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THE EFFECT OF IRON DEFICIENCY AND MENTAL STIMULATION ON INDONESIAN CHILDREN'S COGNITIVE PERFORMANCE AND DEVELOPMENT*

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INDEXING WORDS

anemia; iron supplementation; mental stimulation; cognitive function

SYNOPSIS

Three studies conducted in Indonesia will be described.

Soewondo (12) investigated the relation of iron deficiency and cognitive function and impact of iron supplementation on verbal intelligence, attention and concept learning among iron deficient children without anemia and iron deficient anemic children. Half of 176 children, aged 3 - 6 years, received elemental Fe for 8 weeks and the other half received placebo. There were significant changes from pre to post intervention evaluations in ferritin, transferrin saturation, free erythrocyte protoporphyrin, and hemoglobin in the iron deficient anemic children. Pre and post treatment psychological test data showed that iron deficiency anemia produced alterations in cognitive processes related to visual attention and concept acquisition. These alterations can be reversed with iron treatment.

Idjradinata (4) assessed the impact of iron supplementation on iron deficient infant's mental and psychomotor development. Hundred twenty six subjects aged 12 to 18 month were randomly assigned to either iron treatment or placebo intervention. After 4 months of iron supplementation, the hemoglobin, ferritin and transferrin saturation changed significantly in the iron deficient infants. A developmental delay was observed in the iron deficient anemic infants before intervention and the conditions were reversed after 4 months of iron treatment.

Soemiarti (8) examined the effectiveness of a training course given to mothers of children aged 12 to 24 month on the rearing environment and consequently to the child's development. The subjects were 69 mothers of 20 - 35 years old.

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The training lasted for 21 days by giving mothers training using the program "Ibu Maju Anak Bermutu". The rearing environment improved, also the child's mental and psychomotor development.

INTRODUCTION

Indonesia the largest archipelago on this planet earth, is inhabited by around 180 million population and 45 million out of this amount are children under five years of age (1), the inheritor of the future of this country. Half of the children are still being brought up in rural areas and in a condition around the poverty line. Due to dimension of infant mortality, malnutrition and diseases which affect many children in Indonesia, special efforts have been made to improve the physical well being of those children. Several potential resources are devoted to take care of the youngsters.

A vital aspect of physical health is proper nutrition. Adequate nutrition for children is a basic requirement if we want the children to grow up into physically and psychological healthy person. Nutritional deficiencies are proven to have negative consequences on intellectual and cognitive function.

In Indonesia the prevalence of iron deficiency anemia is 46.5% among children under 5 years of age (5). There is evidence from several studies that there is a relationship between iron deficiency and behavioral changes in infants and children. Pollitt et. al. (6) found that the children with iron deficiency showed relative performance deficits in simple tasks, but the deficits were reversible after iron therapy.

In Indonesia several studies have been conducted to investigate the effect of anemia on behavior, to determine the impact of iron supplementation on behavior. Two studies will be described below.

To promote the total development of the youngsters into healthy and capable adults, other efforts to improve the mental development must be carried out.

Many children living in rural areas are raised in an environment lacking adequate stimulation for mental development. Social and environmental deprivation will result in growth and development deficits. Pollitt et. al. (7) stated that under conditions of marked social and environmental deprivation, these deficits in children will augment as the children grow older.

To overcome the problems faced by the children living in these "deprived environment", we should start to counteract the lack of experiences by giving the children extra stimulation starting in the early childhood. As a result of a survey and a workshop to increase the child services in low income areas, a conclusion was made that, there was a need to develop a systematic approach for Indonesia to stimulate the cognitive development of children at an early age (10). For this purpose the Bina Keluarga Balita (B.K.B) program was initiated in 1981-1982.

The B.K.B. is an action program for the enhancement of the role of women in

a comprehensive child development. The essence of the program is teaching uneducated mothers from low income families how to give proper stimulation to their Balita (Bawah Lima Tahun = Under five years of age) Children to ensure better development of the child's potentials. The program is providing an enriching environment for the development of young persons. One study to evaluate the effectiveness of such a program will be described.

STUDY 1

IMPACT OF IRON DEFICIENCY AND IRON SUPPLEMENTATION ON COGNITIVE PERFORMANCE OF CHILDREN AGED 3 - 6 YEARS (10, 11, 12).

OBJECTIVE

1. The objective of this study was to determine the relationship between iron deficiency and cognitive performance.
2. To investigate whether there was any significant improvement in the cognitive test scores of iron deficient children as a result of iron supplementation.

METHODS

Sample

The subjects were 176 children from three tea plantation in the district of Pangalengan, Southeast of Bandung the capitol of West Java Indonesia.

The home environment and income of the families were more or less similar to each other. The mothers were in general tea pickers.

The 176 children were divided into three groups: iron replete, iron deplete and iron deficiency anemia. The criteria for iron replete: Hgb $\geq$ 11 gm/dl, and two out of the following: ferritin 12 $\geq$ ug/1, transferrin saturation (TS) $\geq$ 16%, and free erythrocyte protoporphyrin (FEP) 100 $\leq$ ug/dl RBC.

The criteria for iron deplete: Hgb $\geq$ 11 gm/dl, and two out of the following: ferritin < 12 ug/l, TS < 16 % and FEP > 100 ug/dl RBC. The criteria for iron deficiency anemia: Hgb < 11 gm/dl, and two out of following: ferritin <12 ug/l, TS < 16 %, and FEP > 100 ug/dl RBC. The groups were then subdivided into iron and placebo treatments.

The first group consisted of 49 children, 26 were given iron and 23 placebo, the second group consisted of 57 children, 24 received iron and 33 placebo, the third group consisted of 70 children, 27 were given iron and 43 placebo.

Supplementation

The iron treated groups received 50 mg/day of elemental iron in 10 ml of syrup for eight consecutive weeks. A placebo in liquid form respectively, similar in appearance to those containing iron, were given daily to the other half of the sample following the same procedures.

Measurement

The subjects were examined before and after iron intervention on their iron status and a battery of psychological tests.

The children were subjected to three kinds of psychological tests the Peabody Picture Vocabulary Test (PPVT), two Discrimination learning tasks, and four Oddity tasks.

The PPVT is a test that estimates subjects verbal intelligence. Forms A and B from the 1965 version (2) were used. The nature and order of presentation of the pictures and the correct responses were the same of those of the manual. In the discrimination tasks, the subjects must learn to discriminate between two visual stimuli. Criterion for learning is established as seven consecutive responses of the stimulus that has a cartoon "happy face" on the reversed side of the card. Once the child reached the learning criterion, the reward values of the two stimuli are changed by reversing the location of the "happy face". The previous incorrect answer now become correct. This reversal shift is made in both discrimination tasks. The subject must then learn to reverse the original response and again reach the learning criterion. The oddity learning test taps concept formation and attention. This cognitive test consist of 4 oddity learning tasks. Each time three stimuli (pictures) two of which identical were presented simultaneously on a 7' x 18' black poster board. The child must point the correct one. The instruction given was to find the winner. The oddity test consist of four series, non repeated, all the pictures on every card were different; repeated once, the same picture is repeated in an other card; repeated twice, the same picture is repeated on two other cards; repeated trice, the same picture is repeated on three other card. The four tasks like wise differed in level of complexity and in demanding attention.

For the statistical analysis a 3 x 2 way anova and ancova was used.

RESULTS AND DISCUSSION

Socioeconomic factors and nutritional status could play an important role in the causality of iron deficiency. Thus the possible confounding effects of these variable should be controlled in an assessment of the relation between iron and behavior.

Three way analyses of variance of the socioeconomic variables showed that there was an equivalence between the six groups in connection with father's occupation, education, mother's and child's education, family income and

expenditure (Table I).

Analyses of children's age yielded statistically significant differences ($p < 0.05$) between the iron replete and deplete groups (Table II). Since psychological test depends also very much on age, age must be entered as a covariate in the statistical model.

Mean values of the iron indicators for the iron and placebo groups broken by the iron status of the children at T1 are given in Table III. The changes from T1 to T2 in all iron indicator among the anemic and iron depleted children treated with iron were statistically significant ($p < 0.05$). Conversely none of these changes were significant among the iron deplete and anemic children who received a placebo. Changes among the iron replete children treated with iron were statistically significant ($p < 0.05$) for ferritin and transferrin saturation. There were no significant differences in the iron indicators of the placebo treated iron replete children. Iron treatment had a positive effect on the iron indicators values.

Analysis of covariance of the psychological test data showed no significant differences between the iron replete and iron deplete children before and after intervention. We will present only tests result of iron replete and anemic children.

Table IV showed the mean scores of the PPVT for the iron replete and anemic children before and after intervention. The T1 scores of the iron replete ($M = 41.3$) and anemic ($M = 40.95$) children were similar to each other. Because of randomization the mean score of the placebo children ($M = 42.7$) was higher than that of the children assigned to the iron treatment ($M = 39.62$).

Among the iron replete children the mean score of the placebo children ($M = 44.85$) was higher than the children who got iron treatment ($M = 37.90$). The differences statistically significant ($p < 0.05$) are attributed to chance. The T2 scores of the iron replete ($M = 44.11$) and anemic ($M = 44.85$) children were similar to each other. The children treated with iron had a greater score ($M = 46$) than the placebo children ($M = 42.9$). The differences however was not significant.

Mean trials to criterion of the reversal presentation of the discrimination learning tasks before and after treatment is given on Table V. The analysis of covariance of T1 scores in the reversal color presentation yielded significant differences ($p < 0.01$). The iron replete children ($M = 17.98$) learned faster than the anemic children ($M = 23.92$). Likewise in the aggregate reversal scores the iron replete children ($M = 16.68$) obtained a higher learning score than the anemic ($M = 20.26$). The differences were statistically significant ($p < 0.05$). The analysis of covariance of T2 reversal presentation of the color and aggregate discrimination tasks showed that iron replete children (30.61) took more trials to reach the learning criterion for the color and discrimination task than the anemic children ($M = 16.29$) both treated with iron. The differences were statistically significant ($p < 0.05$).

Comparisons of the mean aggregate scores showed that among the groups treated with iron the anemic children ($M = 15.90$) learned faster than the iron

replete (M = 18.59) children. The differences were statistically significant ($p < 0.05$). Among the placebo children the iron replete (M = 12.66), had better scores than the anemic (M = 21.8). We can say that attentional processes were affected by iron deficiency anemia, the anemic children took more trials to reach the learning criteria compared to the others. After iron therapy there was an improvement, the anemic treated with iron took less trials to reach the learning criteria than the other groups.

From Table VI it is apparent that in the oddity learning tasks repeated twice and repeated trice the mean correct responses at T1 are the lowest for the anemic group, respectively M = 6.76 and M = 6.26, compared to the iron replete children M = 7.87 and M = 7.51. Those differences were statistically significant ($p < 0.01$). The data suggest that the iron deficient anemic children had more difficulties pointing the correct answers. The results of the oddity repeated twice, repeated trice tasks showed that among those children treated with iron, the anemic children had more correct responses (M = 9.02) (M = 8.90) than the iron replete children (M = 7.32), (M = 7.27). Planned comparisons showed that the respectively differences were statistically significant ($P < 0.05$).

STUDY 1

TABLE I.
MEANS OF FATHER'S JOB, FATHER'S, MOTHER'S CHILD'S EDUCATION, FAMILY INCOME AND EXPENDITURE OF IRON AND PLACEBO CHILDREN WITH DIFFERENT BODY IRON LEVELS.

SOCIO ECONOMIC	TREATMENT	REPLETE	DEPLETE	ANEMIC
FATHER'S JOB	Rx	1.28	1.26	1.4
	Pl	1.45	1.35	1.65
FATHER'S EDUCATION (YRS)	Rx	4.80	4.43	4.30
	Pl	4.21	4.35	4.65
MOTHER'S EDUCATION (YRS)	Rx	2.34	2.52	2.46
	Pl	3.16	2.8	2.6
CHILD EDUCATION (YRS)	Rx	0.3	0.8	0
	Pl	08	03	09
FAMILY INCOME (RP)	Rx	11362	11623	12585
	Pl	10842	13068	9617
FAMILY EXPENDITURE (RP)	Rx	9975	9494	11046
	Pl	8241	10654	8507

STUDY 1

TABLE II.

MEANS OF AGE OF IRON AND PLACEBO TREATED CHILDREN WITH DIFFERENT BODY IRON LEVELS.

TREATMENT	REPLETE	DEPLETE	ANEMIC
Rx	57.7	54.2	54.11
Pl	57.3a	51.6a	54.9
TOTAL	57.5b	52.9b	—

NOTE : VALUES WITH THE SAME SUBCRIPT ARE DIFFERENT AT A STATISTICALLY SIGNIFICANT LEVEL ($P < 0.05$).

STUDY 1

TABLE III.

HEMATOLOGIC AND BIOCHEMICAL VALUES BEFORE AND AFTER IRON AND PLACEBO TREATMENT OF PRESCHOOL CHILDREN CLASSIFIED ACCORDING TO THEIR IRON STATUS BEFORE TREATMENT.

		ANEMIC		IRON DEPLETE		IRON REPLETE	
PARAMETERS	INTER-VENTION	PRE	POST	PRE	POST	PRE	POST
HEMOGLOBIN (gm/dl)	Rx	10.6xx	11.4xx	11.5x	12.2x	12.1	12.8
		(0.5)	(1.0)	(0.38)	(0,53)	(0.52)	(0.63)
	Pl	10.5	10.9	11.6	11.7	12.3	12.4
		(0.60)	(0.74)	(0.48)	(0.45)	(0.40)	(0.53)
FERRITIN (ug/l)	Rx	14.4x	22.3x	10.9xx	39.9xx	14.3x	27.6x
		(13.9)	(15.6)	(6.3)	(57.8)	(9.6)	(24.0)
	Pl	17.8	19.6	11.0	13.0	19.5	16.8
		(20.6)	(11.1)	(4.8)	(8.4)	(17.7)	(13.4)
TRANSFERRIN SATURATION (%)	Rx	12.7xx	16.8xx	14.5xx	18.2xx	18.2x	21.8x
		(2.6)	(3.5)	(2.2)	(3.0)	(4.3)	(4.8)
	Pl	13.0	13.7	14.6	15.7	18.8	18.1
		(2.0)	(2.0)	(2.3)	(2.2)	(2.6)	(3.0)
ERYTHROCYTE PROTOPORPHYRIN (ug/dl)	Rx	138.6x	112.0x	127.6xx	100.9xx	92.9	89.9
		(18.4)	(20.0)	(23.3)	(14.0)	(22.9)	(9.8)
	Pl	133.9	119.4	118.6	115.7	92.9	102.2
		(19.0)	(19.6)	(15.6)	(19.8)	(11.9)	(12.3)

- XX $P < 0.01$
- X $P < 0.05$

STUDY 1

TABLE IV.

MEAN RAW SCORES IN THE PEABODY PICTURE VOCABULARY TEST OF IRON REPLETE AND IRON DEFICIENCY ANEMIA CHILDREN BEFORE AND AFTER TREATMENT *

NATURE OF TREATMENT	BEFORE TREATMENT			AFTER TREATMENT		
	IRON REP.	ANEMIA	TOTAL	IRON REP.	ANEMIA	TOTAL
IRON	37.90a	41.34	39.62b	44.60	47.39	46.00
PLACEBO	44.85a	40.56	42.71b	43.62	42.31	42.97
TOTAL	41.38	40.95	—	44.11	44.85	—

WITHIN ROWS OR COLUMS, FIGURES WITH THE SAME SUPERSCRIPT LETTER ARE SIGNIFICANTLY DIFFERENT AT $p < 0.05$ OR BETTER.

STUDY 1

TABLE V.

MEAN TRIALS TO CRITERION IN THE REVERSAL PRESENTATION OF THE DISCRIMINATION LEARNING TASK AMONG THE IRON REPLETE AND IRON DEFICIENT ANEMIC CHILDREN BEFORE AND AFTER TREATMENT.

TREATMENT	COLOR : REVERSAL PRESENTATION					
	BEFORE			AFTER		
	IRON REPLETE	ANEMIC	TOTAL	IRON REPLETE	ANEMIC	TOTAL
IRON	17.87	25.02	21.44	30.61b	16.29b	23.22
PLACEBO	18.09	22.81	20.45	26.11	27.16	26.59
TOTAL	17.98a	23.92a	-	28.14c	21.68c	-
	AGGREGATE (COLOR + FORM) : REVERSAL PRESENTATION					
IRON	16.78	20.57	18.67	18.59b	15.90b	17.24
PLACEBO	16.59	19.95	18.27	12.66c	21.83c	18.49
TOTAL	16.68a	20.26a	-	15.63	18.49	-

NOTE : VALUES WITH THE SAME SUBSCRIPT ARE DIFFERENT AT A STATISTICALLY SIGNIFICANT LEVEL ($p < 0.05$)

STUDY 1

TABLE VI.
MEAN NUMBER OF CORRECT RESPONSES IN THE TWO ODDITY LEARNING TASKS AMONG THE IRON REPLETE AND IRON DEFICIENT ANEMIC CHILDREN BEFORE AND AFTER TREATMENT.

TREATMENT	REPEATED TWICE					
	BEFORE			AFTER		
	IRON REPLETE	ANEMIC	TOTAL	IRON REPLETE	ANEMIC	TOTAL
IRON	7.58	6.18	7.18	7.32b	9.02b	8.17
PLACEBO	8.15	6.73	7.44	8.52c	7.78c	8.40
TOTAL	7.87a	6.76a	-	7.92	8.40	-
	REPEATED THRICE					
IRON	7.50	5.90	6.70	7.27b	8.90b	8.08
PLACEBO	7.5	6.62	7.07	7.76	7.36	7.56
TOTAL	7.51a	6.26a	-	7.51	8.13	-
	AGGREGATE (NON-REPEATED + REPEATED TASKS)					
IRON	8.7	7.66	8.18	8.54b	9.85b	9.20
PLACEBO	8.7	7.8	8.27	9.36	9.18	9.20
TOTAL	8.7a	7.73a	-	8.95	9.52	-

NOTE : VALUES WITH THE SAME SUBSCRIPT ARE DIFFERENT AT A STATISTICALLY SIGNIFICANT LEVEL ($P < 0.05$)

Among those that received a placebo the iron replete children (M = 8.52) in the oddity task repeated twice had a significant ($P < 0.05$) larger number of correct answers than the anemic children (M = 7.78). The aggregate oddity scores yielded also significant differences (P = 0.05) between iron replete (M = 8.72) and anemic children (M = 7.73) at T1. After iron supplementation the correct responses of the anemic children (M = 9.85) were higher than the iron replete children (M = 8.54).

The best performance in the oddity learning task at T2 was that of the anemic children treated with iron. The data suggest that iron therapy improved cognitive performance, attention and learning processes.

STUDY 2

IRON DEFICIENCY ANEMIA IS A CAUSE OF DEVELOPMENTAL DELAYS (3, 4).

OBJECTIVE

The purpose of this study is to analyze the relation between iron deficiency in anemic infants 12 - 18 months of age and developmental performance.

METHODS

Sample

The subjects were 119 infants attending the under five clinic, Department of Child Heath, School of Medicine, Padjadjaran University Bandung Indonesia. The infants were divided into three groups: iron replete, iron deplete and iron deficiency anemia. The criteria for Iron Replete Hgb $\geq$ 120 g/L, Transferrin Saturation > 10%, Serum Ferritin > 12 ug/L. Iron Deplete Hgb $\geq$ 120 g/L, Transferrin Saturation $\leq$ 10% and Serum Ferritin $\leq$ 12 ug/L. Anemia Hgb $\leq$ 105 g/L, Transferrin Saturation $\leq$ 10% and Serum Ferritin $\leq$ 12 ug/L. The infants were then divided into iron and placebo treatment. The first group consist of 44 infants, 22 were given iron and 22 placebo. The second group 28 infants, 14 were given iron and 14 placebo. The third group 47 infants, 24 were given iron and 23 placebo.

Supplementation

Iron treatment consisted of ferrous sulphate 3 mg kg^{-1} d^{-1} in syrup form for 4 consecutive months. The placebo was a syrup similar in appearance to the ferrous sulphate, and both had a sweet, cherry flavor. Parents gave the syrups to infants at home. Compliance was checked weekly by a nurse who visited infants homes and determined the amount of syrup consumed.

Measurement

Infants were examined before and after iron supplementation on their iron status and tested with the Bayley scales on motor and mental development.

RESULTS AND DISCUSSION

Analyses of mother's and father's education yielded significant difference of mother's education. So, mother's education was entered as covariate.

Analyzed by iron status class at T1, mean values of hemoglobin, transferrin saturation and serum ferritin did not differ significantly between infants assigned to receive iron or placebo (Table VII).

After 4 months of iron supplementation, the mean hemoglobin of iron-treated anemic infants (M = 129.4 g/L) was no longer significantly different from that of the iron deplete (M = 134.6) and iron replete (M = 131.4) at T2, all the iron-

treated anemic infants had hemoglobin above 110 g/L, the usual cut-off point for definition of anemia in this age group. Ferrous sulphate treatment had significant effects on transferrin saturation among anemic and iron deplete infants ($p < 0.001$). changes in iron replete infants with iron treatment were small (Table VII). Ferrous sulphate treatment, but not placebo, was associated with significant changes ($p < 0.01$) in serum ferritin concentrations among infants in all iron-status classes (Table VII). The changes observed in those that received iron were in the direction of replenishing iron stores.

The mean mental development score of anemic infants at T1 was significantly different from the mean scores of the iron deplete and iron replete infants ($p < 0.01$), it was lower, while the mean scores of the two other groups were not significantly different from each other (Table VIII).

Over the course of intervention, ferrous sulphate treatment was associated with significant change ($p < 0.001$) in the mental development scores of anemic infants (Table VIII). Conversely, changes among the placebo-treated anemic infants and among iron and placebo subgroups in the other two iron-status classes were

STUDY 2

TABLE VII.
HEMATOLOGIC AND BIOCHEMICAL VALUES BEFORE AND AFTER IRON AND PLACEBO TREATMENT OF INFANT CLASSIFIED ACCORDING TO THEIR IRON STATUS BEFORE TREATMENT.

		ANEMIC		IRON DEPLETE		IRON REPLETE	
PARAMETERS	INTER-VENTION	PRE	POST	PRE	POST	PRE	POST
HEMOGLOBIN (gm/dl)	Rx	95.7xx	129.4xx	126.1x	134.6x	126.2	131.4
		(1.1)	(1.9)	(1.0)	(2.6)	(0.7)	(1.5)
	Pl	98.0	107.1	125.6	123.1	128.8	128.0
		(1.0)	(0.9)	(0.6)	(2.0)	(1.1)	(1.7)
FERRITIN (ug/l)	Rx	7.9xx	52.7xx	8.1xx	63.1xx	30.6xx	83.1xx
		(0.5)	(6.4)	(0.5)	(8.7)	(4.0)	(9.4)
	Pl	6.4	12.1	8.0	12.0	29.0	31.3
		(0.5)	(2.7)	(0.7)	(1.9)	(2.8)	(8.4)
TRANSFERRIN SATURATION (%)	Rx	7.5xx	31.2xx	7.5xx	39.6xx	24.4	33.2
		(0.4)	(5.0)	(0.8)	(7.4)	(1.7)	(4.7)
	Pl	8.2	15.2	7.8	15.8	24.8	21.7
		(0.4)	(1.9)	(0.6)	(2.1)	(2.5)	(2.6)

- x $p < 0.0.5$
- x $p < 0.05$
- xx $p < 0.01$
- xx $p < 0.01$

STUDY 2

TABLE VIII.
MEAN (SE) MENTAL AND MOTOR DEVELOPMENT SCORES BEFORE AND AFTER ADMINISTRATION OF FERIOUS SULPHATE OR PLACEBO BY IRON STATUS.*

TREATMENT	MENTAL DEVELOPMENT					
	BEFORE			AFTER		
	ANEMIC	IRON DEPLETE	IRON REPLETE	ANEMIC	IRON DEPLETE	IRON REPLETE
Rx	88.8ab	102.4b	105.4a	108.1d	107.7	109.1
	(2.1)	(2.7)	(2.2)	(2.2)	(2.8)	(2.2)
Pl	92.4	101.8	104.7	92.9d	109.3	106.8
	(2.2)	(2.7)	(2.2)	(2.3)	(2.8)	(2.3)
TREATMENT	MOTOR DEVELOPMENT					
	BEFORE			AFTER		
	ANEMIC	IRON DEPLETE	IRON REPLETE	ANEMIC	IRON DEPLETE	IRON REPLETE
Rx	88.5ab	102.9b	105.3a	112.0c	107.8	108.7
	(2.1)	(2.7)	(2.1)	(2.0)	(2.6)	(2.1)
Pl	92.4	103.5	105.9	97.5c	106.6	108.3
	(2.2)	(2.6)	(2.2)	(2.1)	(2.6)	(2.1)

WITHIN ROWS OR COLUMS, FIGURES WITH THE SAME SUBSCRIPT LETTER ARE SIGNIFICANTLY DIFFERENT AT $P < 0.05$ OR BETTER

negligible. At T2 there was no significant difference between the mean mental development score of the iron-treated anemic infants and the scores of the iron of placebo treated iron replete infants. The mean motor development score of anemic infants before intervention was significantly lower ($p < 0.01$) than the score of iron deplete or iron replete infants (Table VIII). Analysis within iron-status classes revealed that after intervention the change in mean motor development score among iron-treatment anemic infants was significantly larger ($p < 0.001$) than the change observed among placebo-treated anemic infants. Pretreatment to post-treatment changes in the two intervention subgroups within the iron deplete and iron replete classes were not significantly different (Table VIII). The change in motor development score in the iron-treated anemic subgroup was larger ($p < 0.01$) than the changes in any of the other subgroups, and at T2 the mean score of the iron-treated anemic subgroup was not significantly different from the scores in either subgroup of iron replete infants.

The developmental delay (motor and mental) observed among the anemic infants before intervention was reversed after 4 months of iron treatment.

STUDY 3

AN EARLY INTERVENTION PROGRAM AS MEANS TO PROMOTE THE DEVELOPMENT OF CHILDREN (9).

OBJECTIVE

The study aimed to examine the effectiveness of an early intervention program "IBU MAJU ANAK BERMUTU" to promote the rearing environment and the development of children aged 12 to 24 months.

METHODS

Samples

The subjects were 69 mothers aged 20 - 35 years, and had young children aged 12 - 24 months. They lived in the village Pendowohardjo (the experimental group) and Bangunharjo (control group) Yogyakarta, Mid Java. There were 35 mothers in the experimental group, and 34 mothers in the control group.

Intervention

An early intervention program: "Ibu Maju Anak Bermutu"

(Mothers Improved, Qualified Children) is a training package given to mothers from the experimental group to promote the rearing environment of their children. This program consists of ten training sessions, each lasting for 120 minutes, and was given during a 21 day period. The topics discussed were: active listening, I message, learning and playing, intelligence, gross and fine motor movements, socialization. Mothers in the control group received a series of lectures about a happy family which were also given with the same amount of sessions.

During the next two months the trainers visited the homes of the experimental group to observe and monitor how they practiced knowledge and skills which were learned earlier.

Measurement

Before and after intervention the rearing environment were measured with the home inventory, while the infants were tested with the Bayler Scales of infant development.

RESULTS AND DISCUSSION

Possible confounding effects of socioeconomic factors should be controlled in an assessment of the intervention program.

Statistical analysis of these variables showed that, between the experimental and the control group, the results were equivalent (Table IX).

Table X showed the mean scores of the home inventory before and after intervention. Before intervention the total score and subscale scores of the experimental group were similar to the scores of the control group. After intervention the total score of the experimental group (M = 22.71) was significantly higher ($p < 0.01$) than the control group (M = 17.71).

STUDY 3

TABLE IX.

MEANS OF CHILD'S AGE, MOTHER'S AND FATHER'S AGE, MOTHER'S AND FATHER'S EDUCATION, FAMILY INCOME AND EXPENDITURE.

SOCIO ECONOMIC FACTORS	EXPERIMENT	CONTROL
CHILD'S AGE (MONTH)	18.09	18.56
MOTHER'S AGE (YEARS)	27.69	25.74
FATHER'S AGE (YEARS)	30.29	29.94
MOTHER'S EDUCATION (YEARS)	6.51	5.68
FATHER'S EDUCATION (YEARS)	7.77	7.18
FAMILY INCOME (RP)	86328	74059
FAMILY EXPENDITURE	67000	56809

STUDY 3

TABLE X.

MEAN SCORES OF THE HOME INVENTORY BEFORE AND AFTER EARLY INTERVENTION PROGRAM.

	BEFORE		AFTER	
	EXPERIMENT	CONTROL	EXPERIMENT	CONTROL
EMOTIONAL AND VERBAL RESPONSIVITY MOTHER	7.23	7.82	9.31xx	7.68xx
AVOIDANCE OF RESTRICTION AND PUNISHMENT	5.06	5.15	4.77	4.24
ORGANIZATION OF THE ENVIRONMENT	1.51	1.79	0.63xx	0.32xx
PLAY MATERIALS	1.83	2.47	4.34xx	2.97xx
MATERNAL INVOLVEMENT	2.57	2.38	3.57xx	2.44xx
VARIETY IN STIMULATION	0.09	0.06	0.09	0.06
TOTAL	18.29	19.68	22.71xx	17.71xx

- X $P < 0.05$
- XX $P < 0.01$

Three subscales scores, emotion responsibility of mother, play materials and maternal involvement of the experimental group were significantly better than the subscales score of the control group, scores of subscale avoidance of restriction and variety in stimulation did not improve after intervention. While the score of subscale organization of the environment became lower compared to scores before intervention. The rearing environment in connection with mothers responsiveness, mothers involvement and play material improved. The mothers became more responsive, they talked more, initiated verbal interchanges, expressed ideas and feelings, looked often at them, provided toys that challenge the child to develop. What still needs attention from the trainers is how to improve "the involvement of the father," "avoidance of restriction"and "organization of physical environment".

From Table XI it was apparent that the mental score of the experimental group (M = 124.74) and control group (M = 127.76) were similar before intervention, after intervention there were significant differences ($p < 0.01$) between mental development score of the experimental group (M = 140.23) and the control group (M = 135.53). The same findings ($p < 0.01$) were found in the motor development score of the experimental group (M = 65.74) and control group (58.29). Before intervention the score of the experimental (M = 55.64) and control (M = 56.09) were similar.

It was evident that there was a significant improvement in the scores of the rearing environment, and the scores of the motor and mental development of the children whose mother's received the early intervention training using the "Ibu Maju Anak Bermutu" program.

STUDY 3

TABLE XI .
MEAN MENTAL AND MOTOR DEVELOPMENT SCORES BEFORE AND AFTER INTERVENTION.

	BEFORE		AFTER	
	EXPERIMENT	CONTROL	EXPERIMENT	CONTROL
MENTAL DEVELOPMENT	124.74	127.76	140.23xx	135.35xx
MOTOR DEVELOPMENT	55.46	56.09	65.74xx	58.29xx

- XX $P < 0.01$

SUMMARY

From the two studies on irondeficiency we can conclude that irondeficiency anemia has an adverse influence on cognitive performance and children's development, but the negative effect is reversed after iron therapy.

The third study shows that the early intervention program "Ibu Maju Anak Bermutu" given to mothers can promote the rearing environment of children and enhance the motor and mental development of infants.

To promote the total development of Indonesian youngsters in the 21th century into healthy and capable adult, one step that can be done is by minimizing the prevalence of irondeficiency and improving the program by providing mental stimulations for psychological development of the children. The essence of the program is teaching uneducated mothers how to give proper stimulations to their children, who are under five years of age, to ensure better development of the child's potential.

Those two kinds of child services can be integrated with other health service which have already existed in Indonesia.

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