Chapter 2

Review of Literature
There are several socially backward communities in India, tribal community or schedule tribe is one of them. The term "Scheduled Tribe" refers to specific indigenous people whose status is acknowledged to some formal degree by national legislation. A tribe viewed historically or developmentally, consists of a social group existing before the development of, or outside of, states. The English word 'tribe' occurs in 13th-century Middle English literature as referring to one of the Twelve Tribes of Israel. The word is from Old French tribu, in turn from Latin tribus, referring to the original tripartite ethnic division of the Roman state: Ramnes (Ramnenses), Tities (Titienses), and Luceres, corresponding, according to Varro, to the Latins, Sabines, and Etruscans respectively. The term's ultimate etymology may be found in the Latin word for three, tres. The dative and ablative declensions of this word are both tribus. The word tribus could therefore mean "from the three" or "for the three." Another theory holds that tribus is perhaps derived from the Proto-Indo-European roots tri- ("three") and bhew- ("to be") (Fried 1975).

There are 645 types of schedule tribes or tribal populations in India and few groups were identified as more backward communities among the tribal population. These groups have been categorised as 'Primitive Tribal Groups' (PTGs) by the Government at the Census in 1975. So far seventy-five tribal communities have been identified as 'primitive tribal groups' in different States of India (Sanyal 2006). Santals have been recognized as one of the primitive tribes of India.

2.1. THE SANTALS

2.1.1. Background

Santal is the third largest schedule tribe (ST) in India. According to Skreisird (1968), the word 'Santal' is derived from Saontar. The word was adopted by the tribe after their settlement
for several generations in the villages of Midnapore. Another version reveals that the word Santal originated from ‘Samantapal’ or broader guard (Bhowmick 1985). The Santali people are descendants of the oldest humans in India; indeed, linguistic evidence shows this tribe’s ancestors as part of the original human migration out of Africa. The Santali language is a form of the Austro-Asiatic linguistic family rather than the dialect of the Aryan family commonly found in India.

Santal tribes of India take pride in their past. Historically, these Indian tribes were at front end against the British, and their heroics against Lord Cornwallis are well known. Many famous personalities such as Sidhu and Baba Tilka Majhi were part of these enthusiastic tribes of India.

Belonging to pre Aryan period, these tribes of India are found in regions of West Bengal, Bihar, Orissa and Jharkhand. The community came to their present habitat through successive waves of migration. They link up their traditional homeland to central India, known as Dandakaranya area (Das & Basu 1982). Then they went to Sagber, a plain land on the bank of a great river. Thereafter, they went to Champa of Madhya Pradesh. Here they ruled for about 200 years. In eastern India, Santals first settled in Dumka of Bihar which was situated in Santal Parganas of Bihar through 1790-1810 A.D. (Das & Basu 1982). During the 19th century, the Santals lived in many parts of West Bengal (Banerjee 1981). Their settlement in Purulia can be traced back to two hundred years or more (Das & Basu 1982).

Santals are divided into twelve exogenous totemic groups (clans). They are ‘Hansda’, ‘Kisku’, ‘Soren’, ‘Murmu’, ‘Marandi’ or ‘Mandi’, ‘Tudu’, ‘Hembram’, ‘Baske’, ‘Besra’, ‘Pauria’, ‘Chore’, and ‘Bedia’. The last three groups are not found at present. Each group is again subdivided into 13 to 20 subgroups. Each subgroup is further divided into a group of patrilineal kinsman, the unit is known as ‘Mitkhand’ (Orans 1965).
2.1.2. Distribution

Total 84,326,240 ST populations are present in India which comprises about 8.2% of the total Indian population (Census 2001). In West Bengal, total ST populations are about 4,406,794 (5.5% of total West Bengal population), whereas total Santal populations in West Bengal are about 2,280,540 (2.85% of total Indian ST Population and 51.8% of total ST population of West Bengal). Total ST Populations in Purulia district are about 4,63,452 (18.27% of total population of Purulia district) and total Santal populations in Purulia district are 3,33,686 (15% of total population of Purulia district and 65.45% of total ST population of Purulia district) (Table 2.1).

Table 2.1. Distribution of total Santal population in West Bengal.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2,280,540</td>
<td>2,163,044</td>
<td>117,496</td>
</tr>
<tr>
<td>Male</td>
<td>1,147,655</td>
<td>1,087,385</td>
<td>60,270</td>
</tr>
<tr>
<td>Female</td>
<td>1,132,885</td>
<td>1,075,659</td>
<td>57,226</td>
</tr>
</tbody>
</table>

2.1.3. Physical characteristics

Santals belong to the Astroid and Drawdian races. Physically, Santals are short statured people with solid, broad structure and flat, sunken nose. They have thick and protruding lips with broad and expanded mouth. Their complexion is dark and the hair is straight, wavy, or sometimes curly. The colour of their skin is black, brown (Fuchs 1973).

2.1.4. Habitation

The Santal tribes of India have a typical tribal lifestyle. The villages of the Santali tribe are located mostly in forest areas. The Santals of Purulia district lives in mud-built, thatched huts. They use earthen and a few metal vessels as utensils. Simple wooden furnitures are their
major household items of furniture. Marriage strictly occurs among different clans. Those that marry within their own clan are seen as incestuous and driven out of the tribe. Each village has its own judicial system, priest and hereditary leader. While the Santali have their own cosmogony (or creation myth) and practice animism to some degree (as a Christian would pray to saints, the Santali animism prays for favors from intermediaries including ancestor ghosts and gods of natural features,) they are mostly followers of the Sama religion, a belief system following Singbonga, or the Sun God. Art, music and dance are highly prized in Santali culture. Physical mediums of art such as painting or sculpture use mythological figures or ancestors as their subjects. Beginning with the instruments, Santali music is predominantly flute and drum. These instruments are typically elaborately decorated and are believed to have the power to communicate with the dead. Instruments can be passed down through generations or occasionally are cremated with the body of the owner. Songs are communal in nature. Dances are held at all major life occasions: Birth, marriage, and death along with all periods of the agricultural calendar. In addition the Santalis also hold courting dances on full moon nights and welcoming dances when people from other clans visit, but these are more informal social gatherings. The purpose of these dances is as varied as their occasion, but the overall emphasis of every dance is to reinforce community identity and solidarity. Because of highly ritualized dance ceremonies and festivals, strong, separate language, and tribal sovereignty within the Indian State, the Santalis have maintained their identity and cohesiveness over centuries when bombarded with invasion, new government, and technologies even in the modern era.

2.1.5. Language

The dialect that has been accepted by the members of the Santal tribe as their mother-tongue is called Santali. Like most of the lingoes used by the tribes, this language has also been
derived from the Austro-Asiatic group of languages and has a lot of features common with the languages like Vietnamese and Khmer. The alphabet utilized by the Santali language is known as Ol Chiki. A strange feature of this alphabet is that it does not possess any similitude with the Indic or the Devanagiri scripts. Another speciality of the Santali language is that they possess three extra vowels along with six regular ones. Apart from Santali, they also speak Bengali, Oriya and Hindi.

2.1.6. Literacy rate

According to Census 2001, national average literacy rate of ST population is about 47.1%, which is about 43.4% (Male 57.4% and Female 29.2%) in West Bengal. Recent report demonstrated that the literacy rate of Santal population in West Bengal is about 12.5% (Male 20.8% and Female 4%), (ASECA 2007).

2.1.7. Occupation

Santals of Purulia are mainly engaged in cultivation work, mostly as share-croppers, agricultural serfs and small or marginal farmers. Plough, hoe etc. are their main agricultural implements. Santals are also engaged in hunting and fishing. They use bows, arrows, bolts, and catapults etc. as hunting weapons. Fishing nets and traps are their major fishing implements. Both male and female take part in cultivation, but hunting and fishing activities are dominated by males. Santals rear small and big domestic animals. Besides these, a number of Santals are engaged in road construction and other kinds of construction as labours. Some of them also brew Mohua spirit and sell it in local market.

2.1.8. Economic status

The majority of tribals constitute the labour work force though their participation in the works is declining, but not steadily. More than half of the rural tribal population is found to be below poverty line as per latest survey available with Ministry of Rural Development (1993-94).
However, there is a perceptible declining trend in persons from tribal communities below poverty line.

The per capita income of tribals continues to be one of the lowest in the country and their alienation from their own land continues. As on January 1999, the tribals were alienated from 9,17,590 acres of tribal land and only 5, 37,610 acres of such land was restored as per latest statistics published by the Ministry of Rural Development (Census 2001).

2.2. NUTRITIONAL ANTHROPOMETRY

2.2.1. Background

The nutritional anthropology is the most simple and one of the valuable tools for evaluating the nutritional status of children, which cannot be obtained with equal confidence using the other assessment methods. It comprises measurements of the variations of the physical dimensions and the gross composition of the body (Gibson 1990). As growth is the major characteristic of childhood which is again dependent on adequate supply of nutrients; measurement of growth by anthropometric measurements like height, weight, body mass index, circumferences of mid-arm, head, chest, thigh, mid-calf, and skinfold thicknesses of triceps, biceps, supriliac, subscapular and calf can easily represent an idea about the nutritional status of a child (Jelliffe 1996).

2.2.2. Applications

Height is a measure of linear growth of the body and the degree of the skeletal development, and weight is a measure of total body mass including sum of protein, fat, water and bone mineral mass. Hence, these are sensitive to change in body fluid, fat, muscle mass as well as skeleton of the body. Weight reduction can easily occur as result of impairment of metabolism, decrease in nutrient intake or increase requirement of the same. Immediate decrease
in weight reflects current nutritional status (Gibson 1990). Mid-upper arm circumference (MUAC) assesses the degree of muscle and fat around the bone in the mid-upper arm region. A decrease in MUAC may therefore reflect a reduction in muscle mass, a reduction in subcutaneous tissue, or both. In developing countries, where the amount of subcutaneous fat is frequently small, changes in MUAC tend to parallel changes in muscle mass and hence MUAC is particularly useful in assessment of undernutrition (Lohman 1988). Measurement of head circumference is important because it is closely related to brain size and can be used as an index of chronic undernutrition. Chronic undernutrition during the first few months of life, or intrauterine growth retardation, may decrease the number of brain cells and result in an abnormal low head circumference. If undernutrition continues, it affects the total head circumference in later ages (Gibson 1990). The body mass index (BMI) proved to be useful in ascertaining the change in nutritional status over a period of time, when dietary indicators could not be relied on to reflect the change(s) because of their large variations. BMI can be a reasonably good substitute not only for assessing energy status of the subject but also for evaluating the nutritional status of the child. BMI is used to diagnose undernutrition, controlling for age and gender. BMI is closely associated with the weight rather than the height of the individual because weight is the responsive variable to energy balance (NIN 1990). Measurement of chest circumference of young children is useful parameter for assessing the nutritional status (Jelliffe 1996). Chest, thigh and mid-calf circumferences are the most useful measurements for grading and predicting for body fat and for describing adipose tissue distribution. In girls, thigh circumference is highly correlated with fat mass and body fat percentage. Correlations of thigh and mid-calf circumferences with measurements of body fat are somewhat lower, and these circumferences tend to be more strongly influenced by variations in appendicular skeletal muscle (Steven & Richard 2006).
Skinfold thickness measurements are said to provide an estimate of the size of the subcutaneous fat deposition, which in turn provides an estimate of the total body fat. Variations in distribution of subcutaneous fat in different locations like tricep, bicep, subscapul, suprailiac and calf occur with changes in nutritional status (Lee & Nieman 2003). Weight, MUAC and skinfold at tricep are affected within a short duration of inadequate nutrient intake. Hence, these parameters are sensitive and indicative to assess nutritional status which is responsive to acute nutritional deficiency or acute undernutrition; while height deficiency during childhood is an indication of chronic or prolonged nutritional deprivation. It can be said that growth retardation (assessed by anthropometrics), especially during childhood, is regarded as a sign of undernutrition and extend depends upon the degree of undernutrition (Lohman 1988). Hence, nutritional anthropometry is a sensitive index to assess the nutritional status. Several indices of fat-free mass and body fat like upper arm muscle circumference (UAMC), upper arm muscle area (UAMA) and upper arm fat area (UAFA) are calculated from MUAC and/or skinfold measurement and these are useful parameters for undernutrition measurement (Frisancho 1990).

2.3. DIETARY ASSESSMENT

2.3.1. Background

Nutritional status is directly related to the nutrient intake, so measurement of nutrient intake is probably the most widely used indirect indicator of nutritional status. Estimating an individual’s usual dietary and nutrient intake is difficult. The task is complicated by weaknesses of data-gathering techniques, human behavior, the natural tendency of an individual’s nutrient intake to vary considerably from day to day, and limitations of nutrient composition tables and databases. Despite these weaknesses, nutrient intake data are valuable in assessing nutritional status when used in conjunction with anthropometric, biochemical and clinical data. Assessing
dietary status includes considering the types and amounts of foods consumed and the intake of the nutrients and other components contained in foods. When food consumption data are combined with information on the nutrient composition of food, the intake of particular nutrients and other food components can be estimated (Lee & Nieman 2007).

2.3.2. Reasons for measuring diet

The ultimate reason is to improve human health. Food and nutrient intake data are critical for investigating the relationship between diet and nutritional problems, identifying groups at risk for nutrient deficiency or excess and formulating food and nutrition policies for disease reduction and health promotion (Elizabeth 2000). There are four major uses of dietary intake data: assessing and monitoring food and nutrient intake, formulating and evaluating government health and agricultural policy, conducting epidemiologic research and using the data for commercial purposes (Lee & Nieman 2007). Beside these, dietary assessment is used in determining the extent of malnutrition in a population, developing nutrient intervention and consumer education programs, constructing food guides, devising low-cost food plans, and providing a basis for food and nutrition legislation. Comparison of dietary practices and nutritional intake with the distribution of disease has demonstrated important links between diet and disease and has shown how dietary changes can modulate disease risk and enhance health.

2.3.3. Approaches to measuring diet

Various methods for collecting food consumption data are available. There is no single best method exists, each method has its own advantages and disadvantages (Lee & Nieman 2007). Being informed about the strengths and weaknesses of the methods available will better enable to scrutinize nutrition research and to draw the conclusions about a study’s results. Selecting the appropriate measurement method, correctly applying it, and using proper data analysis techniques can make the difference between data showing a diet-disease relationship.
and data showing no relationship where one may actually exist. Choosing the appropriate method for measuring diet depends on such considerations as the research design, characteristics of the study participants, and available resources.

2.3.4. Techniques for measuring diet

Measurement of dietary intake usually is conducted for three purposes: to compare average nutrient intakes of different groups, to rank individuals within a group, and to estimate an individual’s usual intake. Dietary measurement techniques can be categorized as daily food consumption methods (food record and 24-hour recall) and recalled ‘usual’ or ‘average’ food consumption methods (diet history and food frequency questionnaire). These techniques have also been categorized as meal-based (food record and 24-hour recall) and list-based (food frequency questionnaire).

(a) 24-hour recall: In this method, a trained interviewer asks the respondent to recall in detail all the foods and drinks consumed during a period of time in the recent past. In most instances, the time period is the previous 24 hours, thus the method is most commonly called 24-hours recall method. In addition to recording responses, the interviewer helps the respondent to remember all that was consumed during the period in question and assist the respondent in estimating portion sizes of food consumed. The recall proceeds from the morning of the present day to the current moment. The interviewer then begins at the point exactly 24 hours in the past.

Strengths: It is inexpensive, it is quick to administer (20 minutes or less), and it can provide detailed information on specific foods. It requires only short-term memory. It is well accepted by respondents because they are not asked to keep records, and their expenditure of time and effort is relatively low.
Limitations: Respondents may withhold or alter informations about what they ate because of poor memory or embarrassment or to release or impress the interviewer and researchers. Respondents tend to underreport being eating, consumption of alcoholic beverages, and consumption of foods perceived as unhealthful.

(b) Food record: In this method, the respondent records, at time of consumption, the identity and amounts of all foods and beverages consumed for a period of time, usually ranging from 1 to 7 days. Food and beverages can be quantified by estimating portion sizes, using household measures, or weighing the food or beverages on scale. This method is sometimes referred to as estimated food record because portion sizes are estimated, or household measures are used. When food is weighed, the record may be referred to as a weighed food record.

Strengths: The food record does not depend on memory because respondent ideally records food and beverage consumption at the time of eating. In addition, it can provide detailed food intake data and important information about eating habits.

Limitations: This method requires a literate and cooperative respondent who is able and willing to expend the time and effort necessary to record dietary intake. However, such a respondent may not be representative of the general population. The act of recording food intake after several days can lead even motivated respondent to reduce the number of foods and to decrease the complexity of their diets to simplify the recording process. Thus, the food record may significantly underreport energy and nutrient intake.

c) Food frequency questionnaires: This method assesses energy and/or nutrient intake by determining how frequently a person consumes a limited number of foods that are major sources of nutrients or of a particular dietary component in question. The
questionnaires consist of a list of approximately 150 or fewer individual foods or food groups that are important contributors to the population’s intake of energy and nutrients. Respondents indicate how many times a day, week, month or year they usually consume the food.

**Strengths:** This method places a modest demand on the time and energy of respondents and generates estimates of food and nutrient intake that may be more representative of usual intake than a few days of diet records. They are relatively quick to administer. They can be self-administered and thus are relatively economical to use in large-scale studies.

**Limitations:** The food list is limited to approximately 100 to 150 foods and food groups; these must be representative of the most common foods consumed by respondents in the sample. Short questionnaires are faster and easier to administer but lack comprehensiveness. Long questionnaires may do a better job of assessing nutrient intake but also require respondents to make an almost overwhelming number of decisions. Longer food frequency questionnaires have the disadvantages of being tedious to complete.

**(d) Diet history:** It is used to assess an individual’s usual dietary intake over an extended period of time, such as past month or year. The method involved four steps: (i) collect general information about the respondent’s health habits, (ii) question the respondent about his or her usual eating pattern, (iii) perform a cross-check on the data, and(iv) have the respondent complete 3-day food record.

**Strengths:** It assess the respondent’s usual nutrient intake, including seasonal changes, the data on all nutrients can be obtained. The method is one of the preferred methods for obtaining estimates of usual nutrient intake. Most people are able to report what
they typically eat, even if they cannot report exactly what they ate during a specific period of time.

**Limitations:** Minimum 1 to 2 hours are required to conduct the interview, highly trained interviewers needed, coding is difficult and expensive, and nutrient intake tends to be overestimated. The method also requires a cooperative respondent with the ability to recall his or her usual diet.

(e) **Duplicate food collection:** The limitations of using food consumption data to arrive at nutrient intake are the incompleteness of food composition table, mistakes in coding and entering data, and nutrient loses during food storage and preparation that may not be accounted for in food composition table. A more direct method of calculating nutrient intake that avoids these particular problems is duplicate food collections.

**Strengths:** This method provides a more accurate determination of actual nutrient intake, compared with calculations based on food composition data.

**Limitations:** A participants may have eaten a food that was introduced recently into the marketplace that is not listed in a food composition table or database.

(f) **Food accounts:** It is used to measure dietary intake within households and institutions where congregate feeding is practiced, such as penal institutions, nursing homes, military bases, and boarding schools. The methods accounts for all foods on hand in the home or institution at the beginning of the survey period. When used to measure household food consumption the usual survey period is 2 to 4 weeks.

**Strengths:** The survey can include a large sample size, food consumption can be monitored relatively long period of time, and the data on the annual mean consumption and general food patterns and habits of the population can be obtained. The method is
also relatively economical because personnel need only make periodic visits for supervising and controlling the recording.

**Limitations:** Because respondent literacy and cooperation are necessary, families or institutions willing to keep food accounts may not be representative of the population of interest. Accuracy may suffer due to forgetfulness or lack of faithfulness in maintaining food accounts. The method provides information only on the mean daily consumption of the whole family; it does not indicate how food is distributed among the various family members. Thus, it is only appropriate for measuring food consumption of groups.

### 2.4. NUTRITIONAL BIOCHEMISTRY

Compared with other methods of nutritional assessment, biochemical tests provide the most objective and quantitative data on nutritional status. Biochemical tests often can detect nutrient deficits long before anthropometric measures are altered and clinical signs and symptoms appear. It is well established that nutritional inadequacy is first indicated by biochemical changes, then damage occur in cell or organ and finally clinical malnutrition is established. Biochemical test available for assessing nutritional status can be grouped into two general and somewhat arbitrary categories: static and functional tests (Gibson 1990). These sometimes referred to as direct and indirect tests. Static tests are based on the measurement of a nutrient or its metabolites in the blood, urine or body tissue - for example, serum measurement of albumin. Although they indicate nutrient levels in the particular tissue or fluid sample, they often fail to reflect the overall nutrient status of an individual or whether the body as a whole is in a state of nutrient excess or depletion (Underwood 1990). Functional tests of nutritional status are based on idea that the final outcome of a nutrient deficiency and its biologic importance are
not merely a measured level in tissue or blood, but the failure of one or more physiologic processes that rely on that nutrient for optimal performance (Benjamin 1989). One drawback of some functional tests is a tendency to be nonspecific; they may indicate general nutritional status but not allow identification of specific nutrient deficiencies (Benjamin 1989).

The striking biochemical changes include lowering of serum protein especially albumin, ferritin, transferrin; serum iron; vitamin content such as Vit-A etc. Serum protein concentration can be useful in assessing protein status for evaluating a subject’s response to nutritional support. Use of serum protein measurements is based on the assumption that decreases in serum concentration are due to decreased liver production. This is considered as a consequence of a limited supply of amino acids from which the serum proteins are synthesized or a decrease in the liver’s capacity to synthesize serum proteins. The most familiar and abundant of the serum proteins, as well as the most readily available clinically, is albumin. Serum albumin has been shown to be an indicator of depleted protein status and decreased dietary protein intake. Measure over the course of several weeks, it has been shown to correlate with other measures of protein status and to respond to protein depletion. Its relatively long half-life (14 to 20 days) and large body pools (4 to 5 gm/kg of body weight) cause serum levels to respond slowly to nutritional change, making it poor indicator of early protein depletion and repletion (Benjamin 1989, Gibson 1990). About 60% of the body’s albumin is found outside the blood stream. When serum concentration falls during early protein energy malnutrition (PEM), extra vascular albumin moves into the blood stream maintaining normal serum concentration despite protein and energy deficits (Benjamin 1989, Gibson 1990). Serum transferrin is a β-globulin synthesized in the liver that binds and transports iron in the plasma. Because of its smaller body pool and shorter half-life, it has been considered a better index of changes in protein status compared with albumin (Benjamin 1989). Serum transferrin has been shown to be associated with clinical outcome in
children with kwashiorkor and marasmus. Iron deficiency is the most common single nutrient deficiency in developing countries and the most common cause of anemia.

Iron deficiency results when ingestion or absorption of dietary iron is inadequate to meet iron losses or iron requirements imposed by growth. Anemia is a hemoglobin level below the normal reference range for individuals of the same sex and age. Descriptive terms such as microcytic, macrocytic and hypochromic are sometimes used to describe anemias. Microcytic refers to abnormally small RBC defined by a mean corpuscular volume (MCV) <80 femoliters (fL), whereas macrocytic describes usually large RBC defined as an MCV >100 fL. Hypochromic cells are those with abnormally low levels of hemoglobin as defined by a mean corpuscular hemoglobin concentration <320 g of hemoglobin/L or by mean corpuscular hemoglobin <27 picograms. The risk of iron deficiency increases as the body's iron stores are depleted. Iron depletion can be divided into three stages. The first stage of iron depletion, depleted iron stores, is not associated with any adverse physiologic effects, but it does represent a state of vulnerability (ESWG 1985). The second stage of iron depletion, iron deficiency without anemia, can be considered representative of early or mild iron deficiency because, at this point, adverse physiologic consequences can begin to occur. This stage is characterized by changes indicating insufficient iron for normal production of hemoglobin and other essential iron compounds (ESWG 1985). The third stage of iron depletion, iron deficiency anemia, is characterized by decreased serum ferritin, transferrin saturation, hemoglobin and MCV and increase erythrocyte protoporphyrin (ESWG 1985). Ferritin, the primary storage form for iron in the body, is found primarily in the liver, spleen and bone marrow. As iron stores become depleted, tissue ferritin level decreases. This is accompanied by a fall in serum ferritin concentration (Rabel 1989). Measurement of serum ferritin concentration is the most sensitive test available for detecting iron deficiency, and decrease occur before morphologic changes are seen RBC, in the other
indicators, or before anemia occurs (Rabel 1989). Because iron is carried in the blood by transferrin, serum iron level is a measure of the amount of iron bound to transferrin. Levels fall sometime between depletion of tissue iron stores and development of anemia, although they may actually be normal in persons with iron deficiency (Rabel 1989, Fairbanks 1994). Total iron binding capacity (TIBC) measures the amount of iron capable of being bound to serum proteins and provides an estimate of serum transferrin. It is usually measured by adding an excess of iron to serum (thus saturating iron-binding proteins in serum), removing all iron not bound to protein in the serum, and then measuring serum iron. TIBC is an indirect measure of serum transferrin, because other serum proteins can bind iron. TIBC is not an exact measure of transferrin, especially in cases of iron overload and certain other conditions. In about 30% to 40% of persons with iron-deficiency anemia, TIBC is not elevated (Rabel 1989). Transferrin saturation (TS) is the ratio of serum iron to TIBC. TS is the percent of transferrin that is saturated with iron. In uncomplicated iron deficiency anemia, serum iron levels decrease and TIBC increases, resulting in decreased TS. Measures of serum iron, TIBC, TS and serum ferritin concentration are useful in distinguishing iron deficiency from other disorders capable of causing microcytic anemia (Fairbanks 1994). TS is considered to be a more sensitive indicator of iron deficiency than either serum iron or TIBC (Rabel 1989).

Nutritional status can also be assessed by measuring hematological parameters such as total count of red blood cell (RBC), reticulocyte count, percentage of hemoglobin, mean corpuscular volume (MCV), packed cell volume (PCV), erythrocyte fraction volume etc. Measurement of hemoglobin in whole blood is the most widely used screening test for iron deficiency anemia. The amount of hemoglobin in blood primarily depends on the number of RBC and to a lesser extent on the amount of hemoglobin in RBC (Rabel 1989). Although hemoglobin and hematocrit values or PCV are useful in diagnosing anemia, they tend not to
Chapter 2: Review of literatures

become abnormal until the late stages of iron deficiency and are not good indicators of early iron deficiency. PCV is defined as the percentage of RBC making up the entire volume of whole blood. PCV depends largely on the number of RBC and to a lesser extent on their average size. Normal ranges for PCV are 40% to 54% and 37% to 47% for males and females, respectively (Rabel 1989). The mean corpuscular hemoglobin (MCH) is the amount of hemoglobin in red blood cells (26 to 34 pg). MCH is influenced by the size of RBC and the amount of hemoglobin related to the size of the cell (Rabel 1989). A similar measure, mean corpuscular hemoglobin concentration (MCHC) is the average concentration of hemoglobin in the average RBC (32 to 36 g/dL). MCV is the volume of the average RBCs (80-100 FL) (Lee & Nieman 2007).

2.5. COGNITIVE DEVELOPMENT

2.5.1. Background

Cognitive development is a field of study in neuroscience focusing on a child's development in terms of information processing, conceptual resources, perceptual skill, and other topics. A major topic in cognitive development is nativism versus empiricism. Nativists theorize that children are born with many innate cognitive systems designed to tackle problems that the human species have faced over a very long evolutionary time. Empiricists study how these skills may be learned in such a short time. These systems are learned by general-purpose learning devices, or by domain-specific cognition.

Cognition is the scientific term for "the process of thought". Its usage varies in different ways in accord with different disciplines: For example, in psychology and cognitive science it refers to an information processing view of an individual's psychological functions. Other interpretations of the meaning of cognition link it to the development of concepts; individual
minds, groups, organizations, and even larger coalitions of entities, can be modelled as "societies" (Society of Mind), which cooperate to form concepts (Lycan 1999).

The term cognition (Latin: *cognoscere*, "to know" or "to recognize") refers to a faculty for the processing of information, applying knowledge, and changing preferences. Cognition, or cognitive processes, can be natural or artificial, conscious or unconscious. Within psychology or philosophy, the concept of cognition is closely related to abstract concepts such as mind, attention, reasoning, perception, intelligence, learning, and many others that describe capabilities of the mind and expected properties of an artificial or synthetic "mind". Cognition is considered an abstract property of advanced living organisms and is studied as a direct property of a brain (or of an abstract mind) on the factual and symbolic levels (Lycan 1999).

2.5.1.1. **Attention**: It is the selection of important information. Human mind is bombarded with millions of stimuli and it must have a way of deciding which of this information to process. It is often seen as a spotlight, meaning one can only shine the light on a particular set of information.

2.5.1.2. **Language processing**: The ability to learn and understand language is an extremely complex process. Language is acquired within the first few years of life, and all humans under normal circumstances are able to acquire language proficiently.

2.5.1.3. **Learning and development**: Learning and development are the processes by which humans acquire knowledge and information over time. Infants are born with little or no knowledge, yet they rapidly acquire the ability to use language, walk, and recognize people and objects. Research works in learning and development aims to explain the mechanisms by which these processes might take place.
2.5.1.4. Memory: Memory allows us to store information for later retrieval. Memory is often thought to consist of both a long-term and short-term store. Long-term memory allows people to store information over prolonged periods (days, weeks, years). People do not yet know the practical limit of long-term memory capacity. Short-term memory allows us to store information over short time scales (seconds or minutes).

Memory is also often grouped into declarative and procedural forms. Declarative memory grouped into subsets of semantic and episodic forms of memory refers to memory for facts and specific knowledge, specific meanings, and specific experiences. Procedural memory allows remembering actions and motor sequences and is often dubbed implicit knowledge or memory.

2.5.1.5. Perception and action: Perception is the ability to take in information via the senses, and process it in some way. Vision and hearing are two dominant senses that allow human to perceive the environment. One tool for studying visual perception is by looking at how people process optical illusions.

2.5.2. Piaget's Theory of Cognitive Development

The Theory of Cognitive Development, first developed by Jean Piaget, proposes that there are four distinct, increasingly sophisticated stages of mental representation that children pass through on their way to an adult level of intelligence (Oakey 2004). The four stages, roughly correlated with age, are as follows:

2.5.2.1. Sensorimotor period (years 0 to 2): In this stage, infants construct an understanding of the world by coordinating sensory experiences (such as seeing and hearing) with physical, motoric actions. Infants gain knowledge of the world from the physical actions they perform on it. An infant progresses from reflexive, instinctual action at birth to the beginning of symbolic thought toward the end of the stage (Santrock 2008). Piaget divided the sensorimotor stage into six sub-stages (Table 2.2).
Table 2.2. Six substages of sensorimotor stage according to Piaget (Oakey 2004).

<table>
<thead>
<tr>
<th>Sub-Stage</th>
<th>Age</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Simple Reflexes</td>
<td>Birth-1</td>
<td>Coordination of sensation and action through reflexive behaviors.</td>
</tr>
<tr>
<td>2 First habits and primary circular reactions phase</td>
<td>1-4</td>
<td>Coordination of sensation and two types of schemes: habits (reflex) and primary circular reactions (reproduction of an event that initially occurred by chance).</td>
</tr>
<tr>
<td>3 Secondary circular reactions phase</td>
<td>4-8</td>
<td>Development of habits. Infants become more object-oriented, moving beyond self-preoccupation; repeat actions that bring interesting or pleasurable results.</td>
</tr>
<tr>
<td>4 Coordination of secondary circular reactions stage</td>
<td>8-12</td>
<td>Coordination of vision and touch—hand-eye coordination; coordination of schemes and intentionality.</td>
</tr>
<tr>
<td>5 Tertiary circular reactions, novelty, and curiosity</td>
<td>12-18</td>
<td>Infants become intrigued by the many properties of objects and by the many things they can make happen to objects; they experiment with new behavior.</td>
</tr>
<tr>
<td>6 Internalization of Schemes</td>
<td>18-24</td>
<td>Infants develop the ability to use primitive symbols and form enduring mental representations.</td>
</tr>
</tbody>
</table>

2.5.2.2. Preoperational Period (years 2 to 6): (Pre) Operatory Thought is any procedure for mentally acting on objects. The hallmark of the preoperational stage is sparse and logically inadequate mental operations. During this stage, the child learns to use and to represent objects by images, words, and drawings. The child is able to form stable concepts as well as mental reasoning and magical beliefs. The child however is still not able to perform operations; tasks that the child can do mentally rather than physically (Santrock 2007). Two substages can be formed from preoperational thought.

(i) The Symbolic Function Substage

It occurs between about the ages of 2 and 4. The child is able to formulate design of objects that are not present. Although there is advancement in progress, there are still
limitations such as egocentrism and animism. Egocentrism occurs when a child is unable to distinguish between their own perspective and that of another person's. Children tend to pick their own view of what they see rather than the actual view shown to others. Animism is the belief that inanimate objects are capable of actions and have lifelike qualities.

(ii) The Intuitive Thought Substage

This occurs between about the ages of 4 and 7. Children tend to become very curious and ask many questions; begin the use of primitive reasoning. There is an emergence in the interest of reasoning and wanting to know why things are the way they are. Piaget called it the intuitive substage because children realize they have a vast amount of knowledge but they are unaware of how they know it. Centration and conservation are both involved in preoperational thought. Centration is the act of focusing all attention on one characteristic compared to the others. Centration is noticed in conservation; the awareness that altering a substance's appearance does not change its basic properties. Children at this stage are unaware of conservation. The child also fails to show conservation of number, matter, length, volume, and area as well. Piaget considered that children primarily learn through imitation and play throughout these first two stages, as they build up symbolic images through internalized activity.

2.5.2.3. Concrete operational stage (years 6 to 12): This stage is characterized by the appropriate use of logic. Children in this stage can only solve problems that apply to actual (concrete) objects or events, and not abstract concepts or hypothetical tasks. Important processes during this stage are:
(i) **Seriation:** The ability to sort objects in an order according to size, shape, or any other characteristic.

(ii) **Transitivity:** The ability to recognize logical relationships among elements in a serial order.

(iii) **Classification:** The ability to name and identify sets of objects according to appearance, size or other characteristic, including the idea that one set of objects can include another.

(iv) **Decentering:** The child takes into account multiple aspects of a problem to solve it.

(v) **Reversibility:** The child understands that numbers or objects can be changed, and then returned to their original state.

(vi) **Conservation:** Understanding that quantity, length or number of items is unrelated to the arrangement or appearance of the object or items.

(vii) **Elimination of Egocentrism:** The ability to view things from another's perspective (even if they think incorrectly).

2.5.2.4. **Formal operational stage (years 12 and up):** In this stage, individuals move beyond concrete experiences and begin to think abstractly, reason logically and draw conclusions from the information available, as well as apply all these processes to hypothetical situations. The abstract quality of the adolescent's thought at the formal operational level is evident in the adolescent's verbal problem solving ability. The logical quality of the adolescent's thought is when children are more likely to solve problems in a trial-and-error fashion. Adolescents begin to think more as a scientist thinks, devising plans to solve problems and systematically testing solutions. They use hypothetical-deductive reasoning, which means that they develop hypotheses or best guesses, and systematically deduce, or conclude, which is the best path to follow in solving the problem. During this stage the young adult begins to entertain possibilities for the
future and is fascinated with what they can be. Adolescents also change cognitively by the way they think about social matters. Adolescent Egocentrism governs the way that adolescents think about social matters and is the heightened self-consciousness in them as they are which is reflected in their sense of personal uniqueness and invincibility (Santrock 2008).

2.5.3. Brain areas related to Cognitive development

Cognitive capacity is related to the underlying maturation of the CNS. Cognitive development has progressed with minimal reference to the underlying processes of cerebral maturation. Cognitive and cerebral developments are rapid during childhood, plateauing in early to mid-adolescence, warrants further consideration (Flavell 1992). Attention is represented cerebrally by an integrated neural system, involving contributions from a range of structures, including the brain stem and reticular activating system, posterior and anterior cerebral regions (Stuss et al. 2001) Posner and Peterson (1990) suggested that posterior cerebral cortex, in particular the parietal lobes, and parts of the thalamus and midbrain are directed towards selective attention, and directs shifts in spatial attention. Posner and colleagues (1990) argued that the anterior cingulate gyrus and the areas of the prefrontal cortex are associated with enhancing the intensity of the attention directed towards particular cognitive tasks. Mirsky et al. (1995) postulated that attention is mediated to a large extent by the reticular formation, other brain stem structures and the medial thalamus. Stuss et al. (2001) argued that anterior cerebral structures also play a role in this aspect of attention. Focused attention is associated with the superior temporal, inferior parietal and striatal regions (Mirsky et al. 1991). Higher order skills consistent with more executive processes are subsumed by the prefrontal cortex, including the anterior cingulate gyrus, and stability of attentional effort is mediated by brain stem and midline thalamic structures (Mirsky et al. 1995). Kinsbourne (1996) suggested that attentional capacity depend on
the ability to transmit information both within the cortex and via subcortical-cortical connections.

For language processing, the organ of Corti is involved in the processing of bioelectric signals to the primary auditory cortex from auditory organs. Wernicke's area, where the noted analysis takes part, is concerned with the comprehension of auditory and visual information. Wernicke's area projects via arcuate fasciculus to Broca's area to interpret the information provided by Wernicke's area and transmit information to the closely located motor-related areas of the brain for production of speech (Ganong 2003).

A number of neural structures have been proposed to subsume the memory processes. Maturation of cerebral areas may parallel memory development. In addition, incomplete development of frontal lobes during childhood implies limited ability to organize information and utilize strategies to optimize information-processing capacity (Kinsboume 1996). The basal ganglia and brain stem structures, which mature relatively early in infancy and early childhood, have been linked to procedural memory skills and acquisition of conditioned responses (Nelson 1995). The temporal lobes and in particular the hippocampus are implicated in the encoding and storage of information (Columbo & Gross 1994).

2.5.4. Cognitive development and Nutrition

The role of nutrition on cognitive development is one of the most extensively studied subjects in biological science. Neuronal metabolism is particularly dependent on glucose availability and is very sensitive to periods of carbohydrate deprivation (Volpe 1995). Hypoglycemia has a particularly profound negative effect on the developing hippocampus (Kim et al. 2005). Protein is typically used by the body for tissue protein synthesis in the brain cells. Certain fats and lipoproteins are important for normal neuronal cell membrane integrity and myelination (Fuglestad et al. 2008).
Minerals are not classically considered as essential for brain development, but deficiencies in these nutrients lead to abnormal brain function, mostly through altering neuronal electrical function. With the major minerals, trace elements are also not classically considered to be uniquely important for normal brain development except as their deficiencies affect neuronal functions. Some elements like iron, iodine and zinc are exceptional in their particularly profound effect on cognitive development. Iron is required for enzymes that regulate central nervous system (CNS) cell division, monoamine synthesis, myelination and oxidative metabolism (Fuglestad et al. 2008). Brain development is severely compromised by hypothyroidism with profound effect on cognitive functions (Kretchmer et al. 1996). Similarly, zinc through its role in nucleic acid synthesis, plays a significant role in neurodevelopment. Both neuroanatomic and neurochemical changes have been described in zinc deficiency (Fuglestad et al. 2008).
trace elements, vitamins also play a significant role in brain growth and development. Certain vitamins like vitamin A, folic acid, and pyridoxine appear to be more critical during certain periods of CNS development, and their deficiencies present a greater risk to neurodevelopment (Pollitt 1996). The role of nutrition in cognitive development must be considered with regard to other biological and environmental factors (Figure 2.1) (Fuglestad et al. 2008).

2.6. MOTOR DEVELOPMENT

2.6.1. Background

Motor development is the gradual process by which a child gains use and coordination of the large muscles of the legs, trunk, and arms, and the smaller muscles of the hands. Motor development includes age related changes in posture and movements, the two basic ingredients of motor behavior. A motor skill is a learned series of movements that combine to produce a smooth, efficient action.

2.6.1.1. Gross motor skills: It includes lifting one's head, rolling over, sitting up, balancing, crawling, and walking. Gross motor development usually follows a pattern. Generally large muscles develop before smaller ones, thus, gross motor development is the foundation for developing skills in other areas (such as fine motor skills). Development also generally moves from top to bottom. The first thing a baby usually learns to control is its eyes. Gross motor skills involve large muscle movements. Between one and four years of age, gross motor skills fall into one of three areas: movement, using stairs, and play.

The maturational process occurs fairly predictably from the top down. First head control is gained as the nerves supplying the neck muscles mature and the neck muscles gain strength. The shoulder, upper arms, and hand control improves. Upper body or trunk control is next, then the hips and pelvis, and finally the legs. Balance and coordination are part of
2.6.1.2. Fine motor skills: It includes the ability to manipulate small objects, transfer objects from hand to hand, and various hand-eye coordination tasks. Fine motor skills may involve the use of very precise motor movement in order to achieve an especially delicate task. Some examples of fine motor skills are using the pincer grasp (thumb and forefinger) to pick up small objects, cutting, coloring, writing, or threading beads. Fine motor development refers to the development of skills involving the smaller muscle groups. Fine motor skills involve the small muscle movements of hands and fingers in coordination with eyes. Between one and two years of age, fine motor skills fall into four areas: putting in, building up, putting together, and writing.

All fine motor activities (i.e., braille, writing, hand writing, eating, dressing, etc.) are built upon four important skills. These four skills must be learned before a child can go on to more complicated tasks. They are: Grasping objects, reaching out to objects, releasing objects deliberately and Turning the wrist in various directions. Grasping is the ability to hold onto objects and use them for specific purposes. Young babies have a reflexive grasp; their hands automatically close tightly when pressure or stimulation is applied to their palms. As a baby becomes more aware of his/her hands, he/she is able to open them voluntarily and develop a "true" grasp. The reflexive grasp is inhibited as a baby takes more and more weight on his/her hands. It is replaces by a series of different holding methods which, over time, involve more thumb participation. Bilateral coordination is the ability to use both hands together to manipulate an object. This begins at an early age where an infant is observed to hold objects using two hands (in midline), progressing through transferring objects from hand to hand, to where each hand is used for different functions.
2.6.1.3. Ambidexterity: It is a specialized skill in which there is no dominance between body symmetries, so tasks requiring fine motor skills can be performed with the left or right extremities. The most common example of ambidexterity is the ability to write with the left or right hand, rather than one dominant side.

2.6.2. Stages of motor development

2.6.2.1. During infancy (Birth to 1 year)

The newborn infant gains the ability to hold the head in the increasingly vertical posture. Along the way, infants acquire locomotor skills: first rolling, then crawling and creeping, and then walking with support, until they finally achieve that important milestone of independent locomotion. Motor development of infancy is considered to be the period from birth until the child is able to stand and walk (Table 2.3).

Table 2.3. Milestones of motor development for the first year of life (Auburt 2007).

<table>
<thead>
<tr>
<th>Functional accomplishment</th>
<th>Average age of accomplishment (In month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holds head erect and steady</td>
<td>0.8</td>
</tr>
<tr>
<td>Turns from side to back</td>
<td>1.8</td>
</tr>
<tr>
<td>Sits with support</td>
<td>2.3</td>
</tr>
<tr>
<td>Turns from back to side</td>
<td>4.4</td>
</tr>
<tr>
<td>Sits alone (momentarily)</td>
<td>5.3</td>
</tr>
<tr>
<td>Rolls from back to stomach</td>
<td>6.4</td>
</tr>
<tr>
<td>Sits alone steadily</td>
<td>6.6</td>
</tr>
<tr>
<td>Early stepping movements (with support)</td>
<td>7.4</td>
</tr>
<tr>
<td>Pulls to standing position</td>
<td>8.1</td>
</tr>
<tr>
<td>Walks with help</td>
<td>9.6</td>
</tr>
<tr>
<td>Stands alone</td>
<td>11.0</td>
</tr>
<tr>
<td>Walks alone</td>
<td>11.7</td>
</tr>
</tbody>
</table>
2.6.2.2. During early childhood (2 to 6 years)

Motor development of early childhood leads to the attainment of new skills but not necessarily new pattern of movement what the child acquired in infancy. In early childhood, new locomotor skills are added including running, hopping, jumping, and skipping. These skills require increasing degree of balance and control of force for successful performance. The development of ability within each skill appears to depend on a combination of practice, growth of the body and maturation of CNS. Children require opportunities to exercise their developing abilities within fundamental motor skills. Running is generally acquired between ages of 2 to 4 years. The degree of control in running such as ability to start, stop and change direction is achieved at the age of 5 to 6 years. Jumping ability develops during this age groups, the skill is more characteristic of a stepping-down pattern than an actual jump with two feet off the ground simultaneously. Hopping seems to be an extension of the ability to balance while standing on one leg. Hopping appears about the age of 2½ years, but is not well-performed until the child is 6 years of age. Skipping is a complex locomotor pattern involves a step and a hop on one leg, followed by a stem and a hop on the other leg. Skipping is not achieved by most children until they are 6 years old. Beside these, throwing and striking are two additional skills that undergo developmental change during early childhood. Catching and kicking are two additional skills have also been studied from a developmental perspective (Auburt 2007).

2.6.2.3. During later childhood and adolescent (7 to 12 years and above)

During later childhood and adolescent, changes in the form of movements are related to age. It appears that the individual is constantly seeking the most efficient form of movements within skill that have already been attained. Children have strongly drives to become skillful and to explore the limits of their physical being. Later childhood is a time of slow but steady physical growth that allows gradual mastery of motor skills. Adolescent leads to new patterns of
movement within the skills already acquired. The process of age-related change in motor behavior continues throughout adolescence and adulthood. The later periods of motor development seem to provide opportunities for further refinement and development of control coordination, leading to improve motor performance within skills. Both boys and girls demonstrate improved motor performance within all fundamental skills through early and later childhood. However, boys typically demonstrate greater speed and strength at all ages when compared with girls (Auburt 2007).

2.6.3. Brain areas related to motor development

The motor system is the part of the central nervous system that is involved to movement. It consists of the pyramidal and extrapyramidal system. The motor pathway also called pyramidal tract or the corticospinal tract start in the motor center of the cerebral cortex. There are upper and lower motor neurons in the corticospinal tract (Figure 2.2).

The motor impulses originate in the Giant pyramidal cells or Betz cells of the motor area i.e precentral gyrus of cerebral cortex. These are the upper motor neurons (UMN) of the corticospinal tract. The axons of these cells pass in the depth of the cerebral cortex to the Corona radiata and then to the Internal Capsule passing through the posterior branch of internal capsule and continue to descend in the Midbrain and the Medulla Oblongata. In the lower part of Medulla oblongata 80 to 85% of these fibers decussate (pass to the opposite side) and descend in the White Matter of the Lateral funiculus of the spinal cord on the opposite side. The remaining 15 to 20% pass to the same side. Fibers for the extremities (limbs) pass 100% to the opposite side. The fibers of the corticospinal tract terminate at different levels in the anterior horn of the grey matter of the spinal cord. Here the lower motor neurons (LMN) of the corticospinal cord are located. Peripheral motor nerves carry the motor impulses from the anterior horn to the voluntary muscles.
2.6.4. Motor development and Nutrition

Brain development is most sensitive to a baby's nutrition between mid-gestation and two years of age. Children who are malnourished, not just fussy eaters but truly deprived of adequate calories and protein in their diet, throughout this period do not adequately grow, either physically or mentally. Their brains are smaller than normal, because of reduced dendritic growth, reduced myelination, and the production of fewer glia (supporting cells in the brain) which continue to...
Chapter 2: Review of literatures

form after birth and are responsible for producing myelin). Inadequate brain growth explains why children who were malnourished as fetuses and infants suffer often lasting behavioral and cognitive deficits, including slower language and fine motor development, lower IQ, and poorer school performance.