An Experimental Study for the Effect of Iodine-enforced Snack bar on Attention and Scholastic Achievement in Elementary School Children of the New-Valley Governorate.

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Abstract

The aim of this study is investigating the value of an iodine-enforced snack bar on attention-as measured by the cancellation and an arithmetic tests, and on scholastic achievement scores for pupils, males and females from the elementary schools at the New Valley Governorate.

Testing began eighteen months from the start of the iodine-snack program. This study comprised two groups; a control group, n = 77 pupils have not eaten the snack at all. An experimental group, n = 38 pupils who skipped no snack on any day since the program started.

Iodine excretion increased significantly in the experimental group (males and females) than in the control, especially among the pupils of the fifth school year. That is a good indication that the experimental group benifitted from the snack.

As for the attention tests and the school achievement scores, there were no significant differences in this respect between the experimental and the control groups. However, only the cancellation test (one of the attention tests) detected considerable differences between the two groups. These differences did not reach significance (t = 1.409).

It is then clear that the increase in iodine caused increase in attention, but that increase in attention was not significant. It is worth mentioning that the increase in iodine exeretion has not reached normal levels and this may explain the weak effect it had on attention.

Introduction :

Iodine is an indespensible component of the thyroid hormones triiodothyronine (T3) and tetraiodothyronine (T4 or thyroxine), which regulates the rate of oxidation within the cells and thereby influence physiological and mental development, the functioning of nervous and muscle tissue, and energy metabolism. Iodine is particularly important during development and is critical for normal maturation of the Central Nervous System.

The majority of iodide in the circulation is taken up by the thyroid gland and used in the production of thyroid hormones, the remainder is excreted through the kidney.

Iodide taken up by the thyroid gland is oxidized to iodine and then combined with the amino acid tyrosine and is stored as part of thyroglobulin, a glycoprotein (Kanarek and Marks - Kaufman, 1991); Laycock and Wise, 1983).

The physical, chemical, and physiological development of the brain and consequent behavior in all species of higher animals evolve from the continuous of genetic and numerous environmental factors, among the latter are nutritional, disease, psychological, learning and cultural variables. (Coursin et.al., 1973).

In adults, the absence of sufficient dietary iodine leads to the depletion of thyroid iodine stores and thereby limits the production of thyroid hormones. In addition to causing goiter, iodine defficiency is associated with a variety of symptoms indicative of insufficient thyroid hormone synthesis. Individuals with severly depressed levels of the hormones typically display cold intolarance, weight gain, decreased basal metabolic rate,

enlargement of the tongue, constipation, and reduced cardiac functioning.

Behavioral symptoms include slowed reflexes, problems with corrdination, slurred speech, fatigues, apathy, depression, and impairements in memory.

Endemic cretin individuals are characterized by their short stature, mental dificiency, and problems of coordination and gait, and they frequently are deaf-mute. Endemic cretinism, which occurs when iodine intake is below 25 μg/ day, remains prevalent in many parts of the world (Kanarek and Marks-Kaufman, 1991).

Studies have revealed that motor coordination defects results in apparently normal children subjected to severe iodine deficiency during pregnancy. There is also evidence of an associated intellectual defects.

Aim of the study :

The present study aims at answering the question :

Did the iodine-fortified snack being provided to the elementary School children , in the New Valley Governorate, ameliorate the children's attentiveness, as well as their scholatic performance ? From the previous studies in this respect, we put the following **hypothesis :**

Children who have been taking the iodine-fortified snack bar regularly for the past eighteen months should do better on their scholastic achievement tests, and should be more alert than their mates who had not taken such snack.

Previous Studies :

The link between iodine deficiency and brain development had led to studies in animal models to demonstrate the relationship and the mechanisms involved. A significant effect of severe iodine deficiency on fetal brain development, as indicated by reduced weight, reduced DNA and protein was first observed at 70 days gestation in the sheep. That effect became more marked at 98 and 140 days. Histological studies at 140 days revealed delayed cerebellar maturation with less dendritic arborization of the purkinjie cells. There was also delayed maturation in the hippocampus and motor areas of the cerebral hemispheres (hetzel, 1991).

Follow up studies on detected iodine-deficient newborn humans, without treatment, were neither feasible nor ethical. However, studies have been done (Kochupillai, 1989) to assess two important parameters of brain dysfunction, known to be related to fetal, and or neonatal iodine deficiency and hypothyroidism, namely IQ evaluation and audiometric testing for sensory neural hearing loss, in endemic villages with very high incidence of Neonatal Chemical Hypothyroidism (NCH). The results show that the mean of the IQ scores is greatly less for primary school children from endemic villages compared to children from non-endemic control villages.
Sensory-neural hearing loss was also prevalent in the endemic villages (Fa-Fu et al., 1991).

In his critical overview for research on " Infant Nutrition and Later Achievement ", John Dobbing (1985) questions the relation

between nutrition and behavior; He states : " Whether nutrition of the mother or of the infant has any important influence on the development of brain or behavior in human species is a highly contentious question ". Dobbing admits though, that infant undernutrition modifies brain growth. He adds that much of a human being's ultimate achievement depends on the interplay of countless environmental factors in early life with his genetic endowment.

In a study on the effects of iodine deficiency, and its correction on brain development in the sheep; three groups of ewes received respectively, 400 mg of iodized oil intramuscularly before conception, 400 mg at 100 days of gestation, and no iodine (i.e. control). All were delivered at 140 - days and the fetal brains and thyroids were assessed. The fetal body weight, for the first group, was intermediate between the either two groups as was the fetal thyroid weight, the fetal thyroide iodine was greatly increased. The total brain weights of the fetuses from the 100-day iodine injection were increased over the iodine deficient group, but did not reach those of the controls. This and the measure of myelination by cholesterol, DNA ratio in the cerebellum and cerebral hemispheres suggested a catch-up of neuroblast development. On histologic examination brain density, as indicated by synapse counts in the cerebral cortex was still less in the group given iodized oil than in those of the controls. (Potter et al., 1985).

Fierro-Benitez et al., (1985) compared between two iodine deficient villages in Ecuador. In one, mothers received injections

of iodized oil prior to three months of gestation, while in the other no iodine was given.

Comparison was done between their children 8 to 15 years after prophylaxis, Mean urinary iodine excretions, in ug/g creatinine, were 207 in the treated group and 116 in the untreated group. Analyses included school grades and the stanford - Binet, Wechsler, Goodenough, Goddard, Bender, and Raven Matrices. Scholatic achievement was better in the children of treated mothers when measured in terms of school year reached for age, school dropout rate, failure rate, years repeated, and school marks. There was no differences between the two groups in the stanford-Binet, Wechsler, or Goodenough tests. The children of untreated mothers did less well on the Bender test, and on the Goddard test.

Both groups performed poorly on the Raven test, but the children of treated mothers did slightly worse. Both groups showed impaired school performance, especially in reading, writing, and mathematics, and this was more notable in the children of untreated mothers. Iodine deficiency has, then, in association with other factors; nutritional and social some role in the impairement of intellectual and meuromotor performance.

Fa-Fu et al., (1991) examined 256 school children aged 7 - 14 years, in the townships of Langan and Jiayi, in xinjiang, China. Goiter prevalence in that area was 82%. They also examined a control group of 243 school children aged 7 - 14 years. Where iodine supplementation in the form of Iodized salt has been implemented since 1982, their habits, customs, and income were basically similar to the first group.

Raven Matrices (chinese version) was used as a culturally fair test to measure mental performance, reaction time, hearing levels, and thyroid hormones were also measured in these groups. Results showed that the I.Q. scores for the low iodine group (the first group) were significantly less ($P < 0.01$) than scores of the second group (which has been taking iodine supplments). On reaction time, low iodine group had longer reaction time, though not significant, than the control group. Grip strength ratios did not differ between the two groups. Hearing threshold was significantly higher in the first group.

Following the use of Iodized salt and Iodized oil, studies indicate that individuals benifiting in the form of : increased well being and alertness, increased producitivity and improved school performance in children (Hetzel, 1991).

In the Eastern Mediterranean Region, high prevalence rate of iodine deficiency disorders are found in Afghanistan, Iran, Iraq, Lebanon, and Pakistan. These disorders are also found in restricted areas of Egypt, Libya, Morocco, Sudan, and Tunisia with moderate to high prevalence rates (WHO, 1988).

Coble et al., (1968) studied Iodine deficiency in the Egyptian - New Valley Oases of Kharga, Dakhla, Baris, and Bulag in the southwest Egyptian desert. Urinary iodine excretion of the investigated subjects in the Egyptian New Valley Oases was found to be at a level indicating iodine deficiency. In Siwa Oases iodine excretion levels were normal and no goiter cases were found. This difference was attributed to differences in iodine content of water in the two areas.

In another study, 47 school boys and girls aged 4 to 20 years from the New Valley governorate, and a matched control group of 47 boys and girls from Cairo city were examined with respect to serum triidothyronine (T3), thyroxine (T4), and thyroid stimulating Hormone (TSH), as well as urinary iodine excretion. Children from the New Valley Oases had moderately severe iodine deficiency disorders as reflected in lower T4, lower urinary iodine, and lower serum TSH (Hussein, 1991).

Finally, iron repleted children from Sindion, a village close to Cairo, have done more better on an embedded figures test than iron depleted children (pollitt et al., 1984).

Subjects :

The researchers were lucky to have found out that local authorities, motivated by past researchers's discovery of iodine deficiency in the New Valley governerate, have been implementing an iodine correction program in the New Valley. When we arrived there, that iodine correction program had been going on for eighteen months. The date-bar weighed about 56.5g and is fortified with 3.5 μg iodine and yoghurt was incorporated in the dough. It consisted of the following ingredient; Wheat flour, 25g; vegetable oil, 5g; sugar, 5g; yoghurt, 5g; dates, 15g; yeast, 1g; potassium iodide, 0.05g.

Touring some five regions; Al Kharga, Al dakhla, Baris, Moutte, and Albashandy, we were able to identify a group of the pupils who were not taking the date-iodine-fortified snack bar. Those pupils had never taken that bar ever since the iodine correction-program started because of distaste for that snack. They

were seventy seven pupils; males and females; they were from the fourth and the fifth grades. This group was designated as our control group. The experimental group is composed of 38 pupils from grades four and five. All pupils in this second group have been taking the date-iodine-bar persistently and never skipped a snack. The following table shows the details of the two subject groups.

Table (1) details of the experimental and the control pupils groups.

Group	Fourth grade		Fifth grade		Total	
	n	Age months	n	Age months	n	Age months
Control					77	120.9
		$\bar{X}$		$\bar{X}$		(8.6)
Males	26	115.5	18	129.7		
		(5.0)		(4.1)		
Females	21	114.2	12	130.9		
		(3.9)		(3.9)		
Experimental					38	122.5
		$\bar{X}$		$\bar{X}$		(11.3)
Males	14	115.4	9	133.9		
		(7.2)		(7.7)		
Females	8	113.0	7	133.1		
		(1.4)		(6.2)		

t-test for the age difference between the experimental and the control groups, is $t = 0.769$, not significant.

Materials and Methods :

1. Before going to the New Valley, two tests measure attention were prepared. The first, is the kraeplin's letters cancellation test. On that test a subject is given a page filled of random Arabic alphabetical letters, fifteen letters on each row. He/she is asked to cross over five specific bold-faced letters, shown to the subject, on the first line of the page. A subject was required to finish doing the task, as fast as possible.
2. The second test was an arithmetic test. However, it was used in this study as an attention measure. For that, a pilot study on 20 fourth grade, and 20 fifth grade pupils from an elementary school in Banha has shown that 82% of the first group, and 93% of the second group answered that test correctly. The test is composed of 15 problems each for (a) addition, (b) subtraction, (c) multiplication, and (d) division, subjects were asked frequently, time and time again, to answer as fast as possible, and to turn their papers in immediately.
3. A third measure was the final examination score of each pupil for the previous school year*. Each pupil recorded score in this research is a composite score of his/her marks on : Arabic language, arithmetic, and social science courses.

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* Researchers are thankful to all school - Principals who helped in the collection of this information.

4. Urinery samples were obtained by asking the school children to collect the 24hr. urine. Urine volumes were recorded and aliquots were stored frozen for subsequent analysis of iodine. Urinary iodine was determined after dry alkaline ashing at 600C in presence of potassium carbonate (Armerker et al., 1986). The iodide present in the ash was measured by the ceric-arsenite system in which inorganic iodide acts as a catalyst. Pure potassium iodate solution of different concentrations served as a standard. The concentration of iodine in the urine samples is read from the standard curve. The results were expressed as μg/liter (The first author carried out the assays)*.

The cancellation and the Arithmetic tests were administered in groups of no more than twelve pupils in a session. On the black-board, the instructions were written and were read alowed by one of the two researchers (the psychologist), and demonstration examples were given, after that the beginning signal was given. Immediately after finish answering a test, a subject was to turn in his/her answer sheet, whence the time he/she spent answering was recorded on that sheet. The cancellation test was always given first to each group, followed by the Arithmetic test. Both tests were evaluated for speed of performance, and correct cancellation of letters, and correct solving of the arithmetic problems. The following formula were used in our calculations :

* Researchers are grateful to Prof. Dr. Laila Hussein for allowing the use of her lab, facilities at the National Research Center, Dokki, for this endeovor.

$$\text{Subject's score on Arithmetic test} = \frac{\text{No. Correctly solved problems}}{\text{All Arithmetic Prob}} \times \frac{1}{\text{time taken (min)}}$$

$$\text{Subject's score on cancellation test} = \frac{\text{No. Correctly solved problems}}{\text{All letters to be cancelled}} \times \frac{1}{\text{time taken (min)}}$$

Results :

The following table shows means and standard deviations for iodine, final achievement examination scores, cancellation, and Arithmetic tests, of the experimental and control groups, and subgroups.

Table (2) : Means and standard deviations of the school boys and girls who took (Experimental) and who didnot take (control) the date bar

Group	Iodine excretion 24 grs. µg/L	Final Exam. score	Cancellation test	Arith. test	Tabulated "t" at 0.05, one-tailed
Experimental					
4th. grade males	29.82	184.857	2.309	0.372	
	(13.12)	(42.414)	(2.113)	(0.319)	
4th grade females	17.34	221.875	5.214	0.516	
	(5.67)	(21.384)	(2.658)	(0.369)	
group (1)	25.28	198.318	3.415	(0.369)	
	(12.45)	(39.978)	(2.691)	(.317)	
5th grade Males	55.34	198.333	3.921	0.819	
	(54.27)	(28.675)	(1.168)	(0.593)	
5th. grade females	48.00	197.710	4.286	1.366	
	(29.08)	(28.034)	(2.267)	(0.265)	
group (2)	51.92	198.060	4.081	1.058	
	(42.92)	(27.541)	(1.946)	(0.363)	
All Exp. group (3)	36.08	198.210	3.667	0.691	
	(31.34)	(34.741)	(2.377)	(0.336)	
Control					
4th. grade Males	23.21	191.615	2.346	0.400	
	(12.05)	(31.487)	(2.075)	(0.389)	
4th. grade females	17.28	205.150	3.275	0.315	
	(11.86)	(27.302)	2.617	(0.309)	
group (4)	20.56	197.500	2.761	0.362	
	(12.21)	(30.192)	(2.353)	(0.335)	
5th. grade Males	21.15	199.556	3.187	1.416	
	10.92	(24.286)	(3.087)	(1.119)	
5th. grade females	24.37	194.917	3.454	0.593	
	14.96	(26.155)	(2.823)	(0.469)	
group (5)	22.438	197.700	3.294	1.087	
	(12.205)	(30.192)	(3.323)	(0.693)	
All control group (6)	21.25	197.677	2.969	0.644	
	(12.26)	(30.192)	(2.731)	(0.474)	
T-test, (1) Vs. (4) =	1.487	0.094	1.027	0.728	1.670
T-test, (2) Vs. (5) =	2.690	0.040	1.012	0.186	1.682
T-test, (3) Vs. (6)	2.813	0.085	1.409	0.547	1.661

Discussion and Comments :

T-test results at the bottom of table (2) show that receiving the iodine-enforced-date bar for eighteen months prior to the beginning of this study had just slight positive non-significant effects on alertness as measured by the kraeplin's cancellation, and the arithmetic tests, Fourth and Fifth grade children alike. Scholastic examination scores showed no effect for the iodine supplementary program, suggesting that our psychological tools might have been more sensitive in detecting any positive influence of the iodine correction program. However, we are to acknowledge the lower levels of iodine excretion in the experimental group ($\bar{X}$ = 36.08 μg/L), compared to 50 μg/L, the daily iodine excretion in nondeficient subjects.

Children of the experimental group have benifited from the compansatory nutritional program, but have not reached sufficiency levels in iodine. That may explain the slight increase in alertness in this group.

Finally, had we known of that supplementary nutritional program before it started, we would have preferred to measure the children on attention and other psychological variables at that time and eighteen months later. That might have maximized the benficial effects of that nutritional program.

However, this study stands as one research where specialists from different desciplines cooperate in investigating a " naturally " occuring independent varaible, namely the enforced-iodine-date-bar supplied by local authorities to the school children in the New Valley.

References :

1. Armarkar, M.C., Pandan, C.S., and Krishmamaghari, K.A.V.R., Principle and procedure for iodine estimation. A laboratory manual, Indian Council of Medical Research, New Delhi, 1986.

2. Coble, Y., Davis, J., Schulert, A., Heta, F., and Awad, A.Y., Goiter and Iodine Deficiency in Egyptian Oases. The American j. Clinical Nutrition, 1968, Vol. 21, No. 4, PP. 277 - 283.

3. Coursin, D.B., Barnes, R.H., Birch, H.G., Klein, R., Winick, M., Pearson, P.B., and Read, M.S., Subcommitte on Nutrition. Brain Development and Behavior, Nutrition Review, Vol. 31, # 8, August 1973.

4. Fa-Fu, L., Hong-xin, A.Z., Jin, L., Ji-Yong, J., and Maimaiti, The Relationship of A low-Iodine and High Fluoride Environment to Subclinical Cretinism in Xinjiang. IDD Newsletter, 1991, Vol.7, No. 3, August.

5. Feirro-Benitez, R., Casar, R., Rodriguez, P., Garces, F. Fierro-Renoy, F., and Estrella, E., Long Term Effects of Correction of Iodine Deficiency on Psychomotor and Intellectual Development, IDD Newsletter, 1985, Vol. 1, No. 1, August.

6- Hetzel, B.S. The International Public Health Significance of Iodine Deficiency 1991.

7. Hussein, Laila A., An Investigation into the Iodine Status of School Children in the Egyptian Oases, IDD Newsletter, 1991, Vol. 7, No. 3, August.

8. Kanarek, R.B., and Marks-Kaufman, R., Nutrition and Behavior, Van Nostrand Reinhold, N.Y., 1991.

9. Kochupillai, N., The Impact of Iodine Deficiency on Human Resource Development, Progress in Food and Nutrition Science, 1989, Vol. 13, PP 1 - 15.

10. Laycock, J.F. and Wise, P.H., Essential Endocrinology, 2nd. ed., Oxford University Press., N.Y., 1983.

11. Pollitt, E., Yunis, F., Salem, S., Hussein, M., and Scrimshaw, N.S. : Iron Deficiency Anemia and Cognitive Style Among School Age Children in a Semi-Urban Community In Egypt. INACG, Nov., 1984, Bali, Indonesia.

12. Potter, B.J., Mano, M.T., Belling, G.B., Martin, D.M., Gragg, B.G., Chavadej, and Hetzel, B.S., Restoration of Brain Growth in Fetal Sheep After Iodized Oil Adminstration to Pregnant Iodine-deficient Ewes.
IDD Newsletter, 1985, Vol. 1, No 1, August.

13. World Health Organization (WHO) Guidlines for a National Program for the Control of Iodine Deficiency Disorders in the Eastern Mediterranean Region. Alexandria, Egypt, 1988.

الملخص العربى

دراسة تجريبية لأثر تصبيرة يومية مدعمة باليود على الانتباه والتحصيل الدراسى لدى تلاميذ المدارس الابتدائية بمحافظة الوادى الجديد

الهدف من هذه الدراسة بحث قيمة « تصبيرة » مدعمة باليود تصرف بدون مقابل لأطفال المدارس الابتدائية فى محافظة الوادى الجديد ، أثر هذه التصبيرة على الانتباه كما يقيسها اختبارين للانتباه « اختبار الشطب واختبار حل مسائل حسابية » وعلى التحصيل الدراسى لدى أولئك التلاميذ . وقد كشفت بحوث سابقة على سكان الوادى الجديد عن نقص اليود فى المياه لديهم .

عند وصول الباحثين إلى محافظة الوادى الجديد كان هذا البرنامج الغذائى موجوداً منذ ثمانية عشر شهراً . وقد أمكن التعرف على عينتين من التلاميذ ، إحداهما تتكون من ٧٧ تلميذاً وتلميذة لايأكلون هذه التصبيرة إطلاقاً (ضابطة) والمجموعة الأخرى وتتكون من ٣٨ تلميذاً وتلميذة يتناولون هذه التصبيرة يومياً بانتظام منذ بداية البرنامج (المجموعة التجريبية).

لقد بينت النتائج المعملية لاخراج اليود زيادة هذا الاخراج بصورة دالة إحصائياً عند المجموعتين التجريبيتين عنها لدى المجموعتين الضابطتين. وكانت هذه الزيادة أوضح عند تلاميذ المرحلة الخامسة الابتدائية ، لكن هذه الزيادة لم تكن دالة عند تلاميذ المرحلة الرابعة الابتدائية، وهذا يؤكد استفادة هؤلاء التلاميذ عموماً من هذه التصبيرة فى زيادة اليود لديهم .

أما اختبارى الانتباه ودرجات التحصيل الدراسى فلم تفترق المجموعتين التجريبيتين عن المجموعتين الضابطتين على أى منهم ولو أن اختبار الشطب (يقيس الانتباه) قد ميز بين المجموعتين حيث زادت المجموعتين التجريبيتين عن المجموعتين الضابطتين واقترب الفرق من مستوى الدلالة الاحصائية (ت = ١٫٤٠٩). ومن هذا يتضح أن زيادة اليود فى الطعام لها تأثير على الانتباه لدى التلاميذ ويرجع ضعف هذا التأثير إلى أن التلاميذ لم يستفيدوا الاستفادة الكاملة من التصبيرة المدعومة فمتوسط إخراج اليود لدى المجموعتين التجريبيتين كان منخفضاً عن المستويات العادية، حيث سّ = ٣٦٫٠٨.