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Relationship between Nutritional Status and Cognitive Performance among Primary School Students

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Abstract

A satisfactory diet is necessary for normal brain progress. Healthily nutrition is important especially at critical growth stages. Throughout childhood, under-nutrition causes children to have poor energy, which has adverse effects on cognitive development and academic performance. Under-nutrition also affects physical growth and maturation, therefore affecting growth rate, body weight, and final height. The present study is aimed to assess the nutritional status and cognitive performances in some school- age children (72-119 months).The present study is done on 51 students 25 boys and 26 girls with a mean age of 95.75±1.77 months. All students from cities Giza government. The mean average body weight, body height, BMI, and MUA were 23.65± 0.44 kg, 122.79±0.9 cm, 15.62±0.14kg/m^2, and 18.63±0.33cm respectively. The mean average intake of total energy, protein, fat, and carbohydrate was 1185.02±29.12 kcal, 39.19±0.99 g, 39.40±1.27g, and 141.88±3.47 g respectively. The mean average intake of some minerals (Iodine, Iron, Selenium, and Zinc) was 83.08±5.47µg, 10.45±0.56 mg, and 49.32±2.05µg and 4.75±0.19 mg respectively. The mean average intake of some vitamins (Vitamin A, Vitamin B1, Vitamin B2, and Vitamin C) was 293.83±23.24 R.E, 0.41±0.04 mg, 0.47±0.03 mg, and 16.51±0.97mg respectively. Some biochemical analyses were done, the mean average urinary iodine was 155.29±3.53µg/l, and blood hemoglobin was 11.49±0.07 g/dl. The Wechsler tests were done to calculate student intelligence quotient (IQ), the mean average of verbal IQ was 98.43±0.99, the mean average of performance IQ was 95.09±0.42, and the mean average of total IQ was 96.69±0.42.From these results, it could be concluded that nutritional status may affect cognitive development, and the interventions and dietary supplements may improve cognitive abilities in children.

Introduction

Nutrition is one of many factors that influence brain progress, consequently, the development of children cognitive. These factors fall into two broad categories, genetic and environmental. Nutrition is a part of the biological environment that affects the brain and cognitive development ***(Bryan et al., 2004).***

Investigating nutrition role cognitive development is expected to be challenging, because nutrition is likely to be an outcome of or link with internal and external environmental factors for instance demographic, socioeconomic, health, social, behavioral, and motivational influences, and also may interact with genetic influences, making its effects not easy to specify ***(Wachs, 2000).***

Not only is the timing of nutritional influences complex, but also the nature of nutritional influences on cognitive development is involved. The intake of macro- and micronutrients may have interactive effects on the brain and cognitive development.
School-age is the active growing period of childhood ***(Bryan et al., 2004).***

Primary school age is a dynamic time of physical growth in addition to child mental development ***(Srivastava et al., 2012).***It is well recognized that suffering from under or over-nutrition during the school years can inhibit a child's physical and cognitive development. Stunting (low height-for-age) is linked to long-term consequences, such as impaired intellectual achievement and school performance, and also leads to decaling adult body size and, subsequently, reduced work ability and obstetric complications ***(Martorell et al., 1992).*** Growth monitoring is globally used to assess nutritional status, children's health, and development. Anthropometric assessment is an almost fixed tool to assess health, and nutritional conditions in childhood ***(Kuczmarski et al., 2002).***

Research indicates that health problems due to poor nutritional status in primary school-age children are the most common causes of low school attendance, high absence, early failure, and poor classroom performance ***(Best et al., 2010).***

Adequate micronutrient status is vital for good health and development during childhood. Anemia, which can result from iron, folate, or vitamin B12 deficiency, among other causes, negatively impacts work capacity, intellectual performance, and child cognitive development ***(de Benoist et al., 2008).*** Vitamin A plays a serious role in eye health and immune function and also plays a role in the etiology of anemia ***(Sommer and Davidson, 2002).*** Sufficient iodine is crucial to the growing child to optimize mental development and prevent goiter and its complications ***(Allen et al., 2006),*** while zinc is necessary for many biologic processes and it's deficiency can affect brain development and cognition ***(Golub et al., 1995).***

There is increasing evidence that improving the nutrition of schoolchildren can have a measurable positive impact on cognition, linear growth, and other health outcomes. Access to high-quality data on nutrition and health indicators in this age group would aid in prioritizing and setting up deliberate, evidence-based nutrition intervention programs, targeting the nutritional problems that are of real concern ***(Whaley et al., 2003).*** Many governments, multilateral and bilateral organizations, and other actors recognize that good health and nutrition of children during the primary-school years contribute to educational achievement, growth, and development. Schools are a practical platform to deliver an integrated package of interventions, such as nutritious meals or snacks, micronutrient supplements or on-site fortification, infection control, health promotion, and life-skills education, to improve the health and nutrition of schoolchildren ***(Best et al., 2010).***

There for the objectives of the present study are to assess the nutritional status and cognitive performances of some school-age children (72-119 months).

Subject and Methods

Study Design: Fifty-one healthy children of both sexes aging 72-119 months were recruited from the urban area of Giza governorate. They were attending Primary schools during the academic year 2019-2020. The personal data were collected by their mothers and their ages were assessed from the birth certificates they were excluded if a physical or mental disability was present or ill children at the time of the study.

Data Collection and Field Work

Data collection took place through a home visit. An informed consent form was signed by the parent before participation in the study. The study was approved by the ethical committee of the National research center with registration numbers 18-105. Anthropometric measurements were conducted on the children while the parents were being interviewed and a questionnaire was filled by the investigator on some personal data, socio-demographic background, and 24-hour recall of their children. Subsequently, a cognitive assessment was conducted on the students one-to-one.

Anthropometric measurements

1- Age was assessed from birth certificates.

2- Body weight was assessed using a beam-type balance while the child wore very light clothes and was barefooted. This weight was taken to the nearest o.5 kg ***(Jelliffe et al., 1989)*** using a kilogram weighing balances ranging from 1-130 kilograms.

3- Body height was measured to the nearest 1 mm for children. Height measurements were taken, while the subject was standing position against a firm wall with a fixed scale. Height was taken with no shoes and recorded to the nearest centimeter ***(Moussa, 1999).***

4- Mid-upper arm circumference (MUAC): was measured to the nearest 0.1 cm with non-elastic tape over light clothing on the upper left arm. The children stood relaxed to the trained technician and the arm hanging freely at the side; the tape was passed around the arm at the level of the mid−point of the upper arm ***(Mazicioglu et al., 2010).***

Dietary intake

Triple 24-hour dietary recalls were administered to the children’s mothers Dietary data were translated into nutrient intake data using a specifically designed nutrient database, (The Egyptian

Food Composition Tables and Nutrient Data Base Management System from National Nutation Institute, 2006).

Cognitive Tests

Cognitive and intellectual functioning was assessed through the application of the Wechsler Intelligence Scale for Children (WISC-R), the Arabic version ***(Ismaiel and Kamal, 1999).***

It is designed to assess and measure the child's verbal, performance, and full-scale IQ through assessment of different functions (short- and long-term memory, comprehension, information, abstract thinking, problem-solving, and speed of information processing), thorough application of (WISC-R), we can assess verbal and practical intelligence quotient (IQ) as well as total IQ ***(Kaufman et al. 2016).***

Biochemical analysis:

1- Blood Hemoglobin: Hemoglobin estimation was done according to ***Shaklai et al., (1977).*** In a reagent solution, the ferrous ions of hemoglobin are oxidized to the ferric state by potassium ferricyanide to form methemoglobin. Methemoglobin subsequently reacts with the cyanide ions provided by potassium cyanide to form cyanmethemoglobin.

Hemoglobin+Cyanide+Ferricyanide= Cyamethemoglobin(Ion).

The amount of cyanmethemoglobin can be measured spectrophotometrically at a wavelength of wavelength 546 nm. The intensity of the color is directly proportional to hemoglobin concentration in the specimen.

2- Urinary Iodine: Urinary Iodine was determined according to ***(WHO, 2013).*** Urine samples were thawed and mixed thoroughly on a rot mixer before pipe ting. 250µl of urine were taken into 13X 100 mm scrolled test tubes then adding 1 ml of M ammonium per sulfate to each tube and the samples were hydrolyzed for 1 h at 100°C. After cool the tubes to room temperature add 2.5 ml arsenious acid solution and mix well then incubate for 15 minutes. Add 300µl of ceric ammonium sulfate to each tube, and then incubate for 30 minutes. Readings were performed using a spectrophotometer (Thermo Fisher Scientific Genesys, USA) at 420 nm, within 30 minutes.

Statistical Analysis Data were analyzed using SPSS Version 20.0 for Windows (Statistical Package for the Social Sciences)

Results and Dissection

Table (1) illustrates the Characteristics of children who participate in the study, the number of children in the study was 51with a mean average age of 95.73±1.77 months, 25 boys (98.38±2.39 month) and 26 girls (95.73±1.77 months). All children live in the cities of Giza Governorate. When asking children mothers some questions about the method of delivery, birth weight, as well as breastfeeding it was found that only 33.33% of children were born in a normal way not cesarean, the mean average of their birth weight was 3.43±0.06 kg and 47.06% of them were breast fed, also when asked children mothers about the time of their children watch T.V, Mobile and Computer we found that they watched them for 4.37±0.18 hour/ day, and only 50.98% of children were playing sports. The weights of children were 23.65±0.44 kg, heights were 122.79±0.90 cm so BMI was 15.62±0.14 kg/m^2, and MUA were 18.63±0.33 cm.

Trend analysis of 2005–14 EDHS data revealed that deliveries by CS have more than doubled between 2005 and 2014 such that 19.9 percent of all live births occurring in the five years preceding the 2005 EDHS were via CS compared to 51.8 percent in 2014 (Abdel-Tawab et al., 2018). Polidano et al, (2017) demonstrated that across several measures, we find that cesarean-born children perform significantly below vaginally-born children, by up to a tenth of a standard deviation in national numeracy test scores at age 8–9. Estimates from a low-risk sub-sample and lower-bound analysis suggest that the relationship is not spuriously related to unobserved confounding. Lower rates of breastfeeding and adverse child and maternal health outcomes that are associated with cesarean birth are found to explain less than a third of the cognitive gap, which points to the importance of other mechanisms such as disturbed gut microbiota. The findings underline the need for a precautionary approach in responding to requests for a planned cesarean when there are no apparent elevated risks from vaginal birth.

Malnutrition is the consequence of a combination of inadequate intake of protein, carbohydrates, micronutrients, and frequent infections ***(Udani, 1992).*** Malnutrition is associated with both structural and functional pathology of the brain ***(Upadhyaya et al., 1992).*** In the present study, the child's intake was recorded for 3 non-consecutive days, including the vacation, to find out the consumption of the child from major and minor nutrients. Table (2) illustrates the mean Total Calorie, Protein, Fat, and Carbohydrate intake by children using data collected by the 24- hour recall and compared to Recommended dietary allowance intake. The mean average total calories recommended for children were 1031.514±9.94 Kcal and the percentage of the actual total calories that were supposed to take were 114.29%, the total recommended Protein intake was 51.56±0.49g while the percentage of actual protein intake was 76.31%, the total recommended Fat intake was 28.65±0.28 g however the percentage of actual fat intake was 138.019%, and the total recommended Carbohydrate intake was 141.83± 1.367g whereas the percentage of actual carbohydrate intake was 100.53%. In our study, it's noticed that the decrease in protein intake, in long run, has serious consequences. Kwashiorkor was also less strongly, but nevertheless significantly, related to cognition at age 11 years ***(Liu et al., 2003).***

On another side, it notices that an increase in fat intake which may cause in the long run over weight and obesity which may have effects on cognitive performance. Obesity may affect brain structure, leptin and insulin dysregulation, oxidative stress, cerebrovascular function, blood-brain barrier, and inflammation ***(Smith et al., 2011).*** Some also suggest that obesity-related changes in metabolism interact with age to impair brain functions ***(Bruce-Keller et al., 2009).*** The high-fat diet increases oxidative stress and inflammatory signaling in the brain ***(White et al., 2009)***. In children, intake of saturated fatty acids impairs both relational and item memory ***(Baym et al., 2014).***

Brain growth and development are critically dependent on several micronutrients. Table (3) present some mineral intake using data collected by the 24- hour recall and compared to Recommended dietary allowance intake. According to US Institute of Medicine recommends the intake of 90 µg daily of iodine for children under 4–8 years of age ***(Trumbo et al., 2001)*** and WHO 120 µg daily of iodine for those aged 6–12 years ***(WHO, 2007),*** On the other hand, the EFSA estimates that adequate iodine intake for children between 4 and 10 years of age is 90 µg/day ***(Arrizabalaga et al., 2018).*** In our study, the mean average intake of iodine was 83.08±5.47 and the percentage of the actual intake among children was92.31%. According to ***Domellof et al., (2014)*** iron is recommended to age 5-9 years 6.1 to 10 mg per day, also ***FAO/WHO, (2002)*** recommended that iron intake 6.3 to 8.9 mg /day. In this study iron mean intake was 10.45±0.56 mg and the percentages of the actual intake among children were 117.42%.

Whereas the selenium RDA was 30-40µg/d, the mean average intake from selenium was 49.32±2.05 and the percentage of the actual intake among children was 123.3%. However, zinc RDA was 4.8-5.6 mg/d. In our study, the mean average intake of zinc was 4.75±0.19 mg and the percentage of the actual intake among children was 84.82%. Iodine, a dynamic nutrient present in thyroid hormones, the thyroid hormones are important for brain development and proper brain function throughout life and iodine is important for the production of these hormones ***(Abel et al., 2017).***

Iodine deficiency increases infant mortality and is the leading preventable cause of mental deficiency in childhood ***(Nyaradi et al., 2013).*** Iron plays a vital role in brain function and is involved in brain energy production, neurotransmitter synthesis, and myelination. Thus, brain areas responsible for cognitive outcomes are also sensitive to iron deficiencies ***(Hermoso et al., 2011).***

Cross-sectional, longitudinal, and intervention studies show that iron deficiency with or without anemia has adverse effects on cognitive development and performance in children. There is a preponderance of evidence demonstrating that anemic children have poorer cognition and school achievement than non-anemic children ***(Jáuregui-Lobera, 2014)***. The biological effects of selenium on brain health are mediated by selenium-containing proteins (selenoproteins), with evidence that this micronutrient is utilized by cells via the presence of selenocysteine (SeCys) amino acid residues in 25 identified selenoproteins. Among the different roles played by selenoproteins, it is noted that at least one-third have antioxidant characteristics, which is essential for neuroprotection ***(Cardoso et al., 2015).***

However, studies regarding the association of Se status and cognitive performance to date have been limited to animal models or related to age-induced memory loss in humans ***(Qin et al., 2014).*** Zinc is a vital modulator of intracellular and intercellular neuronal signaling ***(Sensi et al., 2011)*** that is found in high levels in the brain particularly the hippocampus, considered as the area involved in learning and memory ***(Levenson, 2006),*** and in the amygdala, striatum and neocortex ***(Bitanihirwe and Cunningham, 2009).***

Zinc is essential for the activity of a large number of metalloenzymes, cellular functions including RNA and DNA synthesis ***(Terhune and Sandstead, 1972),*** cellular growth, differentiation, and metabolism. During early development, cellular activity may be particularly sensitive to zinc deficiency, which has been shown to compromise cognitive development ***(Black, 2003).***

Experimental studies in animals have shown that, during the early stages of brain development, deficiency of zinc caused brain defects, reducing the cerebellum size and altering zinc homeostasis, whereas zinc deficiency during the latter stages of brain development impaired function ***(Takeda, 2001).***

Table (4) present some vitamins intake using data collected by the 24-hour recall and compared to Recommended dietary allowance intake. According to ***(FAO/WHO, 2002)*** vitamin A recommendation was 450-500 RE/d. in our study vitamin A intake among children was 293.83±23.24 R.E and the percentage of the actual intake among children was 58.76%. However, vitamin B1and B2 recommendation was 0.6-0.9 mg/d. the mean average intake of vitamin B1 and B2 were 0.41±0.04mg and 0.47±0.03 mg respectively and the percentage of the actual intake among children was 45.56 and 52.22% respectively.

Whereas Vitamin C recommended was 30-35 mg/d the mean average intake from vitamin C was 16.51±0.97 mg and the percentage of the actual intake among children was47.17%. Vitamin A plays a vital role as an antioxidant that reduces lipid peroxidation ***(Carney et al., 1991),*** the production of ROS, apoptosis, and protein and DNA oxidative damage. Vitamin A deficiency was also linked to iron deficiency anemia, a risk factor for cognitive impairment.

Epidemiological evidence from observational studies thus far suggests that those antioxidants in the diet, supplements, and serum may play a neuroprotective role ***(Park et al., 2018).*** Low levels of these B vitamins have been associated with increased homocysteine (Hcy), known to have a direct neurotoxic effect ***(Ho et al., 2001).*** Also ***(Kim et al., 2007)*** reported that hyperhomocysteinemia may be a significant related risk factor for mild cognitive impairment (MCI). The biological benefits of the water-soluble vitamin C (L-ascorbic acid or ascorbate) are acting as a reducing agent, donating electrons in various enzymatic and non-enzymatic reactions ***(Hatch, 1995).***

Increasing evidence is pointing to vitamin C as a main redox homeostatic factor in the central nervous system, relating to a poor dietary intake of Vitamin C to adverse effects on cognitive performance ***(Tveden-Nyborg and Lykkesfeldt, 2009).*** Several in vitro and in vivo experiments have supported an essential role for Vitamin C in the brain, both as a powerful antioxidant and scavenger of ROS, as well as a key factor in the recycling of other brain antioxidants ***(Lykkesfeldt et al., 2007).***

The laboratory analysis used in the biochemical tests is shown in table (5). The urine taken from the children in the study was used to assist Iodine. The results show that the mean average of urinary iodine was 155.29±3.53µg/l, whereas the blood taken from children was used to analyze hemoglobin. The results show that the mean average of blood hemoglobin was 11.49±0.07 g/dl. Its notice that there is no iodine deficiency or anemia among the children, these results reflect the intake of food, especially iron and iodine. ***Aref and Khalifa, (2019)*** reported that the prevalence of anemia was 38.7% among males were 23.3%, while 53.8% among females with a statistically significant difference. ***Elsayed et al., 2015*** reported that iodine deficiency (ID) (< 100 µg/L) is present among 10 % of the studied primary schoolchildren in seven governorates

The Wechsler IQ tests for children are the most frequently used individual IQ test used worldwide. It's providing two primary index scores: verbal tests which contain six tests Information, Comprehension, Arithmetic, Similarities, Vocabulary and Digit Span, and Performance tests which contain Picture completion, Picture Arrangements, Block design, object assembly, coding, and Maze.

These tests convert to scores that express the IQ of children. IQ results among the children in our study showed in table (6). This study showed that the Verbal IQ of children was 98.43±0.99, the performance IQ of children was 95.09±1.14 and the total IQ was 96.69±0.42. The results of IQ tests showed a normal range average in children's IQ (the average ranges were 90-109). From the previous results its childhood, while a healthy diet, associated with high intakes of nutrient rich foods described normal to the children in the study to have good IQ results. ***Northstone et al., 2012*** reported that poor diet associated with high fat, sugar, and processed food content in early childhood may be associated with small reductions in IQ later at about the time of IQ assessment may be associated with small increases in IQ.

Conclusion

From the previous data, it's found that the nutritional status may affect cognitive development and we suggested that interventions and dietary supplements may improve cognitive abilities in children so Future studies may confirm or deny that.

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Parametes	Boys	Girls	Children
Sex (Number)	25	26	51
Age (Month)	98.38±2.39	93.18±2.53	95.73±1.77
Civilize Residence (%)	100	100	100
Normal (vaginally) Delivery (%)	39	30.7	33.33
Birth weight (kg)	3.52±0.09	3.34±0.08	3.43±0.06
Breast Feeding (%)	48	46.15	47.06
Technology Time (hour/d)	4.16±0.26	4.58±0.26	4.37±0.18

Table (1): Characteristics of the Study Population (Mean ±SE).

Play Sport (%)	52	50	50.98
Weight (kg)	24.64±0.61	22.69±0.58	23.65±0.44
Height (cm)	124.6±1.17	121.1±1.30	122.8±0.90
BMI* (kg/m²)	15.79±0.14	15.45±0.22	15.62±0.14
MUA** (cm)	18.63±0.33	19.14±0.47	18.13±0.43

*Body Mass Index
**Mid Upper Arm

Table (2): Total Calories and Macro Nutrient Intake among Children (Mean ±SE)

Parameters	Boys	Girls	Children
Energy (kcal)	1182.68±43.45	1167.64±39.75	1175.02±29.12

Parameters	Boys	Girls	Children
Protein (g)	39.85±1.28	38.55±1.55	39.19±0.99
Fat (g)	38.81±1.81	39.99±1.81	39.40±1.27
CHO* (g)	144.84±5.13	139.04±4.71	141.88±3.47

*Carbohydrate

Table (3): Minerals Intake among Children (Mean ±SE)

Iodine (µg)	86.77±8.33	79.54±7.23	83.08±5.47
Iron(mg)	11.14±0.86	9.79±0.72	10.45±0.56
Selenium (µg)	50.18±3.13	48.49±2.70	49.32±2.05
Zinc(mg)	4.63±0.23	4.86±0.29	4.75±0.19

Parameters	Boys	Girls	Children

Table (4): Vitamins Intake among Children (Mean ± SE)

Vitamin A (RE)	273.6 ±29.08	313.2 ±36.15	293.83 ±23.24
Vitamin B1 (mg)	0.37 ±0.04	0.45 ±0.07	0.41 ±0.04
Vitamin B2 (mg)	0.51 ±0.04	0.42 ±0.04	0.47 ±0.03
Vitamin C (mg)	16.35±1.56	16.67±1.19	16.51 ±0.97

Parameters	Boys	Girls	Children
Urinary Iodine (µg/L)	155.1±4.73	155.45±5.31	155.29±3.53

Table (5): Biochemical Analysis of Children (Mean ±SE)

Blood Hemoglobin (g/dl)	11.45±0.08	11.54±0.12	11.49±0.07

Table (6): Intelligence Quotient (I.Q) Scale among Children (Mean ± SE)

Parameters	Boys	Girls	Children
Verbal IQ	98.08±1.42	98.77±1.39	98.43±0.99
Performance IQ	94.48±1.73	95.69±1.51	95.09±1.14
Total IQ	96.2±0.51	97.15±0.65	96.69±0.42

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العلاقة بين الحالة التغذوية و الأداء المعرفي بين طلاب المدارس الابتدائية

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الملخص العربى

اتباع نظام غذائى سليم ضروري لصحة العقل. التغذية الصحية لها دور هام خاصةً في مراحل النمو الحرجة. طوال فترة الطفولة، يؤدي سوء التغذية إلى ضعفا لطاقة لدى الأطفال، مما له أثارضارةعلى التطور المعرفي والأداء الأكاديمي، و كذلك ايضا يؤثر على النمو البدني والنضج ،وبالتال يؤثرعلى معدل النمو و وزن الجسم وأخيرا الطول. تهدف هذه الدراسة إلى تقييم الحالة التغذوية والأداء المعرفى لبعض الأطفال في سن المدرسة (٧٢-١١٩ شهرا).أجريت هذه الدراسة على ٥١ طالبا ٢٥ صبيا و ٢٦ فتاة بمتوسط عمر ٩٥,٧٥± ١,٧٧ شهر جميع الطلاب من مدينة الجيزة. كان متوسط وزن الجسم، الطول، مؤشركتلة الجسم ،و كذلك محيط الذراع٢٣,٦٥±٠,٤٤كجم،١٢٢,٧٩±٠,٩سم ،١٥,٦٢±٠,١٤كجم/م[2] ، و١٨,٦٣ ± ٠,٣٣سم على التوالي. وكان متوسط كمية الطاقة الكلية المتناولة والبروتين والدهون والكربوهيدرات ١١٨٥,٠٢±٢٩,١٢ سعر حراري، ٣٩,١٩±٠,٩٩ جم،٣٩,٤٠±١,٢٧ جم،و ١٤١,٨٨±٣,٤٧ جم على التوالي. كان متوسط تناول بعض المعادن (اليود والحديد والسيلينيوم والزنك) ٨٣,٠٨±٥,٤٧ ميكروجرام، ١٠,٤٥±٠,٥٦ ملجم،و ٤٩,٣٢±٢,٠٥ ميكروجرام و ٤,٧٥±٠,١٩ ملجم على التوالي. كان متوسط تناول بعض الفيتامينات (فيتامين أ وفيتامين ب ١ وفيتامين ب ٢ وفيتامين ج) ٢٩٣,٨٣±٢٣,٢٤ RE، ٠,٤١±٠,٠٤ ملجم، ٠,٤٧±٠,٠٣ ملجم،و ١٦,٥١±٠,٩٧ملجم على التوالي. كما تم اجراء بعض التحليلات البيوكيميائية،وكان متوسط اليود فى البول ١٥٥,٢٩±٣,٥٣ ميكروجرام/لتر،وكان متوسط الهيموجلوبين في الدم

١١,٤٩±٠,٠٧ جم / ديسيلتر. كما تم اجراء اختبارات القدرات المعرفية لحساب معدل ذكاء الطالب،وكان متوسط معدل الذكاء اللفظي ٩٨,٤٣±٠,٩٩، وكان متوسط الذكاء الادائى ٩٥,٠٩±٠,٤٢ ،و كذلك متوسط االذكاء الكلي ٩٦,٦٩±٠,٤٢.من هذه النتائج ، يمكن الاستنتاج أن الحالة التغذوية قد تؤثر على التطور المعرفي ، والتدخلات والمكملات الغذائية قد تحسن القدرات المعرفية لدى الأطفال.

الكلمات الدالة: الحالة التعذوية ، اليود فى البول، القدرات المعرفية ، اختبارات وسكلر