children who are born at term and with NBW (Kelly, 2001). Studies have reported that individuals with LBW have a lower intelligence quotient (IQ) than those with NBW (Huaiting, et.al, 2017). Data on neurodevelopment impairment from developed countries suggest that individuals born with LBW have a higher risk of lower cognitive function, tend to score lower on academic performance measures, have a higher prevalence of mental disorders, serious emotional and behavioral problems and developmental delay compared to term healthy counterparts (Upadhyay et al. 2019).

Research on cognitive outcomes in Extremely Preterm /Extremely LBW children at 6 years of age or younger reveals deficits in IQ, expressive and receptive language skills, spatial reasoning, visual-motor integration (Baron et.al, 2011). Children less than 10 years of age born LBW had lower cognitive (WMD - 4.56; 95% CI: -6.38, - 2.74) and motor scores (WMD -4.16; 95% CI: -5.42, - 2.89) compared to children with NBW. Within LBW children, those with birth weight < 2000 g had much lower cognitive (WMD -7.23, 95% CI; - 9.20, - 5.26) and motor scores (WMD -6.45, 95% CI; - 9.64, - 3.27) (Upadhyay et.al. 2019). The mean full-scale IQ of LBW children was 4.9 points lower than that of NBW children, controlling for population size, maternal IQ, maternal education, and race (95% confidence interval [CI], 3.0 to 6.8). A large number of research studies have been carried out in western countries compared to India. There is a paucity of studies of LBW in Karnataka State and survival rates of LBW are in increasing trend. Hence the present research was carried out to study the cognitive ability among low birth weight and normal birth weight children at school age.

METHODOLOGY

A cross-sectional school-based study was carried out to assess the cognitive abilities of school-age children born with low birthweight (LBW) and normal birthweight (NBW). The study was carried out in two phases. In the first phase, the investigator visited the selected schools and distributed the self-prepared questionnaire to children studying in 1st and 2nd standard to get the information regarding socio-demographic conditions as well as the birth history of the child. A total of 1000 school children were involved in the first phase and LBW children were identified based on parents' response and Thai card/Birth card. Of the 1000 children, 392 children born with LBW (<2.5 kg) were selected as the target group and a total of 199 children born with NBW (≥ 2.5 kg) were also selected as the control group. A total of 591 school children born during the year 2010 to 2012 were selected where their age ranges from 6+ years and 7+ years at the time of the data collection (2018 to 2019). The samples residing in the jurisdiction of Mysore city were recruited for the study. The purposive sampling technique was used. In the second phase, the investigator visited the schools and households to collect specific information like maternal history, birth history and to assess the cognitive abilities of children using a self-framed questionnaire and standardized psychological scale i.e. Wechsler's Intelligence Scale for Children –IV (WISC-IV) respectively. The Wechsler's Intelligence scale (WISC-IV) (2004) is an updated version of WISC-III and an individually administered test to assess the cognitive abilities of children aged 6 to 16.11 years. This scale consists of 10 core subtests (viz. Block design, Similarities, Digit Span, Picture Concept, Coding, Vocabulary, Letter Number Sequencing, Matrix Reasoning, Comprehension and Symbol Search) and 5 additional/supplemental subtests (viz. Picture completion, Cancellation, Information, Arithmetic, and Word reasoning). The number of items and score ranges differs for each subset. These subtests yield a composite score for general intellectual ability i.e. Full-Scale IQ (FSIQ). It is preferred to administer the entire battery in one session and the administration time ranges from 65 to 80 minutes. Raw scores are compiled and converted into composite scores, standard scores, process scores, percentile ranks, descriptive classifications, and test-age equivalents. As per the WISC – IV administration and scoring manual, the FSIQ range and interpretation were done as mentioned below.

FSIQ Range	Level of Intelligence
≥ 130	Very superior
120-129	Superior
110-119	High Average
90-109	Average
80-89	Low
70-79	Borderline
≤ 69	Extremely Low

The Institutional Human Ethical Committee (IHEC) clearance from the University of Mysore and informed written consent from parents were obtained. The interview technique was used to collect data from mothers and administered WISC-IV to children to assess their cognitive ability. The collected data were tabulated and computed using SPSS 16.0 version for a window. The frequency and percentage were calculated and the chi-square test was applied to see the significant association between the attributes.

FINDINGS AND DISCUSSION

Table 1: Distribution of samples under gender, age, and class

Information about children		LBW		NBW		Total	
		N	%	N	%	N	%
Gender	Boys	200	51.0	101	50.8	301	50.9
	Girls	192	49.0	98	49.2	290	49.1
Age	6 + years	210	53.6	74	37.2	284	48.1
	7 + years	182	46.4	125	62.8	307	51.9
Class	1 st standard	167	42.6	60	30.2	227	38.4
	2 nd standard	225	57.4	139	69.8	364	61.6
Total		392	66.3	199	33.6	591	100.0

Table 1 indicates the distribution of samples under gender, age, and class. Nearly equal percentage of boys and girls were observed among LBW (51.0% and 49.0%) and NBW (50.8% & 49.2%) groups. About the age group, a slightly higher percentage of the samples were observed under 6+ years of age than 7+ years of age under both LBW (53.6% and 46.4%) and NBW (37.2% and 62.8%) groups respectively. As per class-wise distribution of samples, 42.6% of low birthweight children and 30.2% of normal birth weight children were studying in 1st standard while 57.4% of low birth weight and 69.8% of normal birth weight children were studying in 2nd standard.

Table 2: Details about family Background of the sample

Family Social Background		LBW		NBW		Total		χ^2 Value df=1 Sig.
		N	%	N	%	N	%	
Family type	Nuclear	369	94.1	172	86.4	541	91.5	10.106** 0.001
	Non-nuclear	23	5.86	27	13.5	50	8.4	
Monthly Income of Family	Below Rs.15,000	244	62.2	145	72.8	389	65.8	6.616* 0.010
	Rs.16,000 and above	148	37.7	54	27.1	202	34.1	
Source of Income	Business	29	7.3	36	18	65	10.9	15.416** 0.000
	Salary	363	92.6	163	81.9	526	89.1	
Religion	Hindu	359	91.6	142	71.4	501	84.8	41.823** 0.000
	Non Hindu	33	8.4	57	28.6	90	15.2	
Mother Tongue	Kannadiga	308	78.5	125	62.8	392	66.3	16.732** 0.000
	Non Kannadiga	84	21.4	74	37.1	199	33.7	

Table 2 reveals the family background of the samples - type of family, monthly income, source of income of family, religion, and mother tongue. All most all the LBW children (94.1%) and the majority (86.4%) of NBW children belonged to nuclear families. The remaining percentage of LBW (5.86%) and NBW (13.5%) children belonged to non-nuclear families. A highly significant association was observed between type of family and birth weight groups ($\chi^2 = 10.106$ at $P < 0.0001$). Majority of LBW (62.2%) & NBW (72.8%) were belong to income group of >Rs.15000. A significant association was found between monthly income groups and birth weight groups ($\chi^2 = 6.616$ at $P < 0.010$). In the majority (89.1%) of the family, the source of income was salary. Amongst them, 92.6% of LBW and 81.9% of NBW children's families depended on salary, whereas 18% of NBW and 7.3% of LBW children's families depend on the business as a source of income. A highly significant association was found between the source of income and birth weight groups ($\chi^2 = 15.416$ at $P < 0.000$). A higher percentage (91.6%) of LBW children and 71.4% of NBW children belong to the Hindu religion whereas 8.4% of LBW and 28.6% of NBW belongs to the non-Hindu religion group. A highly significant association was observed between religious groups and birthweight groups ($\chi^2 = 41.823$ at $P < 0.000$). The majority (78.5%) of LBW children and 62.8% of NBW children's family speaks Kannada. Whereas 21.4% of LBW and 37.1% of NBW children's family speaks other than Kannada as their mother tongue. A highly significant association was observed between mother tongue and birth weight ($\chi^2 = 16.732$ at $P < 0.000$).

Table 3: Distribution of Samples based on Full-Scale Intelligence Quotient

Birth weight group	Average level of IQ		Low average level of IQ		Borderline IQ		χ^2 Value df=2 Sig.
	N	%	N	%	N	%	
LBW (N ₁ =392)	136	34.7	202	51.5	54	13.8	77.662** 0.0001
NBW (N ₂ =199)	140	70.4	59	29.6	0	0.0	

Table 3 reveals the distribution of samples based on the range of Full-Scale Intelligence Quotient (FSIQ). The higher percentage of LBW (51.5%) children were seen under the low average level of FSIQ compared to NBW children (29.6%). Only 13.8% of LBW children were seen under borderline IQ. About 34.7% of LBW against 70.4% of NBW children were seen under average IQ level. A highly significant association was observed between the level of FSIQ and birth weight groups ($\chi^2 = 77.662$ at $P < 0.001$). A cross-sectional study included children aged 6-7 from a historical birth cohort with low birth weight (<2,500 g) infants evaluated cognitive and behavioral development of preterm and low birth weight newborns living in a disadvantaged socioeconomic environment at school age and findings indicated that the borderline intelligence quotient was observed in 9.3% of the LBW children. (Procianoy, et al, 2001).

Table 4 Gender wise distribution of sample based on Level of FSIQ

Gender Group	Birth weight group	Average level of IQ		Low average level of IQ		Borderline IQ		χ^2 Value df=2 Sig.
		N	%	N	%	N	%	
Boys($n_b=200$)	LBW	66	33.0	106	53.0	28	14.0	44.424** 0.000
	NBW	72	71.3	29	28.7	0	0.0	
Girls ($n_g=192$)	LBW	70	36.5	96	50.0	26	13.5	33.669** 0.000
	NBW	68	69.4	30	30.6	0	0.0	

Table 4 reveals the gender-wise distribution of the sample based on the Full-Scale IQ (FSIQ) level. The majority (53.0%) of LBW boys were seen under the low average level of IQ when compared to NBW (28.7%). A higher percentage of LBW girls (50.0%) than NBW girls (30.6%) were seen under the low average level of IQ. Only 14.0% of LBW Boys and 13.5% of LBW girls were seen under borderline level. A higher percentage of NBW boys (71.3%) and NBW girls (69.4%) were found under Normal IQ levels. A highly significant association was observed between the level of FSIQ and birth weight groups within gender.

Table 5 Age wise distribution of Samples based on level of FSIQ

Age Group	Birth weight group	Average level of IQ		Low average level of IQ		Borderline IQ		χ^2 Value df=2 Sig.
		N	%	N	%	N	%	
6+ years ($n_1=210$)	LBW	86	41.0	114	54.3	10	4.8	27.287** 0.000
	NBW	56	75.7	18	24.3	0	0.0	
7+ years ($n_2=182$)	LBW	50	27.5	88	48.4	44	24.2	61.280** 0.000
	NBW	84	67.2	41	32.8	0	0.0	

Table 5 indicates the age-wise distribution of the sample based on FSIQ level. Within 6+ years age groups, a higher percentage of LBW (54.3%) than NBW (24.3%) children were found under the low average level of FSIQ. Vice versa results were seen under the average level of IQ i.e. the higher percentage of NBW (75.7%) children than LBW (41.0%) children were observed under the average level of IQ. Only 4.8% of LBW children were seen under borderline IQ level. A highly significant association was observed between levels of IQ and birth weight groups within 6+ years of age ($\chi^2 = 27.287$ at $P < 0.001$). Under the age group 7+ years, 48.4% of LBW and 32.8% of NBW children were found under the low average level of IQ. Only 24.2% of LBW children were seen under borderline IQ. A higher percentage of NBW (67.2%) children than LBW (27.5%) children were observed under the average level of IQ. A highly significant association was observed between the level of FSIQ and birth weight groups within the 7+ years of age group ($\chi^2 = 61.280$ at $P < 0.001$).

Table 6 Class wise distribution of samples based on level of FSIQ

Class	Birth weight group	Average level of IQ		Low average level of IQ		Borderline IQ		χ^2 Value df=2 Sig.
		N	%	N	%	N	%	
1 st standard ($n_1=167$)	LBW	69	41.3	92	55.1	6	3.6	18.740** 0.000
	NBW	44	73.3	16	26.1	0	0.0	
2 nd standard ($n_2=225$)	LBW	67	29.8	110	48.9	48	21.3	65.857** 0.000
	NBW	96	69.1	43	30.9	0	0.0	

Table 6 reveals the class-wise distribution of the sample based on FSIQ. With regard to 1st standard children, the higher percentage of LBW (55.1%) children than NBW (26.1%) children fall under low average level of IQ, About 3.6% of LBW were noticed under borderline IQ. A highly significant association was observed between the level of FSIQ and birthweight groups within 1st standard group children ($\chi^2 = 18.700$ at $P < 0.001$). Among 2nd standard children, 48.9% of lbw and 30.9% of NBW children had low average level of intelligence, 21.3% of lbw children had borderline intelligence level, 29.8% of lbw and 69.1% of nbw

children had average level of intelligence. Highly significant association was observed between level of FSIQ and birth weight within 2nd standard children ($\chi^2 = 65.857$ at $P < 0.001$).

Table 7: Income wise distribution of sample based on level of FSIQ

Family Income Group	Birth weight Group	Average level of IQ		Low average level of IQ		Borderline IQ		χ^2 Value df=2 Sig.
		N	%	N	%	N	%	
Below Rs. 15000	LBW	84	34.4	122	50.0	38	15.6	54.551**
	NBW	101	69.7	44	30.3	0	0.0	0.000
Rs.16000 and Above	LBW	52	35.1	80	54.1	16	10.8	23.729**
	NBW	39	72.2	15	27.8	0	0.0	0.000

Table 7 reveals the income-wise distribution of the sample based on FSIQ. Within the family income group of Rs. <15,000/-, the majority (50%) of LBW children were having a low average level of IQ against 30.3% of NBW children. Only 15.6% of LBW children were observed under borderline IQ. Whereas a lesser percentage of LBW (34.4%) children compared to NBW (69.7%) children were having an average level of IQ. A highly significant association was observed with Full-scale IQ level and below Rs. 15000 family income ($\chi^2 = 54.551$ at $P < 0.001$). Among family income group of Rs.16000 and above, only LBW children (10.8%) were found under borderline IQ. The higher percentage of LBW (54.1%) than NBW (27.8%) were having a low average level IQ. Vice versa result was noticed under the average level of IQ where the 72.2% of NBW against 35.1% of LBW children were having average level IQ. A highly significant association was observed between level full-scale IQ and birthweight groups within the family income of Rs. 16000/ and above group ($\chi^2 = 23.72$ at $P < 0.001$).

SUMMARY AND CONCLUSION

The present study confirms that the LBW children were having low average and borderline levels of FSIQ at school age. The cognitive deficits were distinctively higher among school children born with LBW than NBW children. A significant association was found between birthweight groups and the levels of FSIQ. A significant association between birthweight groups and the levels of FSIQ within the groups of gender, age, class/education, and family income was noticed. On the whole, the present study confirms that children born with low birthweight have cognitive deficits at school age. This study calls for in-depth research on low birthweight children from bio-socio-environment factors like parents' IQ, parenting, home environment. The study also suggests the need for implementation of Intervention programs/early stimulating programs to reduce the long-term consequences for low birthweight is needed.

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