Intelligence, academic performance and nutritional condition among primary - school children in Bangkok Metropolitan schools

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Lertmaharit S, Lim L, Nuchprayoon T, Makesupa O. Intelligence, academic performance and nutritional condition among primary - school children in Bangkok Metropolitan schools. Chula Med J 1999 Sep; 43(9): 631-43

Background : *Intelligence development in primary-school children is a major concern of the Thai government. Many studies have found that found genetic factors, nutritional condition and socio-economic status influence intelligence development and academic performance, but those studies were not conducted among Thai school children. This study was conducted to survey the intelligence and the extent of association between intelligence, academic performance and nutritional condition among primary school children in Bangkok.*

Objective : *This study was conducted to survey the intelligence, nutritional condition and academic performance, and the extent of their association.*

Setting : *Seven primary schools of Bangkok Metropolis from 3 regions were selected by one - stage cluster sampling.*

Research design : *A cross-sectional school-based study.*

Subjects : *A total of 1369 primary school children in Bangkok Metropolitan schools.*

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Methods : *All of the children from two randomly chosen classrooms in each of the six grades with their mothers were interviewed and the children were assessed for nutritional condition and intelligence by trained nurses and psychologists. The data were analysed by STATA software using the method of Mantel- Haenszel and multiple logistic regression.*

Results : *The findings showed that 26.6 % (95 % Confidence Interval (CI) : 24.3-29.0 %) of the children had a below average IQ (< 90). After adjusting for family factors, malnourished children were found likely to have a poor IQ and a poor GPA. Some factors, such as the parents' marital status and education, were associated with the IQ and GPA. After combining results across the schools using a random effects model, the odds of having a below average IQ and a poor GPA among malnourished children was 1.35 times (95 % CI: 0.94-1.92) and 1.11 times (95 % CI: 0.83-1.46), respectively.*

Conclusions : *This study suggests an association between nutritional condition and intelligence and academic performance in Thai school children, a finding which is consistent with previous studies in Western countries. Given the poor nutritional status of many Thai school children, there may be value in the Thai government sponsoring randomized studies to determine whether school-based interventions designed to improve the nutritional status of the children would lead to improved intelligence and academic performance.*

Key words : *Intelligence, IQ (Intelligent Quotient), Nutritional condition, Academic performance, GPA (Grade Point Average), Primary school children.*

สมรัตน์ เลิศมหาฤทธิ์, ลินเน็ท ลิม, ทัสสนี นุชประยูร, อรพรรณ เมฆสุภะ. เชาวน์ปัญญา, ผลการ ศึกษาและภาวะโภชนาการในเด็กนักเรียนชั้นประถมศึกษาในโรงเรียนสังกัดกรุงเทพมหานคร. จุฬาลงกรณ์เวชสาร 2542 ก.ย; 43(9): 631-43

ปัญหา
: การพัฒนาเชาวน์ปัญญาในเด็กนักเรียนชั้นประถมเป็นสิ่งที่รัฐบาลไทย ให้ความ สำคัญ มีการศึกษาหลายอย่างที่พบว่าปัจจัยทางพันธุกรรม, ภาวะโภชนาการ และเศรษฐานะมีอิทธิพลต่อการพัฒนาเชาวน์ปัญญา และผลการเรียน แต่การ ศึกษาเหล่านั้นไม่ได้ทำในเด็กนักเรียนไทย การศึกษาครั้งนี้จึงนำไปสู่การศึกษา ถึงความสัมพันธ์ของปัจจัยต่าง ๆ ว่ามีอิทธิพลอย่างไรในเด็กวัยเรียนชั้นประถม ในโรงเรียนสังกัดกรุงเทพมหานคร

วัตถุประสงค์
: เพื่อศึกษาความสัมพันธ์ระหว่าง เชาวน์ปัญญา, ภาวะโภชนาการ และผล การเรียนในเด็กนักเรียนชั้นประถม และศึกษาถึงขอบเขตของความสัมพันธ์

สถานที่ศึกษา
: 7 โรงเรียนสังกัดชั้นประถมศึกษาของกรุงเทพมหานคร โดยมาจาก 3 เขต คัด เลือกแบบกลุ่มขั้นตอนเดียว

รูปแบบการวิจัย
: การศึกษาในช่วงเวลาใดเวลาหนึ่งโดยใช้โรงเรียนเป็นฐาน

ผู้ที่ได้ทำการศึกษา
: เด็กนักเรียนชั้นประถมศึกษาในโรงเรียนสังกัดของกรุงเทพมหานคร จำนวน 1,369 คน

วิธีการศึกษา-สถิติ
: นักเรียนจากชั้นเรียน ป.1 ถึง ป.6 ชั้นละ 2 ห้องเรียน ซึ่งถูกสุ่มอย่างง่าย พร้อมทั้งมารดาถูกเชิญมาสัมภาษณ์ ทำการประเมินผลภาวะโภชนาการ, เชาวน์ปัญญา โดยพยาบาลและนักจิตวิทยาที่ผ่านการอบรมแล้ว ข้อมูลทั้ง หมดถูกบันทึกและวิเคราะห์ด้วยโปรแกรม STATA 5.0 โดยใช้วิธี Mantel-Haenszel และ Multiple logistic regression

ผลการศึกษา
: พบว่า 26.6 % (95 % CI : 24.3-29.0 %) ของเด็กนักเรียนมี IQ โดยเฉลี่ยต่ำ กว่าเกณฑ์ (<90) หลังจากปรับตัวแปรกวนต่าง ๆ แล้วพบว่าเด็กที่มีภาวะ ทุโภชนาการจะมีโอกาสพบ IQ ต่ำกว่าเกณฑ์และผลการเรียนต่ำ ปัจจัยด้าน สถานภาพสมรสและการศึกษาของบิดา มารดา สัมพันธ์กับ IQ และ GPA หลังจากรวมผลวิเคราะห์จากทั้ง 7 โรงเรียนด้วยวิธี Mantel-Haenszel โดยใช้ random effects model พบว่าในเด็กที่มีภาวะทุโภชนาการมีโอกาสเป็น 1.35 เท่า (95 % CI = 0.94-1.92) และ 1.11 เท่า (95 % CI = 0.83-1.46) ในการมีเชาวน์ปัญญาและผลการเรียนต่ำกว่าเกณฑ์ตามลำดับ

วิจารณ์ และสรุปผล : *การศึกษาครั้งนี้ชี้ให้เห็นถึงความสัมพันธ์ระหว่างภาวะโภชนาการกับเชาวน์*
ปัญญา และผลการเรียนในเด็กไทยซึ่งให้ผลสอดคล้องกับการศึกษาในประเทศ
แถบตะวันตก รัฐบาลควรสนับสนุนให้มีการศึกษาเชิงทดลองต่อไปในเด็กภาวะ
ทุโภชนาการในโรงเรียน เพื่อปรับปรุงภาวะโภชนาการอันจะนำไปสู่การพัฒนา
เชาวน์ปัญญา และผลการเรียนต่อไป

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The healthy development of the intellect during childhood has been stated as an issue of major concern to the government in Thailand.[1] Factors believed to affect the intellectual development of children include general health status, growth development and nutritional condition.[2] Some studies have reported that children with poor nutritional condition and poor health status do not achieve their academic potential.[3,4]

Approximately 50,000 children living in Bangkok Metropolis enter primary school every year. Most of these children come from low income families and experience problems in learning. In 1990, the Thai government conducted a cross-sectional survey to determine the association between intelligence, academic performance and nutritional condition among primary school children. The aim was to determine whether poor nutritional condition was associated with poor intelligence and poor academic performance.

Methods
Sample

Seven Bangkok Metropolitan schools in 3 regions were selected by one-stage cluster random sampling. In each school, two classrooms from each of the six grades were selected by simple random sampling. Parents of the children in these classrooms were invited to participate in the study by coming to their child's school for an interview on a stated day. All of the children in the selected classrooms who attended school on that day and whose mothers were interviewed were included in the study. This resulted in a total of 1369 children.

Data collection

The intellectual level was assessed by trained psychologists who interviewed each child individually. Testing forms were adapted from the standard test, Stanford Binet, Form L-M and WISC for Thai children aged 2-15 years. IQ scores were classified in categorical data. GPA(Grade Point Average) scores were used to assess academic performance. These were determined from the school examination results of the previous semester. All schools used the same system to calculate the GPA. The grade of each subject was defined as 0=fail, 1=pass, 2=average, 3=good, 4=excellent. The GPA is the weighted average over all subjects where each subject was weighted by the number of teaching hours per week allocated to the subject. The GPA was classified into 3 groups as poor, average and good by tertiles within the schools. Children whose GPA was lower than the 33rd percentile had a poor GPA, between the 33rd and 66th percentile had an average GPA and higher than the 66th percentile had a good GPA. Nutritional condition was assessed by standardised growth charts for Thai children based on weight for age and height for age. Height and weight were measured in kilograms and centrimetres, respectively.

Information such as sex, birth order, number of children in the family and indicators of socio-economic status such as family income, parents' marital status, education and occupation were obtained from the interview with the child's mother.

Statistical Analysis

The IQ level and GPA scores were considered as the outcome variables and the nutritional condition was the study factor. In the multiple logistic regression

analyses, they were categorized into binary variables as follows:

IQ level: Below average IQ (< 90) / Average (90-109) or above average IQ (> 109)

GPA scores: Poor GPA / Average or good GPA

Nutritional condition : Normal (including over-weight) / Malnutrition.

Family factors were child's sex, birth order, number of children in the family, family income, parents' education, occupation and marital status.

All the data was coded and entered by word processor and analysed by STATA software.[5] The Chi-square test was used to test for association and the odds ratio was calculated for the strength of association. The Kruskal-Wallis test was used to test the difference of the GPA in each factor. Multiple logistic regression was used to determine the extent of association between the IQ, GPA and nutritional condition after adjusting for potential confounding factors within the schools, and the results across schools were pooled by the Mantel - Haenzsel method using a random effects model.[6]

Results

Response rate and missing data

On average, there would have been 45 children in each classroom (typical class size in Bangkok Metropolitan schools). The response rate was very low and ranged from 26.5% to 46.7% across the schools. The overall response rate was 36.2% because only children whose mothers could come to school on that day for an interview were included. There were less than 1% missing values in other variables. There were 9.2% missing values of the GPA scores because some children had no record books available from the previous examination, with 31% of them in Grade 1 because they had no record books from kindergartens.

Differences between schools

Schools were ranked by family income and are shown in Table 1. Most of the children came from low income families. There were statistically significant differences among schools in family income, family size, birth order, parents' marital status and education. and their parents had at least primary school education.

Table 1. Column percentage distribution of the differences among schools in confounding factors.

Variables	School*							p-value
	RA	PA	PR	NN	WT	TH	KA	
Family income[a]								
Low	48.5	46.8	48.9	69.0	69.0	74.0	58.2	< 0.0001
Medium	36.5	41.1	39.9	22.7	24.0	22.6	40.2	
High	15.0	12.0	11.2	8.3	7.0	3.4	1.6	
Sex								
Boy	55.9	54.4	58.0	46.3	51.1	55.4	55.2	0.270
Girl	44.1	45.6	45.6	53.7	48.5	44.6	44.8	
Class								
Grade 1	16.1	17.7	13.3	20.2	27.5	17.0	11.5	< 0.001
Grade 2	16.7	15.2	17.5	26.4	15.7	13.0	14.7	

Table 1. Continuous.

Variables	School*							p-value
	RA	PA	PR	NN	WT	TH	KA	
Grade 3	17.3	15.2	14.0	20.2	13.5	16.4	11.1	
Grade 4	19.6	15.2	19.6	12.8	14.8	13.6	23.0	
Grade 5	15.5	14.5	18.9	12.4	11.8	13.6	20.2	
Grade 6	14.9	22.2	16.8	7.9	16.6	26.5	19.4	
Number of children in the family								
1	22.3	15.3	21.3	19.5	19.6	17.5	14.3	< 0.0001
2	51.2	42.0	28.4	33.6	37.1	25.4	25.5	
3	19.8	29.3	24.1	27.4	24.4	31.1	24.3	
4+	6.6	13.4	26.2	19.5	18.8	26.0	35.9	
Birth order								
Only child	22.3	15.3	21.3	19.5	19.6	17.5	14.3	0.002
First child	33.7	29.9	19.9	25.7	31.4	29.4	23.1	
Middle child	10.2	21.0	17.7	22.4	12.7	24.9	24.7	•
Last child	33.7	33.8	41.1	32.4	36.2	28.2	37.8	
Parents' marital status								
Married	72.3	75.3	73.9	68.5	67.7	61.4	75.7	< 0.0001
Widowed	1.8	3.2	2.1	4.1	4.8	5.7	8.8	
Divorced	25.9	21.5	23.9	27.4	27.5	32.9	15.5	
Parents' education[b]								
Neither	7.8	3.2	3.5	4.1	7.9	4.6	13.9	< 0.0001
Either	11.4	12.0	18.2	16.9	13.5	14.8	18.7	
Both	80.8	84.8	78.3	78.9	78.6	80.7	67.3	
Parents' occupation[c]								
Neither	3.6	2.5	4.2	2.1	5.2	5.7	2.8	0.269
Either	37.1	38.0	39.9	46.7	34.9	43.2	40.2	
Both	59.3	59.5	55.9	51.2	59.8	51.5	57.0	

* RA= Ratanakhosinsompoch   PA=Paorohit

   PR=Pradoochimplee   NN=Nang Nong

   WT=Wad Tai   TH=Thammapirataram

   KA=Kanikapol

a = Salary of family in baht (U$1=25 baht) per month

   Low = <5000 baht, Medium = 5000-9999 baht, High = 10000+ baht

b = Parents finished at least primary school

c = Parents were employed

Children in wealthier schools came from smaller families Because of these differences between schools, the analysis was done within the schools separately, and then combined using a Mantel - Haenszel method approach.

Univariate analysis

Table 2, shows that 52.5% of the children had an average IQ and 27% had a below average IQ. This is not significantly higher than the standard population.[2] Regarding nourishment, only 48.8% of the children were normal and 47.5% of them were considered to be malnourished. Only 3.7% of them were overweight and they were included in the normal group.

The association between the IQ and confounding factors, crude OR and 95% CI of having a below average IQ are shown in Table 3. It appears

that the IQ is significantly associated with parents' education, marital status and family history. Children with only one of their parents being educated were 1.5 times more likely to have a below average IQ and the odds increased to 2.57 times in those where neither of the parents were educated. Children with divorced or widowed parents were more likely to have a below average IQ than those with currently married parents, and the odds were 1.04 and 1.98, respectively. Children from medium and low income families were 1.86 and 2.29 times more likely to have a below average IQ, respectively. Similarly, children whose parents were not educated were 1.4 times more likely to have a poor GPA. Those who came from a low income family and whose parents were divorced or widowed were 1.7 times more likely to have a poor GPA.

Table 2. Percentage distribution of the IQ level, nutritional status and GPA.

Variable	Frequency	Percent
IQ level (n = 1369)		
< 50 significantly subaverage	5	0.4
50-70 subaverage	34	2.5
71-79 borderline	94	6.9
80-89 dull	231	16.9
90-109 average	719	52.5
110-119 bright	190	13.9
> = 120 very bright	96	7.0
Nutritional status (n = 1345)		
Normal	657	48.8
1 st degree	531	39.5
2 nd degree	103	7.7
3 rd degree	4	0.3
overweight	50	3.7
GPA (n = 1243)		
Poor	387	31.1
Average	491	39.5
Good	365	26.4

Table 3. Row percentage distribution and crude OR (95% CI) of having a below average IQ and a poor GPA.

Variable	Below average IQ			Poor GPA		
	n	%	OR (95% CI)	n	%	OR (95% CI)
Sex						
Boy	730	26.4	1	666	37.4	1
Girl	639	26.8	1.02 (.80-1.30)	577	23.9	.53 (.41-.67)
Number of children						
1	250	28.0	1	224	37.5	1
2	466	26.4	.92 (.65-1.30)	416	30.1	.72 (.51-1.01)
3-4	498	24.3	.82 (.58-1.16)	459	26.4	.60 (.42-.84)
>= 5	148	33.1	1.27 (.82-1.97)	138	38.4	1.04 (.69-1.61)
Birth order						
Only child	250	28.0	1	224	37.5	1
First child	375	26.9	.95 (.66-1.35)	342	28.4	.66 (.46-.94)
Middle child	264	24.2	.82 (.56-1.22)	243	30.4	.73 (.50-1.07)
Last child	473	27.1	.95 (.68-1.34)	428	29.9	.71 (.51-1.0)
Parents' education*						
Both	1063	23.9	1	958	29.4	1
Either	209	32.1	1.50 (1.09-2.07)	197	36.6	1.38 (1.0-1.9)
Neither	94	44.7	2.57 (1.68-3.95)	85	36.5	1.38 (.87-2.18)
Parents' occupation						
Both	767	26.2	1	694	29.2	1
Either	549	26.8	1.03 (.80-1.32)	501	32.5	1.17 (.91-1.49)
Neither	50	30.0	1.21 (.65-2.24)	45	42.2	1.77 (.96-3.24)
Parents' marital status*						
Married	962	25.7	1	870	27.5	1
Divorced	337	26.4	1.04 (.79-1.38)	306	39.5	1.73 (1.31-2.27)
Widowed	64	40.6	1.98 (1.18-3.31)	62	38.7	1.67 (.98-2.82)
Family income*						
High	106	15.1	1.0	96	22.9	1
Medium	434	24.9	1.86 (1.06-3.29)	392	27.8	1.30 (.77-2.18)
Low	827	28.9	2.29 (1.32-3.95)	753	33.7	1.71 (1.04-2.81)

*Statistically significant at p < 0.05

The extent of association

The extent of association between IQ and nutritional condition within the schools after adjusting for confounding variables such as grade, family income, parents' marital status and education are summarized in Table 4. Malnourished children in school PR were 3.67 times more likely to have a below average IQ than normal children. The odds in other schools were not statistically significant.

Adjusted OR of having a below average IQ within the schools were pooled by the Mantel-Haenszel method using a random effects model and are plotted in Figure 1. All adjusted ORs were homogeneous so they could be combined, and the resulting pooled OR was 1.35 (95% CI: 0.94-1.92). That is, malnourished children were 1.35 times more likely to have a below average IQ

than normal children.

The extent of association between the GPA and nutritional condition was investigated by adjusting for potential confounding factors such as the IQ, grade, sex, number of children in family, parents' marital status and education as shown in Table 4. Although the adjusted ORs were not statistically significant, all of them except in school TH and school KA were greater than one. Adjusted ORs of having a poor GPA among malnourished children from the 7 schools are plotted in Figure 2. Pooled adjusted OR using a random effects model was 1.11 (95% CI: 0.83-1.46). Therefore, malnourished children were 1.11 times more likely to have a poor GPA than normal children, and the odds were slightly lower than that of having a below average IQ.

Table 4. Adjusted OR (95% CI) of having a below average IQ and poor GPA in malnourished children within school.

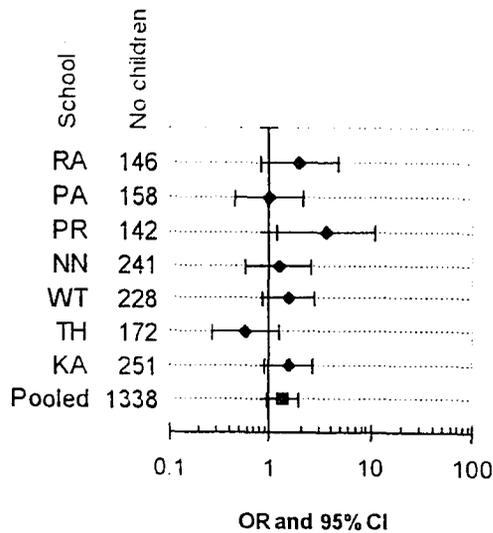| School		ORs (95 % CI)		
	n	Below average IQ*	n	Poor GPA*
RA	146	1.96 (.81-4.74)	124	1.14 (.48-2.75)
PA	158	.98 (.45-2.14)	129	1.27 (.48-3.37)
PR	142	3.67 (1.19-11.29)	121	1.65 (.68-4.0)
NN	241	1.22 (.58-2.57)	239	1.14 (.63-2.08)
WT	228	1.56 (.87-2.78)	223	1.22 (.66-2.26)
TH	172	.57 (.27-1.21)	144	.67 (.29-1.55)
KA	251	1.54 (.91-2.59)	250	.97 (.52-1.82)
Pooled	1338	1.35 (.94-1.92)	1230	1.11 (.83-1.46)

*Adjusted by family factors

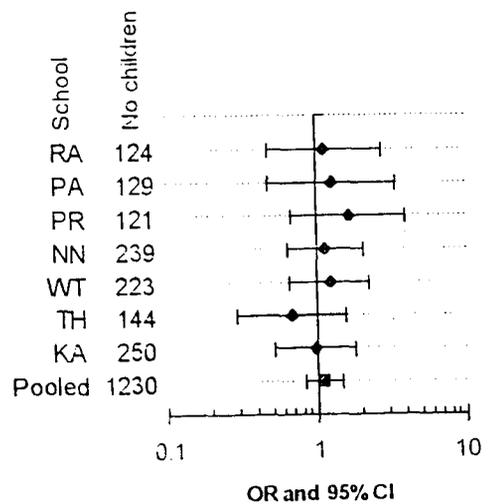**Figure 1.** Adjusted OR (95 % CI) of having a below average IQ within schools and pooled OR

Figure 2. Adjusted OR (95 % CI) of having a poor GPA within schools and pooled OR

Discussion

This study was conducted in Bangkok Metropolitan schools and these schools are different from other types of schools. Therefore, the results can be generalised only to Bangkok Metropolitan schools. A limitation of this study is that those children who were studied were those who were in school on that day and one of whose mothers could come to the school for the interview. This may introduce the bias in the study because these mothers were more interested in looking after their children's health than the others. However, the information obtained from the mothers was considered to be more accurate than it would have been from the children. But those children who were not included in the study may have had a lower IQ which may bias the result, since the IQ was considered as the primary outcome measure. There might be response bias and recall bias in the study. In addition, children who were sick and not in the schools on that

day might have had a poor IQ and poor academic performance as suggested by the study of Pollitt E[4] and Barro SM.[7] Some diseases in childhood influence the intellectual development and school performance of children.[8,9]

Health status in children should be examined and the history of the mother during pregnancy should be determined. Health status is closely related to nutritional conditions.[10] There are a number of studies showing the association between child 's health status, mother's history during pregnancy and child's intelligence development and school performance.[11-15] It is suggested that these factors should be investigated in a further study.

After adjusting for confounding variables, it appeared that the malnourished children in each school are more likely to have a below average IQ. This result supports the studies of Pollitt E et al [3] and Grantham MS.[16] Pollitt E et al conducted a double-

blind clinical trial in Thailand and found that there is a positive association between iron status and school achievement. Our study was a cross-sectional survey but the association between nutritional condition and academic performance was also found. Grantham MS found that school - age children suffering from early childhood malnutrition have generally been found to have poorer IQs and school achievement. In 1994, Pollitt E[4] reported that children's problems in concurrent illness and poor nutrition interferred with their schooling. It was also found that malnourished children tend to have poor academic performance. However, school performance is not only influenced by malnourishment but other factors such as the teacher, teaching technique and motivation, and these should also be considered. Because of considerable differences in characteristics between schools, all analyses were performed within the schools separately and the results combined using a Mantel-Haenszel approach.

There are other factors that influence poor academic performance. Children in higher grades, and boys overall, are more likely to have poorer academic performance. Children from low income families whose parents were divorced or widowed and not educated had a poor GPA. These results agree with the studies from Green EJ[17] and Felner RD.[18]

Finally, this study is consistent with previous studies in Western countries and suggests an association between nutritional condition and academic performance in Thai school children. Given the poor nutritional condition of many Thai school children, there may be value in the Thai government sponsoring randomized studies to determine whether school-based interventions designed to improve the nutritional condition of children would lead to improved academic performance.

References

1. Bangkok Metropolis. Report of Health Division, Municipality of Bangkok Metropolis in 1989.

2. Hughes GJ, Griffith FJ. Synopsis of Paediatrics 6th ed. St. Louise: C.V. Mosby, 1984.

3. Pollitt E, Hathirat P, Kotchabhakdi NJ, Missell L, Valyasevi A. Iron deficiency and educational achievement in Thailand. Am J Clin Nutr 1989 Sep; 50 (3 Suppl.): 687-96

4. Pollitt E. Poverty and child development:relevance of research in developing countries to the United States. Child Dev 1994 Apri; 65 (2 Spec No): 283 - 95

5. STATA Reference Manual Release 4 Stata Press, College Station, Texas, 1995.

6. Fleiss JL. The statistica l basis of meta-analysis. Stat Methods Med Res 1993; 2 (2):121-45

7. Barro S.M, Kolstand A. Who drops out of high school ? Finding from high school and beyond (Report No. C8-87-397c) Washington, DC: Center for Education Statistics, 1987.

8. Lucas A, Morley R, Fewtrell MS. Low triiodothyronine concentration in preterm infants and subsequent intelligence quotient (IQ) at 8 year follow up. BMJ 1996 May 4; 312(4): 1132-4

9. Lawry KW, Brouhard BH ,Cunningham RJ. Cognitive functioning and school performance in children with renal failure. Pediatr Nephrol 1994 Jun; 8(3):326 -9 ·

10. Turner MR.ed. Nutrition and Health A Perspective. The Current Status of Research on Diet-Related

Disease Lancaster. MTP Press 1982.

11. Bellati U, Pompa P, Liberati M. Evaluation of the effect of a "Mediterranean diet" and prepregnancy body mass on fetal growth. Minerva Ginecol 1995 Jun; 47(6): 259 -62

12. Lagerstrom M, Bremme K, Eneroth P, Janson CG. School marks and IQ-test scores for low birth weight children at the age of 13. Eur J Obstet Gynecol Reprod Biol 1991 Jul 1; 40(2): 129-36

13. Lucas A, Morley R, Cole TJ, Lister G, Leeson -Payne C. Breast milk and subsequent Intelligence quotient in children born preterm. Lancet 1992 Feb 1; 339(8788): 261-4

14. Olds DL, Henderson CR Jr, Tatelbaum R. Intellectual impairmant in children of women who smoke cigarettes during pregnancy. Pediatrics 1994 Feb; 93(2): 221-7

15. Griffith DR, Azuma S, Chasnoff IJ. Three - years outcome of children exposed prenatally to drugs. J Am Acad Adolesc Psychiatry 1994 Jan; 33(1): 20 -7

16. Grantham - McGregor S. A review of studies of the effect of severe malnutrition on mental development. J Nutr 1995 Aug; 125(8 Suppl): 2233S -2238S

17. Green EJ. Birth Order, Parental Interest and Academic Achievement. San Francisco: R&E Research Associates, 1978.

18. Felner RD, Brand S, DuBois DL, Adam AM, Mulhall PF, Evans EG. Socioeconomics disadvantage, proximal environmental experiences and socioemotional and academic adjustment in early adolescence : investigation of mediated effects model. Child Dev 1995 Jun; 66(3): 774 -92