

ORIGINAL ARTICLE

COGNITIVE POTENTIAL AND ITS PREDICTORS IN CHILDREN
FROM A RURAL DISTRICT OF PAKISTAN

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Background: Effective interventions are available to reduce cognitive deficit currently estimated to affect more than 200 million children under 5 years of age in developing countries. However, developing world's investment is negligible in this regard mainly because of non-existent global indicators to monitor progress with respect to the childhood cognitive development. Intelligence Quotient (IQ) or Full Scale Intelligence Quotient (FSIQ) is an indicator of the cognitive development. This study was designed to assess cognitive potential of 6–7 years old children from a rural district of Pakistan by calculating their FSIQ. Predictors of the FSIQ were also determined. **Method:** This cross-sectional research was carried out in 40 rural Union Councils (UCs) of 2 sub-districts in district Rawalpindi utilizing simple random sampling technique. Wechsler Pre-school and Primary Scale of Intelligence (WPPSI-IV) was administered to 6–7 years old children (n=300) for measuring their FSIQ. **Results:** FSIQ of rural Pakistani children, relative to the normative sample, was found to be in the category of low-average. Findings of multiple regression analysis concluded grade/class of the child as the most influential predictor of the FSIQ followed by the level of mother's and then father's education. **Conclusion:** FSIQ of the rural Pakistani children, relative to the normative sample, was found to be in the category of low-average. Predictors of the FSIQ, seen in this research, were school grades and non-educated parents of the children warranting future research on the contribution of environmental influences to the variability in cognitive potential.

Keywords: Cognitive; Rural; FSIQ; Children; Predictor; Pakistan; Indicator

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INTRODUCTION

In spite of long enduring history of research into measuring cognitive abilities of children and defining a universal indicator; international consensus on indicators of the intellectual development is at a standstill.¹ Effective interventions are available to reduce the cognitive and social-emotional deficit currently estimated to affect more than 200 million children under 5 years of age in developing countries. Despite the substantial evidence that comprehensive early development interventions are effective in increasing children's chances of success; developing world's investment is negligible in this regard. One of the important reasons that governments do not invest in early childhood development is lack of globally accepted indicators to monitor progress with respect to the childhood cognitive development.² Intelligence Quotient (IQ) or Full Scale Intelligence Quotient (FSIQ) is an indicator of the cognitive development.¹

Lack of cognitive development research on children of the developing countries is attributable to several factors. For example, requirements of the highly-specialized field of psychometry are difficult to be satisfied in resource-poor settings³ as compared

to physical health, survival and nutritional monitoring indicators. For most developing countries, already overwhelmed by the challenges of dealing with morbidities and mortalities due to prevailing communicable diseases, there is a moral dilemma of undermined weightage on the intellectual wellbeing of surviving children.⁴ Thus, potential of majority of children to succeed in school, at work and in society is hampered particularly if they have disabling conditions on account of their living conditions and poverty.⁵ Furthermore, cognitive development tests are time-consuming to standardize and expensive to purchase⁶, leading to financial constraints in their use in resource poor setting of the developing countries¹. Quantification of human psychological attributes is intricate because of the need to define underlying psychological constructs at the outset. Hence, a psychometric test is always pre-evaluated for its validity and reliability.⁷ Cognition and intelligence are considered interchangeable⁸, therefore, measures of 'intelligence' are also referred to as tests of 'cognitive ability'⁹.

Wechsler intelligence scales are frequently used tests of cognitive development.¹⁰ Research is being conducted with Wechsler scales from over

70 years in order to align them with concurrent advances in intelligence theories and psychometric techniques.¹¹ In this study, process towards shaping cognitive development indicator was initiated to improve future productivity of children in Pakistan by utilizing the Wechsler Preschool & Primary Scale of Intelligence – 4th edition (WPPSI-IV). Increase in the FSIQ scores, over four decades, has been concluded from 73 studies conducted on the same group of participants.¹² Rural setting was selected for this research because Pakistan has 63% of the rural area.¹³ Therefore, cognitive potential of rural children ought to be assessed on priority and they should be the prime recipients of any cognitive-stimulating interventions designed after dissemination of the findings of this research.

WPPSI-IV normative information is based on a national sample of 1,700 representatives of the US English-speaking population of children.¹⁴ As WPPSI-IV is standardized on a normative sample whose living conditions and quality of schooling are different from rural setting in Pakistan, hence, determining predictors of the FSIQ in 6–7 years old children from a rural district were also included in this research.

MATERIAL AND METHODS

Cross-sectional study design was utilized in this research for measuring the FSIQ. In descending order of size, Pakistan is administratively divided, into provinces, divisions, districts, sub-districts (*Tehsils*), and Union Councils (UCs). This study was carried out in District Rawalpindi of the Punjab province. Estimated population of District Rawalpindi is 4.5 million and the average household size is 6.2 members. Rawalpindi district is divided into seven *Tehsils* which are further subdivided into 175 Union Councils (UCs), out of which 119 are rural and 56 are urban. Forty rural UCs of two *Tehsils* were selected for data collection (n=300). These forty UCs, 29 from *Tehsil* Gujar Khan and 11 from *Tehsil* Kallar Syedan, have mainly agrarian based population.¹⁵

An independent team prepared the sampling frame by utilizing the records of the Lady Health Workers (LHWs) in the LHW-covered areas. Vaccinators and Traditional Birth Attendants (TBAs) were consulted in the LHW-uncovered areas. Inclusion criteria for the child were 6–7 years of age, mother alive and resident of the study area. Adopted, twins or triplets and children diagnosed with mental, hearing or physical disability were excluded from the study. Moreover, diagnosed mental illness of mother was also an exclusion criterion. Eligible children were

selected through computer generated randomization from the sampling frame.

Full Scale Intelligence Quotient (FSIQ) is the outcome variable in this research. Under variable ‘grade/class of the child’, formal primary education system included nursery, grades 1, 2 and 3 while ‘*madrassa*’ represented informal education system. Data regarding education of the parents were collected in ‘number of years’. In Pakistan, illiterate, Primary, Matric, FA/FSc, BA/BSc, and Masters refer to 0, 5, 10, 12, 14 and 16 years of education, respectively.¹⁶

Variable ‘family system’ included ‘multiple household’ which meant a household where child’s mother lived with her in-laws but did not share the same kitchen whilst she lived separately with her husband and children in a ‘nuclear’ household. In variable ‘father’s occupation’, ‘manual workers’ included factory worker, farmer, labourer, driver and shopkeeper whereas occupations such as teacher and clerk were depicted as ‘non-manual workers’. Variable ‘type of education’ was further disaggregated into public, private, *madrassa* and home-schooling.

Adequate sample for establishing the FSIQ norms in a subgroup is typically comprised of 256 subjects.¹⁷ Hence, 300 children were selected for this research. Data collection material used in this study included items provided by the test manufacturer of the WPPSI-IV. For example, age-appropriate stimulus books, response books, record forms and materials used in various subtests. Administration and Scoring Manual and Technical and Interpretive Manual were also provided by the manufacture of the test. Mother Questionnaire was used for collecting data regarding socio-demographic profile of the households. Child Questionnaire contained administration instructions, questions and sample responses and child’s schooling information.

Ethical approval of this research by the Institutional Ethical Review Committee of the Health Services Academy, Islamabad was followed by the final endorsement by the Board of Advanced Studies & Research (BASR) of the Quaid-e-Azam University, Islamabad. Identification and recruitment of eligible children, at the village-level, was carried out with the help of LHWs, vaccinators and TBAs. Firstly, mother was approached in her household for obtaining informed consent for the administration of the cognitive development testing on her child. Detail regarding socio-demographic profile was inquired from mother at the household.

During stay at the household, assent was taken upon building rapport with the child. In order to avoid all elements of distraction during cognitive development testing, the tool was administered either at school or the

respective health house of the LHWs. Furthermore, aggregate data was used in this research for protecting individual children from the risk of stigmatization.

Data were analysed using SPSS-16. Graphical method for testing normality included the histogram, boxplot and the Q-Q plot while skewness and kurtosis were amongst the numerical methods. Additionally, Shapiro-Wilk and Kolmogorov-Smirnov tests were included in the formal tests of ensuring normality. Multiple regressions analysis was employed to predict the FSIQ by a set of explanatory variables.

RESULTS

Mean FSIQ of the rural Pakistani children was found to be 84. Median and mode of the FSIQ scores were 81.5 and 79, respectively. Standard deviation of the FSIQ scores was 13 points while inter-quartile range was 17. Descriptive statistic (Table-1) showed positive skewness of the data; z-value obtained by dividing skewness statistic with its Standard Error (SE) was not within ± 1.96 . In the histogram, FSIQ score distribution was also found to be positively skewed. Boxplot showed shift of the median and Q-Q plot depicted non-fitting of the observed and expected FSIQ scores along the diagonal line. Test statistic values for the formal tests of normality (Shapiro-Wilk & Kolmogorov-Smirnov) were lower than 0.05 concluding rejection of the null hypothesis (Table-2).

Table-1: Descriptive statistics of the FSIQ

Statistic	Value	SE
Mean	83.63	0.745
5% Trimmed Mean	83.29	
Median	81.50	
Mode	79	
95% Confidence Interval for Mean	82.17– 85.10	
Std. Deviation	12.900	
Variance	166.400	
Range (maximum–minimum)	132–53=79	
Inter-quartile Range	17	
Skewness	0.505	0.141
Kurtosis	0.418	0.281

Table-2: Tests of normality for FSIQ data

Kolmogorov-Smirnov			Shapiro-Wilk		
Statistic	df	p	Statistic	df	p
0.100	300	0.000	0.978	300	0.000

Table-3: Comparison of maximum and minimum FSIQ scorers

Socio-demographic variables	FSIQ= 53	FSIQ= 132
Frequency	1	1
Gender	Male	Female
Family system	Nuclear	Multiple households
Father's occupation	Manual worker	Non-manual worker
Total monthly income	9000/-	55000/-
Last month spending on education	600	10,000
Mother's education (in years)	0	16
Father's education (in years)	0	16
Type of education	public	private
Child's grade	1 st	2 nd

Table-4: Monthly income of the household

Monthly Income (PKR)	Frequency	Percent
1500–10,000	101	33
10,500–20,000	89	30
21000–30,000	38	13
35,000–40,000	7	2.3
43,000–60,000	6	2
70,000–100,000	3	1
Did not know	56	18.7
Total	300	100

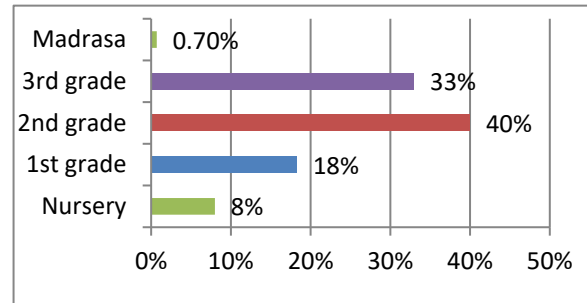


Figure-1: Grade/Class of the child

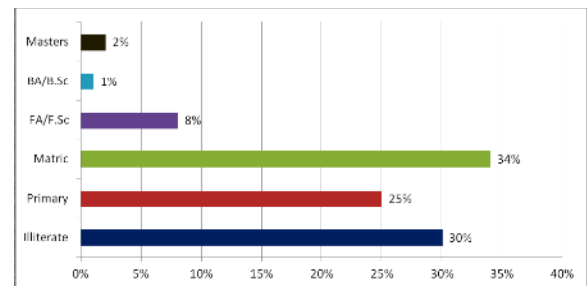


Figure-2: Education of the child's mother

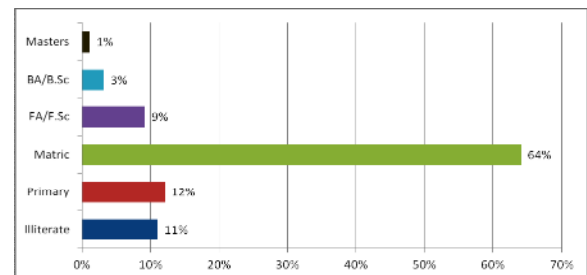


Figure-3: Education of the child's father

In this study, 40% children were in the second grade and 33% were in the third grade, while remaining proportion was behind their grades (Figure-1). Comparison of the maximum and the minimum FSIQ achievers revealed important findings (Table-3). Both the parents of the child, who scored maximum FSIQ, had 16 years of education while the parents of the child with minimum FSIQ were illiterate. Father of maximum FSIQ achiever was a non-manual worker while minimum FSIQ achiever's father was a manual worker. Numerical data on parents' education, collected in 'number of years', is described in six categories for the purpose of simplicity (Figure-2 and 3). Thirty percent of the mothers in this study were found to be illiterate while this percentage for fathers was eleven

percent. Table-4 contains numerical data on monthly income of the household arranged in seven categories for convenience.

Thirty-three percent of the households had monthly income ranging from PKR 1,500 to 10,000 while only 3% had an income in the range of PKR 70,000 to 100,000. There were approximately 19% households whose income was not reported by the mothers particularly because the earning per month was irregular and dependent largely on the availability of the work.

Multiple regressions analysis was employed to predict the FSIQ by a set of six socio-demographic explanatory variables (Table-5). Considering positively skewed distribution of the outcome variable, two models were utilised for the multiple regression analyses. One model contained all the transformed variables in which the FSIQ was log transformed to 'normalise' it while six predictor variables were squared to 'linearise' them. The logarithmic (log) transformation¹⁸ was

used to make positively skewed distributions the less off-centre. Predictor variables were squared to linearise their association with the outcome variable.^{19,20} On the other hand, second model contained all the original variables. After comparison of both the models, transformed variable model was found to be more robust because the value of the mean square due to errors (MSE) was merely 0.003 as compared to 124.870 for the original variables model. The smallest MSE is a recommended fit measure to make good predictions and find strong statistical associations.²⁰ Therefore, multiple regression analysis involving transformed variables concluded the child's grade/class, mother's and father's education as predictors of the FSIQ in rural Pakistani children, after controlling for the effect of other variables in the model. Predictor variables 'education type and spending on education' were not found to be statistically significant in the transformed variable model.

Table-5: Multiple regression analyses

Model		Unstandardized Coefficients		Standardized Coefficients	t	p
		B	SE	B		
Transformed variables	Constant	1.856	0.008		230.013	0.000
	Mother's education squared	0.000	0.000	0.230	3.929	0.000
	Father's education squared	0.000	0.000	0.123	2.176	0.030
	Education spending squared	5.179E-11	0.000	0.086	1.627	0.105
	Education type squared	0.006	0.006	0.056	1.007	0.315
	Child's grade/class squared	0.007	0.001	0.327	6.247	0.000
Original variables	Constant	65.783	2.118		31.066	0.000
	Mother's education (number of years)	0.536	0.164	0.188	3.271	0.001
	Father's education (number of years)	0.465	0.200	0.130	2.323	0.021
	Education spending	0.000	0.000	0.129	2.383	0.018
	Type of education	1.986	1.443	0.079	1.376	0.170
	Grade/class of child	4.660	0.733	0.336	6.361	0.000

DISCUSSION

The FSIQ of rural Pakistani children, relative to the normative sample, was found to be in the category of low-average. For the Wechsler intelligence tests, mean FSIQ and standard deviation (SD) are set at hundred and fifteen points, respectively.²¹ Scores on intelligence tests are interpreted relative to the normative sample and are assumed to be normally distributed.²²

The FSIQ score distribution in this research was found to be positively skewed where scores of majorities of children were aggregated towards the lower side, with few children scoring disproportionately high scores. Median is a more precise measure of the central tendency while the interquartile range is steadier measure of dispersion in case of skewed distributions.²³ However, recommended interpretation of the Wechsler scales is based on the mean and SD of the normally distributed FSIQ scores.

Historically, normal distribution has been believed to be the model for understanding variation in mental abilities. Presently, many researchers argue that the appropriation of cognitive potential to the normal curve might have been due to the limited variability within group of people involved in the process of testing.²⁴ In this study, positively skewed distribution of the FSIQ scores highlights level of difficulty faced by rural Pakistani children during cognitive testing. Tool used in this study measures the FSIQ partially through the vehicle of items taught in the school. Educational system of the rural Pakistani children did not expose them to the similar areas of knowledge tested by the scale used in this research. Empirical evidence also suggests that an indicator of the cognitive development developed and standardized in a developed country ought to be interpreted with caution in a developing country

because the FSIQ is constructed from normative data pertaining to very different kinds of living conditions and educational systems.¹

Findings of multiple regression analyses, carried out in this research, concluded child's grade/ class as the most influential predictor of the FSIQ followed by the level of mother's and then father's education. More or better schooling could produce gain in cognitive abilities over time.¹² A recent study showed strong association of years of education to performance on cognitive testing.²⁵ Mother's education was found to be the second influential predictor of the child's FSIQ which is also in line with the previous studies indicating educated mothers more likely to have children with higher levels of cognitive potential.²⁶ In this study, both the parents of the child who scored maximum FSIQ received 16 years of education while the parents of the child with minimum FSIQ score were illiterate. Child with lowest FSIQ was in the first grade while highest scorer was in the second grade.

Owing to the scarcity of the published literature, comparison of the current research's FSIQ finding could not be made with other similar studies from the developing world. However, findings of a current study, conducted in the United States, uncovered scores of low-income rural children lower on the visual spatial working memory as compared to the verbal working memory, owing to the barrier posed by less everyday visual stimulation in the rural setting.²⁷ Therefore, low-average FSIQ seen in this research may not be reflective of full cognitive potential of rural Pakistani children. Sample of this research was comprised of only rural Pakistani children while the normative information of the tool used in this study has not been stratified according to the rural-urban settings, quality of schooling, and income of the household. Availability of the disaggregated data would have enabled comparison of the various cognitive abilities of a low-income rural Pakistani child to the analogous child in the normative sample.

Thus, it can be hypothesized that the FSIQ differences between the rural Pakistani and the normative sample, seen in this research, are consequent upon the environmental differences associated with growing up in distinctly different settings. Low-average FSIQ seen in the rural sample of this research would have been different if other strata of Pakistani children were included in this research which was not consistent with the scope of the current study.

CONCLUSION

The FSIQ of the rural Pakistani children, relative to the normative sample, was found to be in the category of low-average. Predictors of the FSIQ, seen in this research, were school-grades and non-educated parents of the children warranting future research on the contribution of environmental influences to the variability in cognitive potential.

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