EFFECT OF IODINE CORRECTION EARLY IN FETAL LIFE ON INTELLIGENCE QUOTIENT. A PRELIMINARY REPORT

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In some areas in which goiter is endemic there is a high prevalence of mental deficiency without any other stigma of cretinism (1-6). When surveying the populations of Tocachi and La Esperanza in highland Ecuador in which goiter is endemic we were impressed by the high prevalence of mental deficiency in the general population. This generalized mental deficiency was independent of the typical cases of cretinism. We believe that several factors such as protein-caloric malnutrition and chronic iodine deficiency may contribute toward producing this mental deficit. All of these factors exist in the populations studied.

With these facts in mind we were interested in studying the effect of the correction of iodine deficiency on this endemic mental deficiency. The present study is concerned with this problem, and although the results are preliminary and inconclusive, they underscore the need for critical analysis of this question.

CLINICAL MATERIAL AND METHODS

The studies reported here cover a period of five years since a program of goiter prevention was begun in two rural Ecuadorean villages. Iodized poppyseed oil was given intramuscularly to women of child-bearing age in March 1966 in a village of Andean Ecuador, Tocachi, where endemic goiter is severe and cretinism commonplace. In December 1968 the fertile women were reinjected and some infants born in Tocachi since 1966 received iodine by intramuscular administration. A nearby village, La Esperanza, which is in all respects similar, has served as a control.

Study design and ongoing observations of the iodine therapy program have been described previously (7-12).

A large number of children have been born in the two villages. The "normal" children, those older than 40 months of age, were tested in both populations. The severely mentally retarded children from the control village were excluded.

Among the children born in Tocachi some had received iodine since the earliest stages of embryogenesis, during lactation, and directly by intramuscular administration. Other children only received iodine correction during the last three months of gestation, during lactation, and directly by intramuscular administration. Thus, we can classify the children who were born in Tocachi since March 1966 until October 1967 (older than 40 months at the time of study) in two main groups:

Group I: Children who received iodine during the last period of fetal life, during lactation and directly by intramuscular administration.

Group II: Children who received iodine early in intrauterine life, during lactation, and directly by intramuscular administration.

In the control village, La Esperanza, we studied a group of children with the same chronological ages as the group of Tocachi children.

The nutritional status of each child was evaluated by anthropometric measurements. Since the weight-height ratio is the best mean of evaluating nutrition we measured height and weight, as well as head circumference.

The Stanford-Binet Scale (13), as modified by us, was used to measure intellectual capacity. The modifications of the scale were in picture recognition and vocabulary, which have local characteristics. With the Stanford-Binet test it is possible to determine mental age, basal age, and most importantly, the intelligence quotient of the child.

Statistical analysis of the results was done using Experimental Design Theory (14). We have used a single factor model.

$$X_{ij} = u + T_j + C_{ij}$$

where:

$$u = \text{mean}$$
$$T_j = \text{treatment effect} \quad j = 1, 2$$
$$C_{ij} = \text{experimental error}$$

RESULTS

A total of 150 children were tested, 67 in the treated population (Tocachi) and 83 in the control village (La Esperanza). Twenty six of the Tocachi children were in Group I and 41 in Group II. The corresponding numbers of children in La Esperanza were 33 and 50. There was some variation in the proportion of boys and girls in each group, but it was not greatly different. The mean chronological age of the children in Group I was 65 months. That of Group II was 40 months.

The children of both the Tocachi and La Esperanza groups had the same anthropometric characteristics. Almost all of the children presented undernutrition, but this was equal for all the groups in both villages. Thus we can dismiss nutrition as a factor for differences in intellectual function between comparable groups.

The mean value of the IQ scores in Tocachi Group I was 67.0; in Tocachi Group II it was 80.1 and in the La Esperanza groups 70.1.

From the statistical analysis of IQ of Tocachi Group II versus La Esperanza (Table 1), $F_{calculated}$ was greater than F_{table} and this was highly significant. Therefore, we rejected the null hypothesis that there exists no difference between Group II and the group of La Esperanza. Thus the children of Group II in Tocachi presented a statistically significantly higher IQ than the children in the group from La Esperanza.

From the statistical analysis of Group II versus Group I, both of Tocachi, we had:

$$F_{1,63} = \frac{2667.69}{142.61} = 18.70 \text{ (Table 2)}$$

Because $F_{calculated} > F_{table}$, this is highly significant, which means that there also exists a difference between Groups I and II from Tocachi.

Table 1. Statistical analysis of Tocachi Group II vs. La Esperanza, using the Experimental Design Theory. The model we have used is a single factor.

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE (variance)
T_j	K - 1 2 - 1 = 1	2774.63	2774.63
(error)	N - K 122 - 2 = 120	17228.65	143.57
TOTALS	N - 1 122 - 1 = 121	20103.28	

$$F_{1,120} = \frac{2774.63}{143.57} = 19.32 \quad (F_{calculated} > F_{table})$$

The IQ difference between Tocachi Group I and La Esperanza lacks significance.

Children who had an IQ below 70 were considered to be mentally deficient. From this point, we have found that in Tocachi and La Esperanza there is a significant prevalence of mental deficiency (Table 3). However, in Group II in Tocachi only 20.6 percent had IQ scores in the mentally deficient range, while in Group I in Tocachi 49 percent of the scores were in this range, and in La Esperanza 49.4 percent of the scores were in this range.

Table 2. Statistical analysis of Tocachi Group II vs Tocachi Group I, using the Experimental Design Theory. The model we have used is a single factor.

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE (variance)
Between Treatments (T_j)	K - 1 2 - 1 = 1	2667.69	2667.69
Within treatments (error)	N - K 65 - 2 = 63	8984.92	142.61
TOTALS	N - 1 65 - 1 = 64	11652.61	

When the distributions of IQ scores in each group are plotted they tend to be skewed in the direction of mental deficiency. However, the curve of Tocachi Group II has a tendency toward normality and there is an obvious reduction in the incidence of mental deficiency in relation to La Esperanza.

When the IQ distribution in the two groups of Tocachi was plotted, we observed that mental deficiency was present in both groups and that their curves remained far below the Stanford-Binet standard curve. However, we observed a reduction of the mental deficiency in Group II in relation to Group I. Forty-nine percent of the IQs in Group I were below 70 while only 20.6 percent of those in Group II were below 70. This reflects a reduction of mental deficiency of 25.5 percent in Group II with respect to Group I. This is statistically highly significant. In addition, there were fewer frankly retarded persons (IQ below 50) in Group II (2.6 percent than in Group I (6.7 percent).

Table 3. Percentage Distribution of Composite IQs (Stanford-Binet Scale). A total of 150 children were tested, the mean chronological age of children in Group I was 65 months. That of Group II was 40 months. The group of children from La Esperanza had the same chronological ages as the groups of Tocachi children.

IQ	STANFORD-BINET		TOCACHI I		TOCACHI II		LA ESPERANZA	CLASSIFICATION
100 - 109	23.5		0.0		2.6		1.1	NORMAL OR AVERAGE
90 - 99	23.0		0.0		23.1		2.8	
80 - 89	14.5		15.4		30.8		10.2	LOW AVERAGE
70 - 79	5.6		34.6		23.1		30.7	
60 - 69	2.6		23.1		15.4		28.4	
50 - 59	0.4	3.2	19.2	49.0	2.6	20.6	16.5	DEFECTIVE
40 - 49	0.2		6.7		2.6		4.5	

SUMMARY

Nutritional deficiency, socio-economic deprivation, geographic and biological isolation, and chronic iodine deficiency are among the factors contributing to the high prevalence of mental deficiency in children considered to be "normal" in the villages studied.

Iodine correction after the fifth month of intrauterine life appears to have little or no prophylactic effect in terms of preventing mental retardation.

Iodine correction early in the intrauterine life appears to be an important factor that contributes to improving the intellectual capacities of the child.

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