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The present study investigates the incidence of micronutrient malnutrition and its impact on child development. The study is confined to the rural primary school children in the age group of 5 to 9 years from Dindigul District of the South Indian State of Tamil Nadu. This chapter provides a thorough formulation, a clear-cut definition of the given population, adequate methods of collecting accurate information, precise measurement of variables, statistical analysis and test of significance. The research design, the diagnostic method, study area, time framework, pretest and pilot study, method and details of sampling, selection of tools and techniques, collection of qualitative and quantitative data, processing and analyzing of data. A methodology flowchart and a multistage sampling flowchart have been added to make the chapter self explanatory.

4.1. Research Design

The investigation followed a diagnostic research design so as to see the causes, impact and what could be done to remedy the micronutrient deficiency disorders. This is a study of micronutrient malnutrition carried out exclusively on rural primary school children with regard to its impact on physical, cognitive and socio emotional developments. The study is focused on the primary school child population of 5-9 years. In designing the diagnostic research, the investigator has employed a number of techniques such as anthropometric measurement, clinical examination, biochemical analysis, diet survey, cognitive development scales and projective techniques for describing the twin phenomenon of micronutrient malnutrition and child development and in designing the intervention strategies. Common tools and techniques like interview schedule, focus group discussion and Participatory Rural Appraisal have also been employed.

4.2.1. Diagnostic Research

The study is diagnostic in nature. Diagnostic research is ordinarily the forerunner of action and the action must be based on the understanding of the diagnosis. It is a scientific method of study which is more objective and precise as compared to a non-scientific method of research. It takes cognizance of the existing knowledge in a particular field, carries out further investigations in it and compares the results with those obtained earlier. Diagnostic research refers either to an active process or to the conclusion reached through that process. The meaning of diagnostic research is serving to indicate the value of diagnosis. Modern diagnostic research in the active sense includes the process and the art of using scientific methods to elucidate the whole
compass of problems that influence the variables. It includes the collection of all necessary facts and critical evaluation of every bit of evidence obtained from any and all sources by whatever method is useful. It is a lively art based on a sound and growing science. The facts so obtained, and a knowledge of the principles of data collection through different procedures help to identify and solve the problems. From an array of possible hypotheses, the correct diagnosis is singled out as having the best fit with the findings. The process of selection is properly called diagnostic research.

4.2.2. Scope of Diagnostic Research

Diagnostic research helps to

- Discover and test the variables to discover whether they are associated to each other or not
- Direct towards discovering not only what is occurring but why it is occurring and what could be done about it
- View the problem cross-sectionally through possible dimensions and identify possible solutions to it.

Diagnostic research is not possible in areas where knowledge is not advanced enough to make possible adequate diagnosis.

4.2.3. Steps in Diagnostic Research

Steps in diagnostic research are

- Identifying dependent and independent variables
- Identifying tools and techniques to measure the incidence of both variables
- Identifying the association between the variables
  - Collecting cross-sectional data on both variables
- Finding out the more impacting factors among the variables
- Recommending of intervention strategies for action research

The steps undertaken for the present study are

- Biographical history and all possible data obtained about RPS children from parents and teachers
- Anthropometric measurements collected from children and compared with the standard values of the NCHS
- Data obtained through clinical examination about the symptoms of micronutrient malnutrition
- Conducting of cognitive development scale tests for all the children
Anaemia, iodine and zinc deficiencies diagnosed by biochemical analysis
Correlating the relationships with micronutrient malnutrition and child
development
Finding the more impacting factors on children development by micronutrient
malnutrition
Recommending intervention strategies for eliminating micronutrient malnutrition
as action research for rural primary school children.

4.3. Area of Study

The Diagnostic Research has been carried out in Dindigul District of Tamil Nadu
which comprises of 14 blocks. Athoor and Reddiyarchathram are two adjacent blocks
chosen for the present research. Athoor and Sedapatti are two villages of Athoor Block
and Karisalpatti, Anumantharayankottai and Palayakannivadi are three villages of
Reddiyarchathram Block selected for the study and from each block four Panchayat
Union Primary Schools were selected at random.

4.4. Time Span

The total time taken to complete the research work is two years and four months
from April 2004 to July 2006. The investigator framed the target period and finalized the
work within the stipulated period allotted for the research work. The time frame is given
in Table 4.1.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Period of Work</th>
<th>Nature of Research Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>April - July 04</td>
<td>Review of related research</td>
</tr>
<tr>
<td>2</td>
<td>Aug - Sep 04</td>
<td>Selection of dependent and independent variables</td>
</tr>
<tr>
<td>3</td>
<td>Oct - Nov 04</td>
<td>Conduct of pretest and pilot study</td>
</tr>
<tr>
<td>4</td>
<td>Dec 04 - Jan 05</td>
<td>Finalization of variables and research design</td>
</tr>
<tr>
<td>5</td>
<td>February 05</td>
<td>Identifying area of study</td>
</tr>
<tr>
<td>6</td>
<td>Mar - May 05</td>
<td>Data collection</td>
</tr>
<tr>
<td>7</td>
<td>June - July 05</td>
<td>Coding of data</td>
</tr>
<tr>
<td>8</td>
<td>August 05</td>
<td>Scrutinization of data preparation of dummy tables</td>
</tr>
<tr>
<td>9</td>
<td>Sep - Dec 05</td>
<td>Analysis and interpretation of results</td>
</tr>
<tr>
<td>10</td>
<td>Jan - Feb 06</td>
<td>Chapterization and computation of thesis</td>
</tr>
<tr>
<td>11</td>
<td>Mar - May 06</td>
<td>Consultation with subject experts and interpretation</td>
</tr>
<tr>
<td>12</td>
<td>June - July 06</td>
<td>Refinement and submission of thesis</td>
</tr>
</tbody>
</table>

4.5. Pilot Study

After the dependent and independent variables were finalized for the study, the
tools were prepared and tested on a random of sample 50 children from standard I to
standard IV selected from one school. All the tools prepared for measuring incidence of micronutrient malnutrition and child development variables were tested. The constraints in administering the tools were identified and rectified. The investigator conducted a pilot study as it is a primary work and to gain clear-cut and specific data on research perspectives in the subject of the investigation undertaken. The pilot study helped the investigator in simplifying the task of designing the field work logistics.

4.6. Methodology Flowchart Figure 4.1
Socio emotional development

Draw – A Man Test, Emotional problems of children, Nail biting, thumb sucking, bed wetting, anxiety, stress, shyness, soiling, temper tantrums, hatred, teasing, bullying, jealousy identified

Problem checklist Rating scale

Cognitive development scales

For I std - Play, Story telling, rhyme
For II std – Drawing and painting, Word Association Test, Pintner-Wringlyham Primary Test (PWPT) For III and IV std – Test for Creative Thing Ability (TCTA)-creativity, Mental Health Inventory, SCT and WAT

Student’s performance including scholastic achievements and learning disabilities/disorders noted

Cognitive functions

Proficiency in learning abilities
Application of Knowledge
Recall (Memory)
Student’s educational background
Enduring capacity

Data collected from children and respective teachers

Multistage sampling

Classification of normal/healthy and good in scholastic achievements are separated from poor in studies/micronutrient deficient children

Sub-sample is selected for biochemical analysis
4.7. Sample for the Study

The primary purpose of research is to discover a principle that has universal application. But studying a whole population to arrive at a generalization is not at all practical and is rather impossible. Here comes the importance of sampling in field oriented diagnostic research. The process of sampling makes it possible to draw valid inferences or generalizations on the basis of careful observation of the variables with a
relatively small proportion of the population. The coverage of the population is done in five selected villages, from which eight Panchayat Union Government Primary Schools were chosen. The universe of the study consisted of children of 5-9 years.

4.8. Multistage Sampling

Figure 4.2
Multistage Sampling

Multistage Sampling (N = 1500)

Developmental status of RPS Children (N = 1500)

*Clinical examination (N = 1500)

- Normal
  - Vit A - 928
  - Iron (Hb) - 961
  - Iodine - 1330
  - Zinc - 1410

- **Biochemical analysis
  - Iron (Anemia-Hb level) (N = 1250)
  - Iodine (N = 30)
  - Zinc (N = 30)

- Deficient
  - Vit A - 572
  - Iron (Hb) - 539
  - Iodine - 170
  - Zinc - 90

Experimental and Control Group

- *Vit-A (from 928 - 500 selected from 572 - 500 selected)
- **Iron (Hb) (from 1250 - 75 selected from 250 - 75 selected)
- **Iodine (from 1330 - 30 selected from 170 - 30 selected)
- **Zinc (from 1410 - 30 selected from 90 - 30 selected)

IMPACT ON CHILD DEVELOPMENT

- PHYSICAL
- COGNITIVE
- SOCIO-EMOTIONAL

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Multistage sampling method is a further development of the principle of cluster sampling. Through a pilot study, the district, the blocks and the schools were identified by stages with the help of the Chief Education Officer. As the age is restricted to 5-9 years, RPS children from standard I to standard IV were chosen. The first stage was to select a large primary sample of 1500 children and collect common basic details of the total sample. The sample size was 1500 rural primary school children for whom the basic details such as biographical information, developmental stages for RPS children, anthropometric measurements and clinical examination data were collected. From the clinical examination results, a sub-sample of 1250 RPS children were selected for haemoglobin testing and a sample of 30 each for iodine and zinc deficiencies. Then, as the normal and micronutrient deficient children were classified, the impact of micronutrient malnutrition on child development was studied. Thus, a step by step process of sampling procedure was used for collecting data which is known as multistage sampling. The advantage of using multistage sampling is (a) it is easier to administer than most single stage designs mainly because of the fact that the sampling frame under multi-stage sampling is developed in partial units, (b) a large number of units can be sampled for a given cost under multistage sampling because of sequential clustering, whereas this is not possible in most of the simple designs.

4.9. Details of the Sample Selected

All the 1591 students from the eight schools of the five villages, namely Athoor, Sedapatti, Karisalpatti, Anumantharayankottai and Palayakannivadi were chosen as the sample and out of them 91 children were omitted at random. For the present research, there were 1500 children finally chosen for analysis. Details of the sample selected for the study from the five villages and eight schools are given in Table 4.2. The school-wise, class-wise and sex-wise distribution is given in Table 4.3.
Table 4.2

Details of the sample selected for the study (N=1500)

<table>
<thead>
<tr>
<th>Village (Block)</th>
<th>School</th>
<th>No of students selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athoor Block</td>
<td>Aided RC Harijan Primary School</td>
<td>124 116 240 (16.00)</td>
</tr>
<tr>
<td>Athoor</td>
<td>Panchayat Union Muslim Middle School</td>
<td>64 61 125 (8.33)</td>
</tr>
<tr>
<td>Athoor</td>
<td>Aided Sacred Heart RC Middle School</td>
<td>40 40 80 (5.33)</td>
</tr>
<tr>
<td>Sedapatti</td>
<td>Panchayat Union Primary School</td>
<td>189 141 330 (22.00)</td>
</tr>
<tr>
<td>Reddiyarchathram Block Karisalpatti</td>
<td>Panchayat Union Sacred Heart Primary School</td>
<td>200 0 200 (13.33)</td>
</tr>
<tr>
<td>Anumantharayankottai</td>
<td>Panchayat Union Sacred Heart Primary School(Boys)</td>
<td>0 195 195 (13.00)</td>
</tr>
<tr>
<td>Anumantharayankottai</td>
<td>Little Flower RC Girls Primary School (Girls)</td>
<td>128 142 270 (18.00)</td>
</tr>
<tr>
<td>Palayakannivadi</td>
<td>Panchayat Union Primary School</td>
<td>36 24 60 (4.00)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>781 719 1500 (52.06)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(47.93)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100)</td>
</tr>
</tbody>
</table>

Table 4.3

School-wise, class-wise and sex-wise distribution

| Name of the school - | Class                  | M | F | M | F | M | F | M | F | M | F | M | F | M | F | Total | Total |
|----------------------|------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|-------|-------|
| PUPS, Sedapatti      | Istd                   | 35| 30| 32| 27| 32| 30| 25| 29| 124| 116| 240|
|                      | Hstd                   | 25| 24| 12| 7 | 16| 12| 11| 18| 64 | 61 | 125 |
|                      | Hlstd                  | 17| 13| 7 | 13| 8 | 6 | 8 | 8 | 40 | 40 | 80 |
|                      | IV std                 | 46| 40| 17| 13| 45| 47| 51| 32| 189| 141| 330 |
|                      | Total                  | 204| 190| 31| 27| 10| 20| 177| 173| 214| 173| 186| 183| 781| 719| 1500 |

| Name of the school - | Class                  | M | F | M | F | M | F | M | F | M | F | M | F | M | F | Total | Total |
|----------------------|------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|-------|-------|
|                     | Total                  | 204| 190| 31| 27| 10| 20| 177| 173| 214| 173| 186| 183| 781| 719| 1500 |

Percent: 394 (26.26) 350 (23.33) 387 (25.80) 369 (24.60) 781 (52.06) 719 (47.93) 1500 (100)

* Schools are named in short form; M - Male ; F - Female ; T - Total
4.10. Tools and Techniques of Data Collection

In the current diagnostic research, anthropometric measurements, clinical examination, biochemical analysis, diet survey were employed for collecting the data on the independent variables. The cognitive development scales, projective techniques, Draw-A-Person Test and a checklist were employed for collecting the data on child development. Interview schedule, PRA, focused group discussion and case study were the other methods used for obtaining other relevant data. These variables were mostly used to diagnose and analyze the dual components of micronutrient status of malnutrition and developmental status of primary school children and to examine the impact of micronutrient deficiencies on the physical, cognitive and socio emotional developments of the children.

4.11. Selection of Tools and Techniques

Anthropometric measurements were used to identify the physical development of the RPS children with that of the standard measurements according to age. Clinical examination was used to find the incidence of micronutrient deficiency symptoms, especially vitamin A deficiencies. Biochemical analysis was used to find the level also iodine and zinc deficiencies. Diet survey was used to find the consumption of micronutrient rich foods taken every day by RPS Children. Rating scale and checklist were used to identify the socio emotional development of children. Cognitive development scales and projective technique Draw-A-Person Test were used to mark the cognitive development of RPS children.

4.12. Procedure for Data Collection

The following techniques and procedures were used to assess the status of the physical, cognitive and socio emotional development of the children and the level of micronutrient malnutrition among the children.

A. Micronutrient Malnutrition

1. Clinical Examination

   i. Symptoms of vitamin A deficiency - Xerophthalmia, Bitot's spot, conjunctival xerosis
   ii. Symptoms of iron deficiency - Anaemia
   iii. Symptoms of iodine deficiency - Goiter, cretinism
   iv. Symptoms of zinc deficiency - dryness in hair

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2. Biochemical Analysis
   i. Iron - Cyanomethenoglobin Test - Level of Hemoglobin (Hb)
   ii. Iodine - CLIA (Chemiluminescence Immuno Assay) T3, T4 and TSH (Thyroid Stimulation Hormone) Test
   iii. Zinc - Spectra Photometric Method

3. Diet Survey
   i. Dietary Pattern
   ii. 24 Hours recall method

B. Child Development
a. Biographical Inventory of the child
b. Developmental History of the child
c. Home Environment Inventory (HEI)
   1. Physical Development Anthropometric Measurement
      i. Height for Age in cm
      ii. Weight for Age in kg
      iii. Mid-arm Circumference in cm
      iv. Fore-head circumference in cm
      v. Hip Circumference in cm
      vi. Waist Circumference in cm

2. Cognitive Development
   a. Cognitive Development Scales
      i. For I standard - Rhyme recitation, Story telling and play
      ii. For II standard - Colour and Enjoy, Mental Health Inventory (MHI) and Pintner-Wringer Primary Test (PWPT)
      iii. For III and IV standard - Word Association Test (WAT), Sentence Completion Test (SCT) and Test for Creative Thinking Ability (TCTA) - Creativity Test
   b. Cognitive Functions

3. Socio Emotional Development
   a. Emotional Problem of the child - Checklist
   b. Rating Scale on children assessed by teachers and parents
   c. Emotional disturbance through Draw-A-Person Test

4. Participatory Rural Appraisal (PRA)

5. Focus Group Discussion (FGD)

6. Case study
4.13. Interview Schedule

The child development data for the study have been obtained through personal interviews with the help of pre-designed, field tested interview schedules. The investigator first developed an item pool based on the subject of the study. These items were given to experts for their opinion with regard to relevance and adequacy for the conduct of the study. On the basis of the suggestions from experts, some irrelevant items were dropped and others were modified.

Four main schedules were used in the course of the study,

i. an anthropometric measurement and clinical examination schedule for physicians to conduct a general checkup of the children (standardized NCHS schedule referred);

ii. a biochemical analysis schedule for lab technicians to record the level of micronutrient deficiency among children (standardized method of testing level of anaemia, iodine and zinc deficiencies);

iii. a socio emotional development schedule for the teachers of the respective children to mark their scholastic achievements and to record their problems with the help of problem checklist and rating scale (generated);

iv. a schedule for parents to record the biographical inventory of the child, the developmental history of the child, the Home Environment Inventory (HEI), the diet survey, the obstetric history of the child and the clinical observation (generated).

The schedules were administrated by the investigator on a sample of fifty respondents for pre-test in the Panchayat Union Primary School, Chettiyapatti, Athoor Block of Dindigul District. Based upon the results of the pre-test, some of the questions were reordered, refined and others were modified to form the final schedules for the study. Copies of the schedules are presented in annexures.


Anthropometric measurements were taken by height for age and weight for age using vertical measuring scale for height in cm and platform weighing balance (weighing machine) for measuring weight in kg. With the help of an inch tape, mid-arm circumference, fore-head circumference, hip and waist circumferences were measured in cm with reference to the child’s age. Height for age and weight for age were referred with the standard NCHS values for -SD and +SD using Z scores and the RPS child’s
stuntedness, undernourishment and wasted level were classified to estimate the physical development of RPS children.

4.14.1. Height for Age

Length or height is a very reliable measure that reflects the total increase in the size of the individual up to the moment it is determined and could indicate adequate nutritional status. A vertical measuring scale fixed on the wall is used to record the height of the children. The individual stood barefoot on a flat floor against a perpendicular wall with feet parallel and with heels, buttocks, and shoulders and back of the head touching the wall. According to the age, if the child’s height is below the NCHS standard, the child is termed as **stunted**.

4.14.2. Weight for Age

Weight for age is a commonly used indicator of body size and it reflects the level of food intake. The relative change of weight for age is more rapid than that of height and is much more sensitive to changes in the growth pattern of the individual. Significant changes can be observed over a period of every few days. Therefore, unlike height for age, weight for age is a very sensitive measure of short duration malnutrition. The weight recorded is then compared with the standard values of the NCHS and inferred whether they are normal or undernourished according to the standard weight for age.

4.15. **Clinical Examination**

Clinical examination was carried out to assess the nutritional status of the children by examining the general health, skin, hair, eye, mouth, face, tongue, head, neck, nail, abdomen and any other symptoms that seems to be alarming in the child’s health. It involves looking for changes (clinical symptoms) in the body, which are indicative of a particular deficiency. Eight campaigns in the eight selected schools of the selected villages were conducted in order to find micronutrient deficiencies like vitamins and minerals among the school children. Vitamin A, iodine, anaemia and zinc deficiency symptoms were marked. Due importance was given to each child. The examination was conducted by a Government Pediatrician on consecutive days. There was absolute cooperation from the children, teachers as well as the school administration. A copy of the clinical examination tool used by the physician for marking deficiency symptoms of vitamin A is enclosed in annexure I.

4.16. **Biochemical Analysis**

Biochemical analysis dealt with measuring the level of essential dietary constituents (nutrient concentration, metabolic) in the body fluid (blood) which is helpful
in evaluating the possibility of malnutrition. Biochemical analysis basically works on the principle that any variation in the quantity and composition of the diet reflected by changes in the concentration of nutrients or their compounds in tissues and body fluids, and/or by appearance or disappearance of specific substances (ie. Metabolics). Measuring these essential dietary constituents would, therefore, help assess nutritional status. Biochemical analysis is therefore used in assessing the nutritional status as well as for the purpose of diagnosis on the deficiency of micronutrient malnutrition. To identify the level of heamoglobin (Hb) present in the blood for rural children, one drop of blood sample was taken from each child and cycanomethenoglobin test was conducted in the lab for identification of anaemia level among the children, which is a basic symptom for iron deficiency. Vitamin A deficiency was exclusively analysed using clinical examination. From the results of the level of anaemia and clinical examination the presence of iodine and zinc deficiency was observed using CLIA (Chemi Luminescence Immino Affay) for T3,T4 and TSH (Thyroid Stimulation Hormone) Test and Spectro Photometric Method respectively. Five ml of blood was taken from the selected sample of 30 children for testing iodine and zinc deficiency while anaemia testing was conducted for 1250 children and clinical examination administered to the total sample selected.

4.17. Diet Survey

A diet which provides all the nutrients in adequate quantities and in proper proportion as per the body need is called a 'balanced diet'. If there is a constant imbalance of nutrients in the intake of daily food it results in severe prevalence of micronutrient malnutrition, which adversely affects the normal growth and development of children. Through the parents, data such as type of food, number of times the child eats per day, food liked most, and food supplements from Noon Meal Centre were collected through a diet survey. The dietary pattern of the children was further probed through them for data on consumption of green leafy vegetables, fruits, egg, fish, fleshy food, milk and milk products which are good in micronutrients. Also, a method of 24-hour recall was adopted to see the type of food consumed by the children during breakfast, lunch, tiffin, dinner and late night supper. This helped to reflect the quality of food and nutrients intake. A copy of the schedule for the diet survey is enclosed in annexure III.

4.18. Rating Scale

The rating scale involves qualitative description of a limited number of aspects of a thing or of traits of a person. Child learning disorders, cognitive functions and learning
abilities were studied using a three-point rating scale of “normal”, “below normal” and “weak”. The children were assessed by their respective teachers based on their experience with the child’s class performance and not based on any specific rules. This rating scale method was used to assess whether the child’s learning abilities, cognitive functions and disorders were correlated with the child’s micronutrient malnutrition and, as a whole, the child’s socio emotional development was examined using the three-point rating scale. A copy of the rating scale is presented in annexure IV.

4.19. Checklist

The socialization of the child with friends, peer groups, teachers and their participation in school activities were assessed using an inquiry format, the checklist. A two-point problem checklist was used to see whether the child had problems or not, using a “Yes” or “No” pattern of answers drawn from a schedule specially designed for the socio emotional development of the child with the help of school teachers. An ‘emotional problem’ checklist was also used to see the common negative emotions of children such as teasing other children, nail biting, crying, feeling shy, inactiveness, frequent susceptibility to diseases, violence, jealousy, lying, bedwetting (enuresis), soiling (enopnesis), anxiety and stress, stuttering and stammering. Data on such basic problems of the child were collected using the checklist, a copy of which is enclosed in annexure IV.

4.20. Cognitive Development Scales

This research is the first of its kind to relate the two important dimensions of child study, one the health aspect and the other the physical, cognitive and socio emotional development of the children. Emphasis is, of course, given to the cognitive development with reference to micronutrient malnutrition as the central focus of the study. As the cognitive development of the child will differ according the age, special care has been taken to design cognitive development scales according to the standards. Students in the age group of 5-6 who were in standard I were tested through a rhyme recitation, story telling and performance of out door play. Children were marked with ten marks based on their performance. Students in the age group of 6-7 who were in standard II were tested through three exercises such as Colour and Enjoy, Mental Health Inventory (MHI) and Pintner-Wrringham Primary Test (PWPT) wherein in the first exercise they had to draw the respective figures which were specified and colour them appropriately. In MHI, the children had to remember their date and month of birth and colour those boxes which were left blank for colouring. In PWPT, there were 16 square dots which
had to be joined or connected with a line and made into a figure. III and IV standard students varying in their ages from 8 to 11 years, were given three different exercises such as Word Association Test (WAT), Sentence Completion Test (SCT) and Test for Creative Thinking Ability (TCTA)--Creativity Test. In WAT, ten commonly used and seen words were given for which they had to write relatively associated words that came to their mind immediately. In SCT, there were five 'fill in the blanks' questions, where they had to complete the sentence by using their own words. In TCTA, a comparatively tough exercise when compared to other exercises, the children had to answer five questions, “write the names of all the round things that you know”; “write the names of all the things you can think of that will make a noise” etc., which enabled the children to exhibit their creativity, flexibility, fluency, originality, uniqueness and their overall performance on cognitive development. As a common test for all the age groups, a method of projective technique, namely, Draw-A-Person Test, was formulated and executed to assess the level of maturity according to their age. All these exercises were executed with a time frame of ten minutes during equal intervals with prior information and avoiding to the maximum external influences on the performance of the child. As the students were in Government Panchayat Union Schools and the medium of education was Tamil, all the schedules were field tested, and administered in Tamil. Models of the cognitive development scales are presented in annexures VI-XII.

4.21. Figure Drawing

One relatively quick and easy to administer projective technique is the analysis of drawing. Drawings can provide the psycho-diagnostician with a wealth of clinical hypotheses to be confirmed or discarded as a result of other findings. The use of drawings in clinical and research settings has extended beyond the area of personality assessment. Attempts have been made to use artistic productions as a source of information about intelligence, neurological intactness, visual-motor coordination, cognitive development and even learning disabilities (Neare et al., 1993; Oakland and Dowling, 1983). Figure drawings are appealing sources of diagnostic data, since the instructions for them can be administered individually or in a group by non-clinicians such as teachers and no materials other than a pencil, a sheet of paper and a few crayons for colouring is required. The investigator distributed the paper, pencil and crayons and requested the children to draw a person from their imagination. The test was administered with a time limit of ten minutes in the presence of the school teachers. An innovative method of figure drawing was used, namely the Draw-A-Person test,
which means that, by just making the child draw a human picture, inferences such as the child's creativity, presentation, originality, use of colour and neatness were noted and for each concept one mark was given and the children were ranked on the basis of 5 total marks. Multi-responses on negative aspects like aggressiveness, weak impression of pencil or crayon, emotional disturbance, repetition of drawings, prominent importance to sexual features and drawing human picture with more of animal features etc. were also noted and these were analyzed to see the emotional disturbance of the child, which was then correlated with the micronutrient malnutrition.

4.22. Participatory Rural Appraisal

Participatory Rural Appraisal (PRA) in rural research and project planning is used to generate information at the community level directly from the members of the community. Such information is held to be more reliable, more relevant to community interests than that generated by conventional social research methods (Chambers, 1991). The PRA exercise is an atmosphere based, team based and people based exercise. Improving both the quality of information available to planners and communication between outsiders and community members is central to the rationale for participatory approaches. Venn diagram and seasonal calendar were the two techniques used in the selected villages. The Venn diagram helped to find out the nearest health facility available to them and to see the effectiveness of the Primary Health Centre, the Primary Health Nurse, Government Hospitals, school administration etc. The Seasonal calendar enabled the investigator to understand what are the types of crops are being cultivated (like green leafy vegetables), common diseases affecting the children, period of unemployment etc. over a period of one year which affected the overall performance of the children.

4.23. Focus Group Discussion

After school hours, the focus group discussion was organized among the school teachers and the parents of the respective children in each selected school. “What do you like your children and students to become in future?” was the common question asked by the investigator in all the eight focus group discussions. The group members discussed the children’s future, their aspiration towards development and so on. While the focus group discussion started, the parents said that they do not have any idea about their child’s future. Gradually they involved themselves in interaction and responded well in the brain storming sessions. The school functionaries facilitated the conduct of the focus group discussion.
4.24. Case Study

A form of qualitative analysis, which involves a careful and complete observation procedure called case study, has been used in this research. Five children from the total population were selected so as to have a representative sample from each village for the research. Complete details about the child, starting from the biographical inventory, obstetric history, physical, cognitive, socio emotional development, level of micronutrient deficiency such as iron, iodine, zinc and vitamin A were studied and inferences were drawn. The details are given in the analysis chapter. Though the study was common for the 1500 children, an in depth study by concentrating on every individual variable of the five children selected for the case study vis-a-vis the impact of micronutrient malnutrition on each child’s development enabled the present investigator to study all the related aspects of child development.

4.25. Data Processing and Analysis

For an objective interpretation, the data thus collected using different tools and techniques were processed and organized into appropriate tables. Percentages, frequency distribution and cumulative frequency were worked out wherever necessary and the sample means were computed to find out the group averages. The data from the study sample were matched with the national and internal standards to find out the nutritional status of the child. Intercorrelation between variables and t-test were also applied to assess the relation between micronutrient malnutrition and child development. The Statistical Package for Social Sciences (SPSS) was used for the analysis of the data and to arrive at results on the various factors affecting the nutritional status and the pattern of child development.