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Intelligence Quotient (IQ) Relationship with Energy Intake and Micronutrient Composition among Primary School Children in Baghdad City, Iraq

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Abstract: Nutrient component of diet is very important, especially for children during the development stages. Diet rich in vitamins and minerals is essential for healthy children. This study was conducted to assess the associations between energy intake, macronutrient composition and child Intelligence Quotient (IQ) score. A cross-sectional study was conducted among children aged 7 to 8 years old from 5 primary schools in Baghdad city. Dietary intake was assessed using 24-hour dietary recall. Body weight status was determined using weight and height. While intelligence quotient was evaluated using Raven Colored Progressive Matrices. A total of 480 children participated in this study. The mean age was 8.00±0.56 years. Mean energy intake among the children was 1,020 kcal per day. There were excessive intake of vitamin B1, B2 and B3 (0.88, 1.12, 12.27 mg) respectively. Both low and normal IQ groups showed a large difference in vitamin A and iodine intakes. After adjusting for confounders, parental working status, iodine level and child nutritional status still appeared to be the most important factors influencing child IQ. It is concluded that sufficient nutrient intake is very important during child cognitive development. Child nutritional status and iodine deficiency were the most important factors related to child's intelligence among the respondents.

Key words: 24-hour dietary recall, IQ, Iodine, BMI-for-Age Z score, Baghdad

INTRODUCTION

Nutrition is one of the crucial factors affecting cognitive development of children. The huge and rapid changes in life style during the last 30 years and the rapid increase in fast food availability led to the reduction in the quality of food and its nutrients. Children nowadays consumed foods high in calories and carbohydrate and low in vitamins and minerals which are needed to build their cognition.

In majority countries, children and adolescents constitute a group at risk for nutritional deficiencies. This is due to increased micronutrient needs for growth, as well as changes in eating and lifestyle habits arising from increasing independence from the family. During this time, nutritional requirement is high, yet vitamin and mineral intakes tend to be reduced as there is a greater consumption of fast food, frequent meal skipping, adoption of inappropriate weight control behaviors and decreased vegetable and fruit intake (Serra-Majem, 2001; Hercberg *et al.*, 1991; Gregory and Lowe, 2000). This contributes on the one hand to a greater percentage of nutritional risk in this population and, on the other hand, to an increase in the prevalence of obesity (Tomkins, 2001). Livingstone and Robson (2000) stated that the accurate assessment of food intake in children and adolescents is of concern

because dietary habits formed early in life in response to physiological requirements and psycho-social pressures may have considerable impact on long-term health status.

Body Mass Index (BMI) is a number calculated from a child's weight and height. It is a reliable indicator of body fatness for most children and teens. BMI does not measure body fat directly but research has shown that BMI correlates to direct measures of body fat, such as underwater weighing and Dual Energy X-ray Absorptiometry (DEXA). BMI can be considered as an alternative for direct measures of body fat. Additionally, BMI is an inexpensive and easy-to-perform method of screening for weight categories that may lead to health problems. For children and teens, BMI is age and sex specific and is often referred to as BMI-for-age (Center of Disease control, 2011).

Iodine deficiency is the single greatest cause of preventable mental retardation in the world today. Due to lack of iodine in the diet, 1.6 billion people worldwide are at risk of diminished mental and physical capacities. Iodine deficiency disorders also caused poor eye hand co-ordination, deaf mutism, dwarfism, facial and physical deformity, partial paralysis, cretinism, neurological damage, goiter and lassitude. The risk of miscarriage, stillbirth or prematurity rise significantly if a

pregnant woman is deficient in iodine. Each child in mildly iodine-deficient areas may forfeit as many as 10-15 IQ points (UNICEF, 1998). Bleichrodt and Born (1994) who carried out a meta-analysis of 18 studies found a loss of 13.5 IQ points in children and adults from iodine deficiency areas. Similarly, another meta-analysis on 36 published studies (Qian *et al.*, 1994) concluded that iodine deficiency leads to a 10 point loss in IQ of children living in iodine deficiency areas; in contrast, an 11.5 IQ point increase was found in children in iodine deficient areas that had been involved in the iodine supplementation programme.

The objective of this study was to assess the associations between energy intake, macronutrient composition and child Intelligence Quotient (IQ) score.

MATERIALS AND METHODS

A cross-sectional study was conducted among 480 healthy, with no learning disabilities respondents aged between 7 to 8 years old from five different primary schools in Baghdad city during September and October 2011. A list of all schools in Baghdad city was obtained from the Ministry of Education. Baghdad is divided into five educational areas in which one school was selected from each educational area for better representation. The selection of five schools from the list was carried out using simple random sampling method. Subsequently, a complete list of student names in each selected school was obtained. A total of 106 children from each school were then identified by stratified random sampling according to grade. Self-administered questionnaires were distributed to respondents' parents during the monthly meeting in the schools.

BMI-for-age-Z score and Height -for-age-Z score were used to assess the nutritional status of children based on WHO 2007 cut off points, in which any score less than -2 SD is considered as malnourished and stunted subsequently. A pre test was carried out where the questionnaires were distributed to 31 parents for validation.

Raven's Coloured Progressive Matrices (CPM) tool (Raven *et al.*, 1998) was used to obtain child IQ score. A 24-hour dietary recall method was used to assess children nutrient intake. A well-trained co-researchers obtained the dietary information from the parents. The Recommended Nutrient Intake (RNI) of Turkey (Dietary Guidelines of Turkey, 2006) which is a neighboring country to Iraq, was used to compare with the respondents' nutrient intake because of the absence of RNI for Iraq.

This study was approved by the Research and Ethics Committee of Universiti Kebangsaan Malaysia Medical Centre. Code Number FF-180-2011, Also approval from Iraqi ministry of education was obtained to conduct the research inside the schools. Consent form from the parents was taken.

Statistical analysis: The association between child IQ status and child sex, parents working status and family monthly income were examined by Chi square test (categorical variables). And with weight, height, BMI, Height for age Z score and BMI-for-Age Z score by independent sample t test (continuous variable). After this logistic regression analysis was conducted to determine the factors associated with IQ status. Odds ratios were obtained for each potential factor after adjustment for sex, family income and parent working status. The reference for IQ was normal, for gender was male, for working status was both parents working and for family income was high. All analyses were performed using SPSS version 16.0 (SPSS Inc., 2007) and Nutritionist-pro software (Nutritionst Pro Software, 2012) for dietary analysis.

RESULTS

A total of 480 children from 5 different areas of Baghdad participated in this study. Participants' average age was 8.00 years (± 0.56). The IQ scores showed that 77.7% of the respondents have normal intelligence level as they scored more than 75th percentile.

Table 1 presents the participants' socio-demographic characteristics. Slightly more than half (52.2%) were males. The participants' median monthly family income was 754, 901 Iraqi dinars (which is approximately 649USD).

As shown in Table 2, there was significant association between weight, height, BMI-for-Age Z score and Height -for-Age Z score with IQ status of the respondents.

Figure 1 represents the percentage of nutrient intake consumed by respondents as compared to recommended daily intake for children aged 7 to 9 years old in Turkey.

Table 3 shows the relationship between nutrient intake and intelligence, in which the only significant nutrient associated with IQ was iodine with p-value <0.001. The mean energy intake was 1, 020 kcal per day which is lower than the recommended energy level for this age group. Protein intake was more than the recommended level which is between 26-38 gram per day; also ascorbic acid (Vitamin C) intake was less than the recommended level per day for this age group. The average iodine intake was 64 mcg per day which is less than 90 mcg recommended for children aged 7 to 9 years old. There was an excessive intake of vitamin B1, B2 and B3 (0.88, 1.12, 12.27 mg), respectively.

After adjusting for gender, parents working status and monthly family income using multiple logistic regression analysis. Working status, iodine level and nutritional status still appeared to be the most important factors influencing child IQ (Table 4).

DISCUSSION

The main finding of this study is that iodine is the most important nutrient that can affect children intelligence

Table 1: Socio demographic characteristics of the respondents

Variable	Low IQ		Normal IQ		POR (95%CI)	p-value ^a
	N	(%)	N	(%)		
Child sex						
Male	54	(21.6)	196	(78.4)	1.34 (0.82-2.07)	0.171
Female	62	(27.0)	168	(73.0)		
Parents working status						
Both parents working	29	(18.4)	129	(81.6)		0.005*
One parent work	66	(23.4)	216	(76.6)	1.31 (0.88-1.93)	0.183
Neither working	21	(52.5)	19	(47.5)	3.49 (1.63-7.48)	0.001*
Family monthly income						
Low (less than 700, 000)	72	(28.8)	178	(71.2)	1.71 (1.12-2.62)	0.013*
High (more than 700, 000)	44	(19.1)	186	(80.9)		

^aPearson chi-squared, significant at p<0.05. POR: prevalence odds ratio.

Table 2: Physical characteristics of the respondents

	Low IQ	Normal IQ		p-value ^a	
	Mean±SD	Mean±SD	Md		95% CI
Weight (kg)	24.89±6.05	26.97±5.74	2.08	1.03-3.14	<0.001*
Height (cm)	119.60±8.24	121.60±9.38	2.00	0.42-3.59	0.013*
BMI (kg/m ²)	17.44±4.59	18.30±4.02	0.86	0.08-1.63	0.029*
Height-for-Age Z score	-0.87±1.43	-0.65±1.57	0.22	-0.04-0.49	0.107*
BMI-for-Age Z score	0.52±2.20	1.05±1.70	0.52	0.17-0.88	0.003*

^aIndependent sample t test, significant at p<0.05.

CI: Confidence interval

Md: Mean difference

Table 3: Relationship between energy intake, nutrient composition and intelligence

Nutrient	Low IQ (F = 116)	Normal IQ (F = 364)	p-value ^a
	Mean±SD	Mean±SD	
Energy (kcal)	1010.76±308.57	1024.12±298.00	0.677
Protein (g)	49.26±22.66	50.12±21.08	0.826
Carbohydrate (g)	128.74±41.23	130.36±40.61	0.711
Total Fat (g)	32.77±16.76	33.52±17.74	0.685
Sodium (mg)	1835.05±706.31	1830±650.70	0.948
Potassium (mg)	1430.52±654.13	1416.60±714.46	0.852
Vitamin A (mcg)	460.88±295.55	506.70±361.04	0.215
Vitamin C (mg)	38.73±53.90	40.35±50.27	0.768
Calcium (mg)	809.63±1261.26	731.84±1110.52	0.526
Iron (mg)	9.21±3.66	9.20±2.99	0.985
Iodine (mcg)	33.55±22.74	72.15±44.04	<0.001*
Vit. B1 (mg)	0.89±0.41	0.88±0.29	0.592
Vit. B2 (mg)	1.16±0.52	1.11±0.37	0.245
Vit. B3 (mg)	12.53±9.60	12.41±8.56	0.893

^aIndependent sample t test was performed; Level of significance at p<0.05

level. Most nutritional studies performed during childhood and adolescence in developed countries report intakes falling below recommendations in a significant percentage of the population. Lack of physical activity and inadequate food choices have been proposed as the principal determinants of this phenomenon. However, little attention has been paid to factors associated with the inability to meet recommended intakes in this age group (Serra-Majem, 2001; Hercberg *et al.*, 1991; Gregory and Lowe, 2000; Tomkins, 2001; Zive *et al.*, 1996; Decarli *et al.*, 2000). This study has several strengths. The large sample size and children from five different living areas in Baghdad city which provide information about different socio economic status. However, there were some limitations to this study that need to be highlighted such as, recall

bias in the replies of the respondents' parents, especially in 24-hour dietary recall and logistical problem during field work and data collection, in that the unstable security situation in Baghdad made access to some areas difficult and dangerous. Monthly family income was significantly associated with child's IQ. This is supported by a number of studies that reported significant effects of poverty on children's cognitive and verbal skills (Korenman *et al.*, 1995; Liaw and Brooks-Gunn, 1994; Smith *et al.*, 1997). Low income means less food and nutrient supply to the child which will subsequently affect the IQ development. Parents' working status is one of the important factors that can influence child development especially in the early years of life and the most crucial is the mother because in most cases, mother is the one who takes

Table 4: Multiple logistic regression analysis to identify factors associated with low IQ status

Variable	B	Wald	p-value	Adj OR	95%CI
Female	0.252	0.961	0.327	1.287	0.777-2.129
Low family income	0.029	0.009	0.924	1.030	0.567- 1.868
Parents working	12.904	0.002*			
One working	1.505	11.128	0.001*	4.504	1.860-10.906
Neither working	1.836	12.012	0.001*	6.273	2.221-17.720
BMI-for-Age Z	0.247	13.453	<0.001*	1.280	1.122- 1.416
Height-for-Age Z	0.332	13.175	<0.001*	1.394	1.165-1.668
Energy	0.487	0.004	0.949	1.000	0.990- 1.009
Protein	0.006	0.068	0.795	1.006	0.964- 1.049
Carbohydrate	0.002	0.014	0.9069	1.002	0.965- 1.041
Fat intake	0.006	0.017	0.895	1.006	0.920- 1.101
Iron	0.006	0.015	0.904	1.006	0.909- 1.114
Iodine	0.038	52.714	<0.001*	1.039	1.208-1.050

*Binary logistic regression. Adj OR: Adjusted odds ratio. CI: Confidence interval.

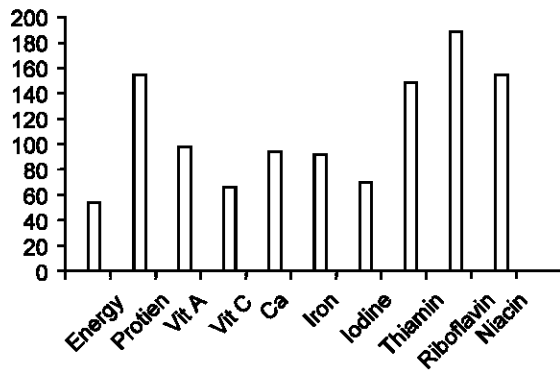


Fig. 1: Compares of respondents nutrient intakes with recommended daily intake of Turkey. The figure represents the percentage of nutrient intake consumed by respondents as compared to recommended daily intake for children aged 7 to 9 years old in Turkey. As seen, most nutrient intake was higher than recommended except for vitamin C, Iodine and the energy. Riboflavin intake was almost double the recommended level for children aged 7 to 9 years old

care of the child as in our study, almost 92% of the mothers were the child guardian during the day. Parents' working status results are supported by other studies which were carried out to examine the effects of maternal employment on child IQ (Brooks-Gunn *et al.*, 2001; Waldfogel *et al.*, 2002).

Nutritional status was associated with intelligence level of children as supported by other studies (Zalilah Mohd Shariff *et al.*, 2000) which concluded that among the three nutritional status indicators, educational achievement differed significantly only according to height-for-age. This indicates that the process of stunting which corresponds to prolonged nutritional deficiencies may have a persistent effect on cognitive development which consequently affects the children's learning capabilities in schools.

Iodine Deficiency (ID) is regarded by the WHO as the most common preventable cause of brain damage in

the world (Hetzel, 2000). Our study results were supported by other studies such as in China which found that IQ scores of all subjects in the severe and moderate iodine deficiency areas were lower than those in the mild iodine deficiency areas (Zhifeng Tabg *et al.*, 2007). Also another study conducted in Mexico regarding iodine deficiency and its association with intelligence quotient in schoolchildren concluded that, moderate iodine deficiency was associated with a 4.26 times higher risk of low IQ level (Pineda-Lucatero *et al.*, 2008). Two possible reasons for the low iodine level among Iraqi children, especially in Baghdad are:

1. first of all, sea food availability is very limited and expensive as the most of low IQ group in our study came from low socio-economic background,
2. secondly, the lack of iodized salt program in Iraq, although there was one program before 2003 war but because of the unstable security situation in Baghdad city and the whole country, the program was stopped.

As a recommendation to our study, food fortification especially iodized salt is the solution for micronutrient deficiencies in Iraq. As proved by in other countries, effective iodine supplementation plays a remarkable role in protecting brain development and can cause a 12 IQ points increase for children born after iodized salt programme for pregnant mothers (Qian *et al.*, 2002).

Conclusion: Sufficient nutrient intake is very important during child cognitive development, especially iodine intake. There was a significant association between child nutritional status, iodine intake and child's IQ level. Our study results will be helpful to the authorities in Iraq in their efforts to improve nutrition and health of the Iraqi children.

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