II. REVIEW OF LITERATURE

Relevant literature pertaining to the present study entitled ‘Nutritional Profile of Elderly in Kochi, Kerala’ is presented under the following heads.

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2.1 Ageing: Concepts, Definitions and Demographic trend

   2.1.1 Concepts and definitions.
   Ageing is a gradual developmental process involving biological, psychological, sociological and behavioural changes, that begins at the moment an individual is born (Chandrasekhar and Bhooma, 1999). It signifies the progression of biochemical changes which determine the structural and functional alteration with age in the cellular and non-cellular tissues (Venkataraman, 1998).

   Mohanty and Maulik (2003) conceptualized the process of ageing as irreversible progressive changes in cellular functions causing under-functioning of various organs of human body. This view was supported by Ghosh (2004) stating that ageing is a manifestation of replacement and repair of the orderly sequence of DNA double strand. According to Natarajan (1999), ageing starts when the first calcific deposition occurs in the vessels and ligments. Moody (2000) also defined ageing as a time dependent series of cumulative, progressive, intrinsic and harmful
changes that begin to manifest themselves at reproductive maturity and eventually end in death.

From a sociological perspective, Natarajan (1999) has defined old age as the age of retirement, as the combined effect of ageing, social changes and diseases cause a breakdown in health. Neuhaus (1982) and Hemalatha (1999) opined that ageing is a complex phenomenon accompanied by physiological, psychological and social changes which contribute to a decline in health status. Thus it could be stated that the physiological age of an individual is not the same as that of chronological age in biological terms, since ageing process differs from person to person.

However cut off points to denote ageing and its progression is very essential. Sreeramulu and Raghuramalu (1999) also opined that though there are no precise definitions of elderly population, generally all those above the age of 65 years may be considered to be elderly. The U.S. Bureau of Census (2001) considers people who are above the age of 65 years as elderly.

But according to WHO (2002), persons who have attained the age 60 are considered as elderly. ICMR (2010) also supported the above WHO definition. WHO (1999) also suggested some cut off points to indicate the progression of ageing. As per this, people who are in the age range of 60 to 75 years are designated as the young old, 75 to 89 years as old and 90 plus as very old.

Biological explanation of ageing process, as given by Chadha (1997), fall under three major categories – Genetic theories, Non-genetic cellular theories and Physiological theories. A genetic programme that sets the upper limit of the life span of all species and loss of replicability (Bird, 2007) may be a good model of the finite characteristics of cells in vitro but it does not appear to be a complete model of ageing. The life span of cell populations in vivo may be very different (Mickey, 1992). But as per Chadha (1997) the DNA damage theory, somatic mutation theory and cellular error theory are the basic theories related to ageing.

Accumulation theories suggested by Hughes and Reynolds (2005) attributed ageing to the accumulation of deleterious substances called toxins in the ageing organism. The free radical theory proposed that molecular fragments containing a single impaired electron makes them highly reactive to proteins, lipids,
carbohydrates and chromosomal material in the cells and this probably leads to changes associated with ageing.

Non biological theories of ageing include disengagement theory which was first proposed by Cumming and Henry (1961). The idea is that separation of older people from active roles in society is normal and appropriate and beneficial to both society and older individuals. However this theory has been much criticized (Stuart and Lago, 1989). In contrast to disengagement theory the activity theory implied that the more active elderly people are the more likely they are to be satisfied with life.

The selectivity theory as suggested by Carstensen et al., (2003) also proposed that that it may benefit older people to become more active in some aspects of their life, more disengaged in others. Continuity theory described best by Atchley (1989) viewed that ageing people are inclined to maintain as much as they can the same lifestyle developed in earlier years. However many authors view the above theories to be optimal for certain people in old age, depending upon both the circumstances and personality traits of the individual concerned.

Thus ageing has been conceived to be a reflection of cellular and systemic processes that occur with time (Mc Ardle et al., 2002) or as a progressive loss in the individual of his physiological adaptability to the environment culminating in death (Shephard, 1987). The basic biological nature of the ageing process is still not very clear. Thus ageing must be viewed in terms of a man as a whole (Potter et al., 1995) since ageing, nutrition and health and/or diseases are intimately interwoven (Souba, 1997) and it is not possible to isolate these factors to evaluate the effect of each component separately. In addition these factors are continually influenced by a multitude of environmental, bio-social, bio-cultural and physiological factors during one’s life to death process. The very multiplicity of hypotheses concerning ageing emphasizes that no current view offers a complete and unique explanation of the known facts about ageing.

2.1.2 Demographic trend

Populations pass through various stages termed as the “epidemiological transition” which represent a shift from high mortality and high fertility to low mortality and low fertility and from a low proportion to high proportion of older persons. The world is at present passing through the third stage of epidemiological
transition (UNDP, 1999). Throughout the world in both developed and developing
countries there has been a shift in the age structure of elderly population because of
a combination of increased longevity and decreased mortality (Patil, 2000).

Demographic ageing is a global phenomenon. WHO (2002) reports
indicated that the life expectancy at birth for men has shown a steady rise from 42
years in 1960s, to 58 years in 1990s. It is projected to reach 67 years in 2011-16.
An increase of about 9 years in a twenty five year period was noted. In case of
females, the increase in expectation of life has been higher by about 11 years during
the same period from 58 years in 1986-90 to 69 years in 2011-16.

According to Reilly (2007), globally the number of persons 60 years or
above is expected to triple, increasing from 673 million in 2005 to 2 billion by
2050. The annual gradual increase of 2.5 percent in the global elderly population is
reported to be due to the geriatric boom.

These projections are supported by the Department of Social and Economic
Affairs (2009). Accordingly the elderly population globally, is expected to reach
1.18 billion by 2025. Of the global population of over 6 billion, almost 10 percent
would be elderly. Further it is projected that the older population in developing
countries will increase much faster than the developed countries. By the year 2020
it will be 100 crores and by 2030, one third of the population is projected to be
elderly and by 2050 developing countries will have three fourth of the global
elderly.

On the basis of the 2001 census, India comprising of 28 states and 8 Union
territories had a total elderly population of 71 million (Rajan Irudaya, 2004).
Currently India ranks second only to China among the countries of the world, in
terms of population of the aged (WHO, 2002). By 2061, it is estimated that India
will have the largest population of older persons in the world (www.aging.state,
2004).

As per the World Bank projections, old age population in India is likely to
increase from 70 million in 1995 to 141 million by 2020 and 508 million by 2100
(Rajagopalan, 2000). World Health Survey Report (2003) predicts that by 2061,
while the present Indian population would climb five times, the number of elderly
would soar 13 times. Thus in India population of elderly is fast growing. Aged persons constituted 5.8 percent of the population in 1961 and 6.8 percent in 1991. In 2016 older persons will constitute 8.9 percent of total Indian population. This increasing trend of aged population tend to have an impact on the dependency ratio. As Rajagopalan (2000) reported, in India, 57.4 percent of the population in the age group 15 to 59 years had to support 42.6 percent of the children and old age people in 1995. By 2100, 46.2% children and old population have to be supported by 53.8 percent of the population in the age group 15-59. Such large dependency ratio seems to be one of the inevitable consequences of demographic transition.

Among the Indian states, Kerala has the largest proportion of elderly population and the growth rate among the aged is increasing higher and higher (Moli, 2004). Kerala Ageing Survey (2005) brought out the dramatic phenomenon of population ageing and feminization of ageing in Kerala. The survey results indicated that Kerala is a ‘grey state’ with more than 10 percent of its population being over 60 years. Luthra (1991) reported that the rate of growth of older women is even more pronounced in Kerala indicating a faster growth of women at older ages as compared to men.

The study undertaken by Centre for Development Studies (CDS) Trivandrum found that Kerala took 20 years to increase the share of its elderly population from 6 to 8 percent and the same increment is expected every 10 years in the immediate future (Rajan Irudaya, 2007).

According to Nayar (2000) the population of Kerala is ageing more rapidly than any other state in India. As per the 1991 census, around nine percent of the population in Kerala is 60 years or older. The elderly will form 20 percent of Kerala’s population by 2021 while all India figures would be about 14 percent. The author also pointed out that in another 10-15 years, Kerala will become an aged society, a status now enjoyed only by industrialized countries.

WHO(2002) reported that there is a virtual decline in mortality rates due to improvement in medical facilities, and as a result, the life expectancy throughout the world is projected to reach 73 years in 2020. Translating this to Kerala, which is the most advanced state in India, in terms of demographic transition with mortality
levels close to the developed nations for the last two decades, means that the rapidity of aging in India would be most pronounced in Kerala (Dilip, 2001).

2.2 Nutritional and Health Problems of Elderly

Ageing has many dimensions - physical, physiological, nutritional, social, psychological and economic with many components including family dynamics and relationships. The challenges come from several areas and are interrelated (Shearer, 2002).

Woo (2000) opined that majority of health problems among the aged are diet related and nutritionally dependent and that appropriate and adequate nutrition is essential for health and well being of the elderly. Several studies (Chernoff, 2001 and Fishman, 2000) have brought out the consequences of malnutrition in older persons. The sequence ranges from physical, mental and social disability. If inadequate dietary intake continues for a longer time, gross undernutrition results which leads to diminished muscle mass and vigour, functional impairment and disability. Malnutrition also causes further lack of enjoyment in eating and anorexia which may generate psychological, medical and social problems (Amarantos, 2001).

2.2.1 Nutritional problems

Several studies have documented the association of nutrition and the phenomenon of ageing. Johnson and Audrey (2003) substantiated the role of optimal nutrition in maintaining the health, overall physical and mental well being and reduction of costly health care resources for older persons.

According to Mahan and Stump (2000), older persons are more susceptible to undernutrition than younger persons, since there is an advancing loss of lean body mass in addition to alteration in most systems including sensory, gastrointestinal, metabolic, cardiovascular, renal, musculo skeletal, neurological and immuno competence.

Sibai (2003) reported that Good Nutrition improves Health Related Quality of Life (HRQOL) by ameliorating secondary malnutrition that is caused by or associated with other diseases. Deteriorated nutritional status as given by Crogan
and Pasvagel (2003) can influence the quality of life and psychosocial well being of elderly. According to Grieger and Nowson (2006) malnutrition results from an imbalance between energy and micronutrient input and output. This may be due to the impaired absorption of nutrients by the body and a decrease in appetite and food intake. Janssen (2005) stated that the negative energy balance results in body weight loss and micronutrient deficiencies among older people.

Many studies have brought forth figures relating to prevalence of malnutrition among elderly. The prevalence of malnutrition in elderly has been reported to be 30 to 50 percent (Corish and Kennedy, 2000). Studies of Burden et al., (2001) and Mackintosh and Hankey (2001) have reported much lower prevalence figures (15-17%) in slightly younger groups. Kostika (2002) highlighted the importance of constant monitoring of the nutritional status of older persons taking into account the high prevalence of malnutrition.

A study conducted by Greiger and Nowson (2006) in Australia among a group of institutional elderly revealed that 68 percent of subjects had low levels of at least one serum marker indicating that nearly three fourths may be at risk of malnutrition and nutrition related diseases.

Malnutrition is a major risk factor for morbidity and mortality among elderly in hospitals (20-60%) or nursing homes (85%). Prevalence of malnutrition in community dwelling elderly was found to be 10 to 51% by Mion et al., (1994). The factors associated with malnutrition were physical function, cognition, mood, alcohol use, socialization, living arrangements, finances and medications.

Undernutrition has been frequently reported among hospitalized elderly (Corish and Kennedy, 2000) also. Thorsdottir et al., (2005) reported 56.3 percent of hospitalized older persons to be malnourished with low BMI, serum albumin, pre-albumin and MUAC. Robinson (2001) in a study in UK reported that malnutrition is likely to be twice as common in over 80’s as in those elderly people less than 80 years of age.

Natarajan (1999) has also reported that the prevalence of underweight in elderly was high in a rural Indian community. Chandrasekhar and Bhooma (1999)
also substantiated that the health and nutritional status of rural Indian elderly was not satisfactory.

Reports by Natarajan (1999) on his clinical studies on 800 rural elderly in Tamil Nadu revealed high prevalence of nutritional disorders. Hypochromic microcytic anaemia (mild to severe) was observed in 47 percent of the elderly. Glossitis (11%), peripheral neuritis (5.1%), angular stomatitis (4.1%), cheilosis (3.9%) and xerophthalmia (1.75%) were detected. Osteoarthritis was observed among 21% of the subjects. Acid peptic diseases were found in 6% of the elderly. The study also revealed a high prevalence of nutritional disorders in the elderly population.

The NNMB (1997) surveys indicated that in India 29 percent of aged among 60-69 years and 38 percent among 70 plus years had Chronic energy Deficiency. The NNMB (1999) conducted a study on the diet and nutritional status of elderly in rural areas of seven states of South India and found that the proportion of elderly meeting 100 percent RDA of all nutrients were only 2.8 percent. The mean intake levels of energy and protein among the elderly were found to be lower than those reported for Chinese elderly as given by Stookey et al., (2000). Repeat surveys (NNMB, 2005-2006) showed that majority of health problems among the aged are diet related and nutrition dependent.

A study conducted at Meerut (Wahlqvist and Savige, 2001) to assess the average dietary intake as well as nutritional status of elderly revealed that the average dietary intake was much lower than the Recommended Dietary Allowances.

Arlappa et al., (2003) observed that 1/5th of Indian elderly were underweight, a finding similar to Bagchi (2001). Nutritionally related key health problems affecting older persons as reported by Wahlqvist and Savige (2000) are frailty, depression and chronic non communicable diseases. Campbell and Buchner (1997) defined frailty as a syndrome which results from a multi system reduction in reserve capacity to the extent that a number of physiological systems are past the threshold of symptomatic clinical failure. Nutritional reserve is certainly one of the key components of frailty (Winograd et al., 1991). Province et al., (1995) listed falls, incontinence and confusion as the clinical consequences of frailty. Urinary
continence and/or protein energy malnutrition which are two factors contributing often results in restriction of fluid intake (Bidlack and Wang, 1996).

Feldblum et al., (2007) compared malnourished elderly with those at nutritional risk and identified lower intake of fruits, vegetables and fluid, poor appetite and eating difficulties as the most sensitive and specific predictors of malnutrition. Frauenrath et al., (1999) has also reported that malnutrition among elderly was related to poor intake of high nutrient density foods. Food intake was shown to be largely independent of factors such as sex, age or life situation thus emphasizing the need for better nutrition education of the elderly.

Regarding the type of nutritional deficiencies observed among the elderly, the following studies have been noteworthy.

Ageing adults, according to Wahlqvist and Savige (2000) are at risk of nutritionally inadequate diets especially in relation to protein, vitamin D, B1, B6, B2, fluids and other compounds. Beck (1999) has documented marginal or inadequate energy intake and vitamin status in homebound, disabled or institutionalized elderly.

Many studies on nutritional deficiencies of the elderly focused on Calcium and Vitamin D stature. Smith et al., (2008) in Longitudinal Aging Study Amsterdam (LASA) study among 1311 community dwelling older men and women of the found that 82.4 percent had serum calcium levels below 30 mg/ml. Further, more than 8.5 percent had one or more osteoporotic fractures.

De Lappe et al., (2006) in the same context concluded that despite supplementation of the osteoporotic patients with 1g Calcium and 800 IU Vitamin D3, significant improvement in mean 25-hydroxy-vitamin D levels were achieved but optimum levels were not reached.

Sohyun and Mary (2006) reported prevalence of Vitamin B12 deficiency increases in elderly. The authors found that approximately 10 to 30 percent of older adults had malabsorption of protein bound Vitamin B12 and about 1to 2 percent lacked the intrinsic factor required for active uptake of vitamin B12 in the small intestine.
In a study conducted by Clarke et al., (2007) it was found that low vitamin B$_{12}$ status was associated with more rapid cognitive decline in older adults. The relevance of vitamin B$_{12}$ supplementation for prevention of dementia was also tested by randomized trials. Cobalamin deficiency in older people have been reported by Andres et al., (2007).

Koehler et al., (1997) found that elderly people with better folate and vitamin B$_{12}$ status have lower homocysteine concentrations and may have lower risk for vascular disease. Mulligan et al., (2007) also suggested that older adults may be at risk for inadequate folate intake if their energy intake is low and they do not take a supplement or are not consuming fortified cereals. However, older adults may be at risk for excess folic acid intake, if supplementation is not medically supervised.

Malik (2007) reported greatest prevalence of low vitamin D status in the institutionalized elderly and several risk factors noted included decreased sun exposure, poor oral intake and multiple co-morbidities. He suggested that long-term care residents should be prescribed higher doses of calcium and vitamin D for adequate bone mineral density and fracture prevention.

Another study by Toss et al., (1980) also found that the serum concentrations of 25-hydroxy vitamin D in a group of 47 elderly people living in homes for the aged were lower than those in a matched control group living in their homes. The low serum concentration of 25-hydroxy vitamin D may be due to less outdoor activities or a smaller dietary vitamin D intake in the institutionalized group.

Anaemia in older individuals is associated with a wide range of complications including increased risk of mortality, cognitive dysfunction, longer hospitalization, reduced bone density and falls and fractures. Anaemia also has a significant effect on the quality of life of the elderly and most cases in older individuals result from iron deficiency, chronic inflammation or kidney disease (Richard et al., 2006).

Beghe et al., (2004) reported a systematic review of literature on prevalence and outcomes of anemia in geriatrics and found that the prevalence rates ranged
from 2.9 percent to 61 percent in elderly men and 3.3 percent to 41 percent in elderly women. Incidence of anemia increased with age and prevalence of anemia was highest in the oldest subjects (> 85 years of age).

The elderly are reported to be vulnerable to anaemia because of poor eating habits and impaired iron absorption. (Looker et al, 1997). The effects of anaemia on elderly include impaired work performance and productivity (Johnson et al., 1994). Also iron status has strong association with ageing process which affects adversely the immune as well as neurological functions (Beard, 2001 and Chandra, 1998). Anaemia in older individuals is associated with a very wide range of complications, including increased risk for mortality, cognitive dysfunction, co-morbid conditions, reduced bone density and falls and fractures. Anaemia also has a significant effect on the quality of life of the elderly and most cases in older individuals result from iron deficiency, chronic inflammatory diseases or may be unexplained (Richard et al., 2006).

Large scale data on anaemia status of elderly population in India is not available. But nation wide studies on anaemia in other age groups have established that anaemia status is inversely associated with the level of educational status (NFHS, 1999) and was significantly higher in females (Bagchi, 2001).

2.2.2 Health problems

Central to the challenges faced by the growing elderly population are their health concerns. WHO (1999) defined health as a state of complete physical, mental and social well being. According to Sivaraju (2002) as age advances, due to deteriorating physiological conditions, body becomes more prone to illnesses which are multiple and chronic in nature. Quality of life of the aged is largely determined by their health. With declining health, individuals lose their independence, social roles, become isolated, experience economic hardship, change their perception and become stigmatized. Therefore the greatest challenge of the ageing population is related to maintenance of their health.

Wadhwa and Sharma (1999) indicated that the most common chronic health problems of aged in developed world included cardiovascular diseases, diabetes, cancer and hearing impairments. In India, blindness, respiratory diseases,
nutritional deficiencies such as anaemia, B complex deficiencies and osteoporosis are added. Dutta (2002) reported that 45 percent of the elderly suffer from chronic illness and 70 percent depend on others for their daily needs.

Surveys indicate that 45 to 55 percent of Indian elderly have chronic illnesses (Shah and Prabhakar, 1997). A nationwide survey conducted by NSSO (1991) also revealed that about 45% elderly suffered from chronic illness. According to Government of India Statistics one third of deaths among the elderly are attributable to cardiovascular disorders, 10 percent to respiratory disorders, another 10 percent to infections, 6 percent to neoplasm and 4 percent each account for nutritional, metabolic and gastrointestinal disorders (Brahmam, 2005).

It is reported that morbidity levels in Kerala are comparatively higher than anywhere in India (Dilip, 2007). This is partly due to the fact that the life expectancy of the state is higher than any other state and as a result more and more frail persons survive until old age and the aged population as such becomes frail and prone to illness. Health surveys in Kerala showed that the incidence of chronic and degenerative disease is increasing very rapidly. Diabetes, hypertension, cardiovascular diseases, coronary heart diseases and cancer incidence has been progressively increasing in Kerala. (Nayar, 2000)

As reported by Singh (2004), heart diseases and its risk factors such as hypertension, hypercholesterolemia, diabetes and central obesity are of sufficient magnitude in the elderly population of India and formed major public health problems. Friedwald (2002) also reported that cardiovascular diseases was a leading cause of death in elderly people.

According to Kumar (2005) the risk of developing coronary artery disease in the Indian population is higher than in other countries. Moreover coronary artery disease is a major cause of disability, limiting the activity and eroding the quality of life of millions of elderly people each year.

Community surveys in India (Das et al., 2005) have documented that between the past 3 to 6 decades prevalence of hypertension among urban elderly has increased by 30 times and by about 10 times among rural elderly. Age and sex specific prevalence of hypertension showed progressive rise of systolic and
diastolic hypertension in women compared to men. Contributory factors to this trend have been confirmed as changes in lifestyle pattern, diet and stress (Natarajan, 2005). Hanna and Wenger (2005) found that CAD was a leading cause of mortality with 84 percent elderly affected by it with variable inputs on morbidity, mortality and quality of life.

Epidemiological studies have demonstrated that in certain populations blood pressure did not rise with age but in industrialized population a high percentage of hypertension has been associated with increasing age (Reddy et al., 1991). Nabi et al., (2010) reported that symptoms of depression in a healthy elderly group put them at higher risk of coronary heart disease and total mortality.

Another health problem associated with increased incidence of CAD is Diabetes. Studies on NIDDM elderly are among the most important efforts in geriatric medicine (Elias, 2000). Studies reveal that the prevalence rate of diabetes is high in India and it increases with advancing age. (Ham and Soloaine, 1997).

In industrialized countries, about 75 percent of deaths of people over 65 years of age are from heart disease, cancer and cerebrovascular disease. Hyperlipidemia with atherosclerosis, hypertension and decreased blood circulation as a major source of morbidity and mortality in elderly has also been documented. (WHO, 2002).

WHO projections also indicate that for the foreseeable future low income countries will face the dual challenge of coping with both high morbidity and disability rates due to infectious diseases and high rates for emerging chronic diseases.

Literature demonstrates that Protein Energy undernutrition, a common problem in older persons, is rarely recognized (Mowe and Bohmer, 1991 and Miller et al, 1990) and has been associated with altered immune function (Kaiser and Morley, 1994), hip fractures (Barstow et al., 1983) cognitive dysfunction (Goodwin and Gary, 1983), anaemia (Lipschitz, 1990) and falls (Vellas et al., 1992).

WHO (2002) reported osteoporosis and associated bone fractures to be a major cause of disability that result in enormous medical expense the world over.
About 25 percent of Indian women over the age of 50 develop osteoporosis and among people aged 80 years and over, osteoporosis becomes the rule and not the exception (Prabhakaran, 2002). Fractures in old age seriously interfere with mobility and leads to a loss of muscle tone and muscle mass and thereafter the former level of physical activity may never be regained (Royal College of Physicians, 1991).

Bhooma and Chitra (2005) reported increased mortality and morbidity from vertebral, hip and other fractures, particularly in Indian elderly women. Rashmi and Lalitha (2005) have also reported similar findings. Edmund and Duthie (2001) and Cobbs and Duthie (2001) agree in the statement that prevalence of osteoarthritis increases steadily with age and it becomes almost universal at age 80.

Earlier studies in the USA (Dwyer, 1994) showed a decrease in mobility with age, with 3.5 percent of elderly of 65 to 69 years having restricted mobility rising to 26.1 percent of those aged over 70 years. Apart from this normal loss of muscle coordination, there is little clinical evidence that significant malnutrition occurs in any normal elderly person as a result of ageing process itself (Lovat, 1996).

Factors such as diet, physical activity and smoking are closely associated with osteoporosis. Lifestyle modifications particularly increased calcium intake and physical activity have an important impact on fracture rates (WHO, 2002). Vijayakumar (1998) enlisted joint pains, gastrointestinal abnormalities and fatigue as the major medical problems of Indian elderly.

Regarding gastrointestinal problems affecting the old, peptic ulcer and constipation are significant. According to Hall (2001) peptic ulcer is an important problem in older patients although the pathogenesis may differ from younger individuals. Twenty percent of deaths due to ulcers occur in patients over the age of 65, primarily due to bleeding. Decreased fibre and fluid intake, immobility and decreased exercise lead to the tendency of constipation among the old. The condition needs aggressive monitoring and management (Dodd, 1999; Anderson et al., 1999). Association of Protein Energy Malnutrition among elderly with the development of decubitus ulcers has been reported by Pinchcofsky et al., (1986).
Another health related concern that can substantially alter the quality of life and independence of older people are sensory changes. Compiling data from several studies initiated by the ICMR, Shah and Prabhakar (1997) reported visual impairments in 11 million older population in India, while 38 million had hearing impairments. Hearing loss can make the patient appear and feel cognitively impaired and its consequences include withdrawal, frustration, irritability, cognitive impairment, loneliness and physical immobility (Elias, 2000). Thus elderly suffer from multiple health problems apart from socio economic and behavioural problems which necessitate the need for giving special attention to their health care needs.

Health problems as a major risk factor affecting the nutritional status of elderly has been documented by many studies as reviewed further.

The sense of taste and smell decrease with age (Schiffman and Gatlin, 1993) resulting in a decreased appetite while dental problems decrease the ability to chew certain foods (Gary, 1992). Physiological changes such as visual loss or diminution of auditory sense or osteoarthritis that affects mobility may decrease an older person’s ability to purchase and prepare food.

Loss of appetite is especially serious in elderly who are already chronically ill and thus at high risk to develop protein energy malnutrition as well as micronutrient deficiencies. Taste and smell changes occur with advancing age and this can lead to poor appetite (De Jong et al., 1995), inappropriate food choices (Duffy et al., 1995) and/or lower nutrient intake (Griep et al., 1996). Laboratory studies of taste and smell perception in the elderly indicate that there are significant chemosensory losses with age (Schiffman, 1997; Stevens et al., 1995). Hyposmia and hypogeusia tend to become noticeable around 60 years of age and the losses tend to progress more rapidly after 70 years of age (Schiffman and Warwick, 1993).

Taste dysfunction in the elderly generally result from normal ageing, from certain disease states, medications, surgical interventions, malnutrition and environmental exposure. Over 250 drugs have been reported clinically to cause taste complaints in elderly (Schiffman, 1991). The degree of taste loss depends on the medical condition and pharmacological regimen of the individual (Cowart et al.,
For unmedicated healthy elderly threshold increases for common tastes are modest, while for elderly who take a modest number of medications greater losses in taste sensitivity at threshold levels are found (Schiffman and Wedral, 1996). Mistretta (1984) concluded that the process of continuous renewal of taste cells with a life span of 10-10 ½ days is compromised by cancer therapy in the elderly.

Losses in smell perception in the elderly result from normal ageing, certain disease states (Cains and Gent, 1991). Greip et al., (1996) and Doty et al., (1984) have demonstrated that odour perception is related to medical condition and medication use. Most research suggests that the sense of smell is even more impaired by ageing than the sense of taste.

When food is perceived as unpalatable, patients often reduce the diversity of foods consumed and fail to eat enough to meet nutritional requirements (Bernstein, 1981). Inadequate intake results in weight loss and malnutrition which impairs a patient’s response to therapies and increase mortality (Trant et al., 1982).

Several studies have documented effect of declining taste and odour perception to cause changes in food consumption and diminished food appreciation (Wysocki and Pelchat, 1993; Ferris and Duffy, 1989) and Friedman and Mattes (1991). Decreased taste sensitivity, loss of teeth and decreased digestion leading to reduced food intake which adversely affects the nutritional status of elderly has been documented by Mehta and Thakore (1995) also.

Poor oral health which includes caries, periodontal disease, defective dentures and poor oral or denture hygiene are quite common among older people (De Baat et al., 1993). It has been suggested that the proportion of people with an insufficient intake of nutrients to be higher among edentulous than dentate people (Steen, 1992). Impaired dental status can alter sensory aspects of eating as retronasally, volatile odours enter the nasal cavity during mastication and declining chewing ability among the elderly prevents the odours from being released from the food (Doty, 1990). There are contradictory studies which reported that there is no clear evidence to support the hypothesis that natural dentition is necessary for elderly to maintain satisfactory nutritional state (Horwath, 1989; Kaurich, 1991).
But population based studies suggest that edentulousness is correlated with lower nutrient intakes and multiple dietary inadequacies (Shay and Ship, 1995). Papas et al., (1989) show a 20 percent drop in nutritional quality of food consumption of those who had one or two full dentures as compared to those who had natural teeth. De Marchi et al., (2008) also found that patients who were dissatisfied with gingival health and partial denture wearers were more likely to be at risk of malnutrition. Griep et al., (1996) concluded that dental state per se may not be a direct cause of poor nutrition but a contributing factor in those elderly who have other risk factors. Significant separate effects of dental state were observed for animal protein, niacin and mono unsaturated fat intake. Kimura et al., (2009) also substantiates that elderly with chewing difficulty were more disabled, depressed and had lower quality of life scores.

Chernoff (1994) indicated a strong correlation between nutritional status and functional dependency in elderly. Dwyer (1994) found that eating ability, oral health and mobility to be important factors related to functional status of elderly. Bates et al., (1999) confirmed the association between dental health and nutritional status and revealed the absence of natural teeth to have a significant impact on the intake of a range of nutrients.

The inter relationships of many factors with nutritional status of elderly are complex. Burg and Gazibarich (1999) found that the commonly reported risk factors for poor nutrition among elderly were polypharmacy, eating alone, having an illness or a condition leading to changed eating habits.

Dwyer (1994) indicated that over four fifth of older adults have chronic diseases that are affected by diet, one fifth have confusion or memory loss and one eighth feel depressed much of the time thus significantly affecting appetite, digestion, body weight and the feeling of well being.

The incidence of malnutrition as per Hengsterman et al., (2008) have been related to demographic and medical factors, self perceived health and health related quality of life. Johansson et al., (2008) further analysed these factors and reported lower hand grip strength and lower self perceived health as two factors with highest power to predict malnutrition in elderly. Increased number of depressive symptoms and higher age were found to be second and third predictors. Malnutrition in elderly
is also associated with reduced grip strength, depression (Cederholm and Hellerstrom, 1993), high prevalence of infections and poor clinical outcome (Sullivan et al., 1991).

Other factors of health concern among the elderly as Lovat (1996) found were age related changes in gut physiology resulting gastric hypochlorhydria with small bowel bacterial over growth and gastrointestinal dysmotility caused by subclinical hypothyroidism which make older people highly sensitive to minor nutritional insults. However Neri et al., (1996) found no correlation between prevalence of Helicobacter pylori infection in elderly inpatients and their nutritional status.

Roe (1994) reported that single drug and drug combinations taken by elderly individuals impose nutritional risk including anorexia, decreased taste sensation, excessive increase in appetite, drug induced nutritional deficiencies and toxic reactions. Moral et al., (1996) recommended instructing the elderly and their care givers to avoid timing errors in drug intake and toxic reactions due to food incompatibility. In addition appropriate levels of nutrient intake would ensure avoidance of drug induced malnutrition.

Few studies have examined effect of ageing and exercise on immunosenescence in elderly people. Sakamoto et al., (2009) examined effect of low intensity exercise on Secretory Immuno globulin A concentration (SigA) levels and found a marked increase in SIg levels which influenced mucosal immune function response to exercise in elderly people over 75 years of age.

Shimizu et al., (2007) studied the effect of exercise, age and gender on salivary secretory Immunoglobulin A (SIgA) in elderly subjects and found that enhancement of mucosal immune function following regular to moderate exercise training occurs in elderly. Studies in healthy centenarians also suggested that an appropriate regular regimen of endurance exercise might help elderly to preserve their immune function (Venjatraman and Fernandes, 1997).

2.2.3 Psychosocial Problems

The Indian society has always considered the elderly indispensable for the community, assuring a well defined status and security for them (Shearer, 2002).
They were considered treasure troves of culture, knowledge and wisdom and their learning and experience were the only source of transferring occupational skills and cultural values. But the impact of several factors like industrialization, urbanization and education have eroded these traditional concepts and therefore the elderly to a great extent are not enjoying the authority and security as earlier (Singh, 2004; Mehta, 2001; Rao 1999 and Kumar et al.,1994).

Studies by Pushpam et al., (2004) have shown that the problems of elderly are compounded by the feeling of insecurity and dependence. They suffer from a feeling of dispossession and reflect loss of roles and status as they are deprived of their earlier identities. Attitude towards old age, degradation of status in the community, problems of isolation, loneliness and generation gap are the prominent thrust areas resulting in socio-psychological frustration among old persons.

Specifically the needs and problems of elderly vary according to their age, family background, health, economic status and living environment as they are by no means a homogenous group (Swaminathan, 1996). Pushpam et al., (2004) also opined that most of the problems of old people are feelings of insecurity, maladjustment, constant fear of ageing and death, loss of self esteem, conflict with younger generation, disappointment from family, dependency, frustration, depression and feeling of loneliness. Moli(2004) was also of the opinion that food, clothing, housing, emotional security, attention and recognition are the generally expressed primary needs of the elderly.

The Chronic Poverty Research Centre has identified the elderly as one of the groups likely to be vulnerable to chronic poverty (Rajan Irudaya, 2004). In a nationwide survey (NSSO, 1991) it was found that 34.2 percent of rural elderly were financially independent as against 28.94 percent of the their urban counterparts. Rajan Irudaya(1999) has also found that elderly having no substantial assets or a good source of income and who are economically dependent find the attitude and behaviour of their family members as unsatisfactory.

Other psychosocial problems of elderly included loss of prestige and status, alienation and loneliness, neglect and lack of attention and care, alcoholism and disengagement (Sumathi and Dalus, 1999). Further the plight of disabled aged,
widows and widowers, chronically sick and the homeless elderly call for immediate attention (Sudhir, 1998).

According to Ganguli et al., (2000) psychosocial problems cripple the elderly most. The high degree of financial uncertainty when not engaged in active work and the loss of prestige and authority lead to development of a negative self image. Social isolation and loneliness are also commonly experienced. These may all mount up to depression in many older people.

Pawaskar (2007) stated that impairments in daily activities and lower health related Quality of Life (HRQoL) were specific predictors of depressive symptomatology in elderly. Jongenelis et al., (2004) adds risk indicators for depression to be pain, functional limitations, visual impairments, loneliness, lack of social support, negative life events and perceived inadequacy of care. Johnson (2005) identified a wide range of factors have a negative influence on the health and nutrition of elderly including lack of family support, economic constraints, loneliness and feeling of unwantedness. He also suggested that at risk elderly had lower levels of social support, life satisfaction and higher levels of depression.

Reports by Solomons (1992) also indicated that fears associated with ageing resulted in emotional stress, loss of appetite and reduced food consumption. Consequently they recommend optimal physical treatment and special focus on psychosocial factors to be major goals in developing care programmes for the elderly.

Several nutritional factors have been associated with depression. One of the common causes of weight loss in elderly is depression. Wurtman and Wurtman (1998) have shown that carbohydrates influence brain serotonin levels and in individuals under stress a preference for sweet, simple carbohydrates have been demonstrated (Christensen, 1997). The most common cause of weight loss in the elderly was found to be depression also. Marcus and Berny (1998) reported that elevated levels of corticotrophin releasing hormone in the cerebrospinal fluid of depressive patients plays a role in the pathogenesis of anorexia in depression. There is also a growing body of evidence which links omega 3 fatty acids to aetiology of depression (Peet and Edwards, 1997). Variation in rates of depression found in
different countries also correlate with fish consumption. (Hibbeln and Salem, 1995).

Another important psychological problem which affects older people is dementia and associated problems. Two epidemiological studies of dementia conducted in older residents in Chennai and a rural block of southern India showed a prevalence of 27 per 1000 and 36 per 1000 respectively (Raj Kumar and Kumar, 1997). Tzeng and Eisendreth (2002) reported that 15 to 20% dementia may be caused by problems of vascular system such as stroke, hypertension and atherosclerosis. Vas and Robinson (2001) reported an overall prevalence of dementia as 18 per 1000 for those aged 65 years and above in an urban population in Mumbai.

Patients with dementia can have difficulty in interpreting sensory data relating to vision, taste, smell or touch. German et al., (2008) found that after controlling for age, cognitive status, functional ability and number of illnesses, undernutrition was significantly associated with depression. Park and Suh (2007) recommended focus on psychological well being of elderly as a higher depression score was found to be significantly related to a higher risk of becoming malnourished. Nutritional risk was found to be associated with diminished cognitive status and diminished self care ability, but not associated with living alone as reported by Pearson et al., (2001).

Many of the psychosocial problems have been identified to be risk factors for malnutrition among the elderly as evident from the following studies. The risk factors for poor nutritional status of older persons as summarized by Bermudez and Dwyer (1999) included socio economic status (low income, low education, single marital status or living alone), mental and physical functioning (physical disability, difficulty with activities of daily living, poor cognitive function and depression), health status (lack of access to health services, presence of chronic illness, dental/oral problems, over or under medication), health behaviours (sedentary lifestyle, alcohol consumption, drug use, smoking), lack of hygienic environment or potable water) and food access (limited food availability, food fads and taboos, lack of knowledge on food selection).
Leaf (1992) also enlisted a variety of physiologic, psychologic, economic and social changes accompanying ageing that compromises nutritional status. According to Tripp (1997) the nutritional risk factors affecting the elderly included inappropriate food intake, poverty, social isolation, multiple and chronic medication use, decreased functional status, changes in physiology, advanced age, morbidities, oral health problems, sensory impairment and cognitive or emotional impairment.

Cook et al., (2002) reported that the most common risk factors for poor nutrition among elderly were eating alone, not having enough money for food, having illness or conditions affecting eating, eating few meals per day and polypharmacy. Lack of care, poor economic status, social deprivation and inappropriate dietary intake will lead to multiple nutritional deficiencies in elderly (Venkateswarlu et al., 2003).

Since old people are isolated, are on a low income or disabled, socio economic factors and disease together are likely to have more influence on their nutritional status than age alone as indicated by Dawson and Hughes (1990). Health and social factors affecting food choices as reported by Wylie et al., (1999) pointed out inadequate money, food storage facilities, loneliness and bereavement to be linked to poor nutritional status. Natarajan et al., (1991) also found that a combination of lack of finance, poor knowledge about nutrition, environmental factors and hygiene, poor dentition, loneliness and physical disability to be the main factors responsible for multiple nutritional deficiencies in the elderly.

Mehta and Shringarpure (2000) also found a strong influence of financial status on nutritional status of elderly. Schuler et al., (2003) also opined that nutrient intake and socio economic characteristics significantly affect the nutritional status of the elderly. On similar lines Robinson (2001) reported that economic status of elderly greatly influenced their nutritional status.

Coleman and Krondal (1993) observed malnutrition among elderly people who were impoverished or have an isolated household. Poverty due to joblessness will be a hindrance to elderly for affording protective foods as reported by Solanki (1986). Prakash (1999) reported alteration of diet during ageing to be linked to retirement, economic factors, loneliness, change in taste and masticatory performance or a combination of these factors.
Stitt et al., (1995) specifically monitored the effect of income on nutritional status of elderly people. The study revealed that dietary intake of low income subjects showed substantial short falls from Recommended Dietary Allowances and it was not due to ignorance or mental decline. Weimer (1997) also found that low income elderly have a substantially greater risk of deficient calorie, calcium, magnesium and zinc intakes than do elderly as a whole.

Castel et al., (2006) evaluated gender differences in nutritional risk of older people and concluded that being a female increased risk of under nutrition by 3.3 fold. Nutritional risk for men was associated with higher depression score, longer hospitalization and poor appetite whereas for women lower functional status and higher morbidity levels were significant factors.

Ritchi indicated that low educational level was significantly associated with a low BMI (Ritchi et al., 1997). Murphy et al., (1990) assessed the impact of social factors and found that companionship was positively related to appetite and nutrient intake. Goyal and Goyal (1999) substantiated that social factors like widowhood may intervene to change the diet of elderly and lead to potential health problems.

Steele (1998) also found that the choice of social factors like when, where and with whom to eat were much limited for the elderly, thus negatively affecting their nutritional status. Guigoz (2006) reported a complete review of literature on preparing on prevalence of malnutrition on various population segment of elderly. The prevalence ranged from two percent in community dwelling elderly to 23% in hospitalized elderly. Institutionalized elderly had a prevalence of 21 per cent.

Studies on protein-calorie nutrition in institutionalized elderly produced markedly different results than those reported for community dwelling elderly subjects. Although total energy intake is not reported to be lower in institutionalized subjects, the proportion of subjects with clinically apparent undernutrition was much higher as reported by Sandman et al., (1987) and Pinchcofsky et al.,(1986).

Rudman et al., (1990) hypothesized that higher prevalence of malnutrition in institutionalized elderly resulted from an increased energy requirement secondary to multiple infection and other chronic illnesses in the institutionalized population.
A widely cited study published in 1986 by Baker et al., provides a major basis for the claim that micro nutrient requirements may be increased in institutionalized elderly persons. Chen and Fan Chiang (1986) assessed riboflavin and vitamin B₆ nutritive in a sample of institutionalized elderly and found evidence of riboflavin deficiency in 34 percent and B₆ deficiency in 56 percent of the population.

Data from developed countries show that the prevalence of undernutrition is not very high in free living elderly (5-8%) (Cederholm and Hellerstrom, 1992; Lowink, 1992) but in nursing homes, homebound elderly and hospitalized elderly, it reaches significant levels (Constans et al., 1993 and Volkert et al., 1992). Undernutrition in the elderly is associated with higher mortality and morbidity (Sullivan et al., 1991), delayed functional recovery (Davalos et al., 1996) impaired immuno-competance and wound healing (Closs, 1993), organ system dysfunction and more frequent hospitalizations (Sullivan, 2000).

In institutions, lack of supervision and assistance at meal times maybe an important factor resulting in poor food intake as found by Hoffman (1993). Hollis and Henry (2007) have reported that older people permanently residing in institutions are at an increased risk of developing under nutrition partly due to lack of dietary varieties.

2.3 Nutritional Assessment of Elderly

Nutritional assessment is a process of several evaluations which when combined defines an individual’s nutritional status (Charles, 1998). Nutritional assessment has several prognostic implications and nutritional variables are now considered a cardinal component of multidisciplinary assessment in acute care setting. Nutritional assessment can take two forms – a screen which identifies those at-risk individuals or a detailed assessment of risk degree and severity using a score system which when repeated at subsequent intervals can map the risk progression and even give an indication of the success of any intervention (Guigoz et al., 1994).

The principal reason for continued focus on nutritional status in the older adult is due to the widespread occurrence of under nutrition in this age group (Mowe and Bohmer, 1991). Therefore accurate assessment of the nutritional
status of elderly assumes importance. But due to the great individual diversity, the ageing segment of the population presents unique problems in the assessment of nutritional status (Shils and Young, 1988). So many factors have to be integrated to provide a comprehensive picture of the nutritional status of aged individuals that the process becomes complex and multidimensional.

Combinations of standard measurements of anthropometric, biochemical, clinical and dietary indices have been selected by most researchers to assess nutritional status of elderly.

2.3.1 Anthropometry

Anthropometry is the measure of body size, weight and proportion. Anthropometric characteristics of individuals and populations are simple and strong predictors of future ill health, functional impairment and mortality (WHO, 1995). Among elderly individuals who are not in ideal health, anthropometry has limitations both in the application of methods and in interpretation of results. WHO also recommended that clinicians recognize the limitations of using anthropometry in such individuals.

Anthropometric measurements in elderly will therefore be meaningful as long as body systems are in homeostasis, the measurer is trained in anthropometric techniques, equipment required is standardized and body sites used are also standardized (Charles, 1998).

The values obtained in the older adult will be affected by reduction in stature (as body height declines by 10-20 mm per decade after 55 years of age), changes in the amount and distribution of body fat and altered tissue elasticity and compressibility (Chilima and Ismail, 1998).

Little information regarding the use and suitability of anthropometry in older adults was available until Chumlea et al., (1994) standardized methodology, recommended equipment and established reference values, though several reference data are available from Celtic populations (Lehmann et al., 1991) and Europeans (De Groot et al., 1992). World Health Organization recommended collection of data to describe local levels and patterns rather than universal reference data (WHO, 1995).
2.3.1.1 Height

Height is important in nutritional assessment as it is expected to be constant and therefore a reference point against which other measurements are compared. However, height decreases with age.

Estimates of height loss range from 1.2 cm / 20 years to 4.2 cm / 20 years. Loss of height is due to the thinning of vertebrae (kyphosis) and osteoporosis as documented by several studies (Pieterse, 1999; Kwok and Whitelaw, 1991). Wahlqvist and Flint (1998) reported vertebral compressions in height and alterations in shape of vertebral discs with aging. Furthermore postural changes such as bowing of the legs and bent knees due to decreased muscle strength might also lead to inaccurate height measurements (Pieterse, 1999). WHO (1995) also reported that the Standard BMI cut off values may not be appropriate for use in individuals 70 years and over, because of age related changes in body composition and hence their relationship to final outcome.

A number of studies have demonstrated that other skeletal measurements might be employed as alternative to height when assessing the nutritional status in older age groups (Kwok and Whitelaw, 1991; Allen, 1989 and Bassey, 1986). The long bone measurement, armspan, has been shown to approximate to height at maturity and is relatively independent of ageing (Reeves et al., 1996), suggesting that it may offer an alternative to height in calculating BMI in older populations (Kwok and Whitelaw, 1991). However most of the studies that looked at the association between armspan and height have focused on specific ethnic groups. Large differences in the association between height and armspan in varying ethnicites have been noticed (Reeves et al., 1996).

Lucia et al., (2002) found that armspan and height of elderly subjects highly correlated in all ethnic groups studied and concluded that armspan can be used as a proxy for height to estimate BMI, if sex and ethnic group specific cut offs are applied. WHO (1995) has also confirmed that it is possible to estimate true height from armspan in elderly people who have conditions limiting their ability to stand straight (eg. Kyphosis) offering a simple and easy way of assessing nutritional status of older adults.
Body weight is clinically important as an independent predictor of increased mortality (Charles, 1998). Weight also declines with age, but the pattern of change is quite different from that of height and varies by sex. In affluent countries the average weight of both men and women increases through middle age. But, weight gain in men tend to plateau at around 65 years and weight generally declines hereafter; in women, however the weight increases are frequently greater and the plateau occurs about 10 years later than in men (WHO, 1995).

Body weight varies not only among individuals but also within a given individual during ageing. Reduction in body water content has been reported as an important cause of decline in weight after 65 years (Steen, 1992). Changes accompanying weight loss include a decline in muscle cell mass and cell mass in general, which is more pronounced in men (Micozzi and Harris, 1990). General muscle strength, gait and balance may also be impaired in the elderly, thus increasing the risk of falls and consequent injury (Vellas et al., 2000). Functional ability of older persons are generally found to correlate well with lean body mass and muscle mass (Frontera, 1999).

The importance of monitoring body weight of elderly especially in institutionalized settings has been stressed by Dwyer (1994) and Potter (1995). A four to five percent unintentional weight loss over a one year period is clinically significant as reported by Wallace (1995). The study found association of weight loss with loss of skeletal muscle, decreased bone mass, restricted reserves and decreased compensatory abilities.

Morley (1998) also suggested weight loss as one of the most sensitive indicators of individuals at risk for developing malnutrition. A weight loss of greater than 10 percent of the individual’s previous weight is highly suggestive of malnutrition. The issue of whether associations between weight and mortality change with age has been a subject of intense debate (Willett, 1997).

The effect of age on body weight associated with the lowest mortality and the effect of age on the mortality risk associated with obesity among older adults are complex issues. Many observational studies suggest that weight changes
(weight increase, weight loss and weight fluctuations) are predictors of mortality (Seidell and Visscher, 2000). Current evidence (Stevens et al., 2000) suggested that body mass index associated with the lowest mortality falls within the range of 18.5 to 24.9 in men and women between the ages of 30 to 74.

Lehmann et al., (1991) have described a range of desirable weights for the older adults. Medical screening is recommended for those individuals who are below the 10th centile of this data.

For those countries who have no local anthropometric data or that lack the resources to develop them, WHO expert consultation (2004) recommended the use of National Health and National Examination Survey (NHANES) – III data for comparison purpose. These data are pertinent if used exclusively as reference data for comparison purposes, that is, to compare means and standard deviations across populations. This provides a gold standard for comparison of body weights of older individuals.

In young and middle aged men and women, there is evidence that overweight is associated with excess morbidity and reduced life expectancy. However Campbell et al., (1997) and Mattila et al., (1986) postulated that being moderately overweight is not associated with any excess mortality risk whereas underweight is associated with increased mortality, increased risk of fractures, infections and specific nutrient deficiencies. Campbell and Buchner (1997) reported that anthropometric indicators of low body weight, low body fat stores and low muscle bulk were associated with an increased risk of death. Mattila (1986) found a progressive increase in the five year survival rate of the elderly over 85 years, as the BMI increased.

2.3.1.3 Body Mass Index

WHO (1995) reports indicated that the average Body Mass Index tends to increase in middle age and stabilizes somewhat earlier in men than in women. In men the plateau begins at 50 to 60 years whereas in women it starts 70 years or later. Both sexes generally show decrease in average BMI after 70-75 years of age (Waaler, 1988).
Data from NHANES I and II have shown that BMI is more highly correlated with subcutaneous fat in younger than in older men and women and with muscle mass in older than in younger adults (Micozzi and Harris, 1990). However age related changes in vertebral morphology influences mobility, balance and posture of older subjects. Body height and weight changes with age have also been documented (Willett, 1997).

These age related changes may make use of the standard classification system for BMI less reliable (Webb and Copemann, 1996). Also, the basic assumption of using the BMI values to grade nutritional status is that increasing weight at any given height reflects increasing amounts of stored fat. In elderly people, especially elderly women, loss of bone and lean tissue may mean that the amount of body fat is much higher than the BMI would suggest (Chilima and Ismail, 1998).

Expert consultations on nutritional assessment of elderly people (COMA, 1992 and WHO, 1995) recommended that there should be more research aimed at clarifying the prognostic significance of BMI in the elderly. The relationship between mortality and BMI was u-shaped with a tendency for mortality to rise at the extremes of BMI (Rissanen, 1991).

The reference values for Body Mass Index specially for elderly are ill defined. Bailey and Ferro-Luzzi (1995) suggested values of less than 19 as underweight, 19 to 21 as normal, 21-23 as overweight and more than 23 as obese levels for elderly. Nutrition Screening Initiative (NSI) USA has adopted BMI cut offs of less than 22 as undernourished, 22 to 27 as normal and >27 as overweight for the elderly. The BMI cut offs suggested by the WHO (1995) are <18.49 undernourished, 18.5 to 24.99 as normal and >25 overweight. Coelho et al., (2006) compared the cut off values suggested by NSI (1992) and WHO (1995) and concluded that NSI cut offs relate specifically to older individuals, whereas WHO data is not specific for elderly individuals and were derived from extrapolation of data obtained from younger individuals.

As given by WHO (1995) conventional BMI cut offs for defining CED may not be appropriate for older people 70 years and over because of age related changes in body composition but fail to propose alternative. However all the
classical studies on nutritional status assessment of older persons the world over have included BMI as a parameter and the data have been mostly presented as means, SDs and percentiles and compared to NHANES III data as proposed by the WHO (1995).

2.3.1.4 Mid Upper Arm Circumference

MUAC has emerged in the literature as a potential screening tool for poor nutritional status. James et al., (1994) analyzed its usefulness in adults and calculated cut offs equivalent to Body Mass Index (BMI) and chronic energy deficiency (CED) using a range of data sets from developing countries. Ismail (1999) reported that with good training highly reliable MUAC values could be achieved. A MUAC cut off value of 21.7 in which had a sensitivity of nearly 86 percent in relation to a BMI cut off of 16 kg/m² was also suggested by Ismail (1999) as an alternative to BMI as part of a screening in an emergency.

Mid Upper Arm Circumference is particularly useful in bed ridden elderly patients. Webb and Copemann (1996) suggested a cut off value of less than 22 cm to indicate increased risk of malnutrition in elderly.

Deurenberg and Roubenoff (2002) described equations using mid upper arm circumference in combination with triceps skinfold thickness to obtain information on muscle mass and fat mass of the upper arm. Average value from NHANES for Mid Arm Muscle Circumference (MAMC) have been compiled by Frisancho (1981) and Bishop (1981). These values do not show significant decreases between the ages of 30 and 70 years and are not consistent with the knowledge that decrease in lean body mass occurs with age. Therefore the WHO (1995) recommended using the 5th percentile values of NHANES data as reference values, in the absence of age, race and sex specific normative data reflective of each age decade through the age of 90 years.

Collins et al., (2000) reported that the use of MUAC may be affected by the redistribution of subcutaneous fat towards central areas of the body during ageing. But still MUAC as an indicator of muscle development would identify acute adult malnutrition and estimate prevalence of undernutrition at a population level.
2.3.1.5 Calf Circumference

Calf circumference is considered to provide the most sensitive measure of muscle mass in the elderly and is superior to arm circumference. It indicates the changes in fat free mass that occur with ageing and with decreased activity (Conceino, 1993).

WHO (1995) reported that changes in fat free mass occur with ageing and decreased activity. On retirement men in developed countries tend to spend an increasing amount of time in sedentary activities which explains age-related loss in fat free mass. A significant negative correlation between age and calf circumference is noted in elderly men but not in women and may be due to general loss of muscle in response to the reported greater reduction in physical activity among men than women. Calf circumference is considered the most sensitive measure of muscle mass in the elderly. Bonnefoy et al., (2002) also reported that calf circumference is a pertinent marker of nutritional state in the elderly.

Cuervo et al., (2009) assessed the utility of calf circumference as an indicator of the risk of malnutrition in elderly. The study concluded that an association between calf circumference and the risk of undernutrition was highly significant and the association was similar among men and women in all age ranges.

2.3.1.6 Body fat measurements

Triceps skinfold measurements provide an estimate of fat stores as measured by a skinfold caliper. The deltid triceps is reported by many (Russell et al., 1998) Kwok et al., (1997) as an ideal site for skinfold measurements in elderly since this area is usually absent of oedema. The skinfold measurements appear most appropriate as an anthropometric measurement for the elderly because they are less affected by state of hydration than is weight and are relatively independent of height (Bowman and Rosenberg, 1984).

Garcia et al., (2005) developed improved predictive regression equations by combining skinfold thicknesses with circumferences and / or bone breadth measures to provide a more precise prediction of percent body fat in comparison with established skinfold equations. Triceps skinfold measurements are variable from
study to study and few measurements have been reported on which a standard may be based.

Results from Ten State Nutrition Survey (TSNS) suggest that the TSF is relatively independent of age in men but affected by age in women. This trend was also observed by Bishop et al., (1981) when examining triceps skinfold measurements from cross sectional data collected by NHANES I. Norms for triceps skinfold as recommended by WHO (1995) need to be derived from NHANES – III data for developing countries.

The use of bioelectrical impedance to calculate the body composition in elderly is difficult since most equations have been found to be inadequate, especially in malnourished elderly (Norman et al., 2007). Bauer et al., (2007) opined that due to unsolved methodical problems, bioelectrical impedance analysis can currently be recommended only to those who are experienced with this method and its limitations.

2.3.2 Biochemical assessment

A diet may appear to be adequate when assessed according to the present dietary standards, yet a change in metabolism and decreased absorption of nutrient may lead to biochemical deficiencies. WHO (2002) has indicated that it is unusual that food intake will explain even 50 percent of variance in blood, urine or tissue levels of that nutrient. WHO reports indicate that biomarkers are more likely to indicate various genetic and lifestyle factors. Interpretation of biochemical results is limited for the same reasons found when interpreting dietary and anthropometric parameters.

Not only might the ageing process itself affect the metabolism of nutrients, resulting in altered biochemical values as well as an altered ability to utilize nutrients, but standards and results that are used for interpretation of biochemical values vary from study to study (Shils et al., 2005).

2.3.2.1 Serum protein markers

Reports on serum protein values in the elderly adult population are conflicting. The TSNS reported that the prevalence of low values of serum protein
appeared to increase with age. Reduced organ function associated with ageing may result in low serum protein among the elderly (Cereda et al., 2009).

In a classical study on serum albumin values in elderly, serum albumin values were approximately 0.4 g/dl lower in people over the age of 80, as compared with people over the age of 40. In this study, it appeared that the lower albumin level could not be pushed higher with dietary protein, indicating that a lower set point for albumin synthesis may occur with the ageing process reported. Lack of normative values for serum albumin or pre-albumin that may be applied specifically to the elderly population and recommended using a cut-off point below 20 percent the lower limit as an indication of malnutrition. (Kuzuya et al., 2007)

A study conducted by Sergi et al., (2006) found that albumin, pre-albumin and Retinol binding protein were significantly lower in underweight elderly subjects and suggested that these indices were useful in detecting malnutrition in the elderly. Miyazaki et al., (2002) focused on Serum albumin is a marker of long term protein intake and concentrations less than 35g/l was found to be a risk factor for protein-energy malnutrition. Banks et al., (2001) has also documented a decrease of some negative acute phase proteins like transferrin, albumin and Retinol Binding Protein in malnourished elderly.

Omran and Morley (2000) detected significantly reduced pre-albumin and Retinol Binding Protein in underweight elderly. A correlation between hypoalbuminemia and mortality in general elderly population (Corti et al., 1999) and in hospitalized older patients (Sullivan, 2000) has also been reported.

Wallace (1995) have documented adult Kwashiorkor in elderly patients with inadequate protein and calorie intakes. According to him decreased serum albumin with a longer half life is a poor marker of malnutrition. The cut off values suggested were 2.8 – 3.4 mg/dl indicating mild deficiency. 2.1 – 2.8 mg/dl n moderate deficiency and < 2.1 mg/dl indicating severe deficiency. Bauer et al., (2007) also reported that diagnosis of serum albumin is of minor importance due to its low specificity.

Decreased serum pre albumin or transthyretin which is more sensitive than albumin due to shorter half life is suggested by Wallace (1995). Other indicators
suggested to screen for elderly malnutrition are Retinol Binding Protein, fibronectin, serum transferrin and serum TIBC. But inflammatory conditions elevate these parameters and poor sensitivity is seen in such conditions.

Bouillianne et al., (2007) determined the biological parameters best related to anthropometric markers of malnutrition in elderly. Nutritional status (BMI, skinfold thickness, albumin, transthyretin) and biological parameters (leptin, IGF – I, C-reactive protein (CRP) were assessed. They concluded that leptin concentration is highly correlated with anthropometric data whereas albumin or transthyretin are also known to be influenced by morbidity and inflammatory conditions.

Lemonnier et al., (1991) had also reported that there was discrepancy between anthropometry and biochemistry in the assessment of nutritional status of the elderly. Usual blood parameters and biochemical markers of protein and energy status (viz. albumin, transthyretin, transferring, somatomedin C as well as serum levels of apolipoproteins) were not affected in the depleted group. However moderate iron deficiency and marked zinc deficiency were found in malnourished elderly. Sergi et al., (2006) investigated the reliability of visceral proteins (albumin, prealbumin, retinol binding protein and transferring) in evaluating nutritional status and their relationship with Fat Free Mass. They concluded that visceral proteins except transferrin were useful in detecting malnutrition and suggested careful evaluation of normal values also.

Berner (2003) also substantiated that nutritional assessment using objective biochemical markers was complicated in elderly due to metabolic changes which affect routine biochemical tests and the reference values for anthropometry being not age adjusted.

2.3.2.2 Hematologic Indices

Evidence indicate both a reduction in hematopoiesis and increased incidence of anaemia in the aged (Ramel et al., 2008). WHO (2002) recommended haemoglobin estimation and blood film indices as invaluable and cost effective in an assessment of elderly population. However whether the lower hematologic values reflect effect of the ageing process remains controversial and interpretation of hematologic findings remain complex (Cunietti et al., 2004).
Yearick et al., (1990) reported low levels of folate among elderly subjects but these findings did not appear to correlate with any hematologic parameters. Low serum folate in elderly have also been reported by Mulligan et al., (2007). However correlation between low folate values and low haemoglobin were not found.

Among nursing home residents low mean haemoglobin and hematocrit values were observed in patients with adequate mean folic acid, plasma iron and transferrin saturation. Both TSNS and NHANES reported a high prevalence of low haemoglobin and hematocrit levels among the elderly subjects. Both surveys also revealed low serum iron and serum transferrin levels in the elderly.

However the above studies excluded iron deficiency as its cause and confirmed the effect of age and sex on biochemical measures. Johnson et al., (1994) have indicated normative changes in iron status indicators with age.

2.3.2.3 Other Biochemical Markers

WHO (2002) recommended the use of Total Lymphocyte Count (TLC) as an index of immune function, since no known decreases in lymphocyte counts occur with age. However cell function does decrease with age. Though a low values, when considered TLC is associated with decreased serum albumin values, when considered alone, TLC is a poor prognostic indicator, reflecting changes in immunological function secondary to PEM. WHO (2002) also indicated the use of antibody level testing following vaccination also to be a useful immune indicator.

Biochemical and other indicators of nutritional deficiency have been found to be associated with reduced responses in immune function tests in disease free, elderly people. Nutritional supplementation has been associated with improvements in both the measures of nutritional status and the measures of immunocompetance (Chandra, 1998).

Woo et al., (1994) reported that various measures of well being and measures of nutritional status were higher in supplemented group of elderly than in the controls. Trauma whether surgical or accidental also has an immuno suppressive effect.
WHO (2002) recommended low technology dry chemistry techniques to assess metabolic disorders like glycaemic disorders and lipid disorders as realistic options. The shift towards chronic non communicable diseases in disease patterns among older persons make estimations of the same highly valuable.

Studies conducted at NIN (2001) on Indians to compare the activity of a key antioxidant enzyme, glutathione peroxidase between young and old subjects. The study showed that there was a significant decrease in the activity of this enzyme in subjects above 60 years as compared to normal controls of 40 years and below.

### 2.3.3 Clinical assessment

Clinical assessment of nutritional status attempts to identify the initial nutritional state as well as the interplay of factors influencing the progression of nutritional abnormalities (Jeejeebhoy and Keith, 2005).

WHO (2002) identified two caveats which need to be recognized in interpreting clinical studies namely non specificity of the earliest clinical signs of malnutrition and the fact that single nutrient deficits rarely occur alone.

Also, the use of clinical signs to diagnose malnutrition may be less applicable in the elderly than in younger age groups since many changes that accompany the aging process closely resemble specific signs of malnutrition (Russell et al., 1998). Therefore clinical data should be corroborated with dietary, anthropometric or biochemical data in order to make a definite judgement as to nutritional inadequacy (Baker et al., 1986). Bauer et al., (2007) specified general muscular atrophy, loss of subcutaneous fat and signs of nutrient deficiencies to be of value in clinical assessment of elderly.

In the NHANES survey, (Lowenstein, 1990) clinical signs of niacin deficiency were seen in 15 percent of elderly. However the symptom was more prevalent among upper income groups. Similarly bleeding gums were found to have no correlation with vitamin C dietary intakes. The clinical signs suggesting malnutrition present in more than 5 percent of elderly were atrophy and fissuring of tongue, absence of knee and ankle jerks, bowing of legs, follicular hyperkeratosis and bleeding gums. However evidence was lacking that these signs actually represented malnutrition of specific nutrients.
Other factors that may result in poor clinical outcome among the elderly are depression or loneliness, chronic illness, medication usage, chronic obstructive pulmonary disease or cancer, use of diuretics, changes in gastro intestinal and liver functions, decline in taste and smell acuity, ill fitting dentures, difficulty in swallowing and neurologic disabilities. (Payette et al., 2000). Since most of the malnutrition cases in developed countries are subclinical only, using functional tests along with the clinical assessment may reveal such instances.

According to Prabhavathy and Tamilarasi (2006) many of the nutritional deficiency symptoms that occurred in older persons were either a result of reduced appetite and intake, impaired absorption or excessive utilization. Kehli et al., (1998) on nutritional assessment of the North Indian elderly found that there is a higher incidence of chronic diseases with advancing age and nutritional deficiencies play an important role in the occurrence and susceptibility to these symptoms. A nationwide survey conducted by NSSO (1991 and 2004) also revealed that about 45 percent of the Indian elderly presented one or more of poor clinical outcomes.

**2.3.4 Dietary assessment**

Methods used for carrying out diet surveys are varied. Weighment of food items before consumption (prospective) and oral questionnaire to recall the food items consumed already (retrospective) are the well utilized methods of such surveys.

Very few studies are available in India about the agreement between these diet survey methods. Pasricha (1959) stated that the oral questionnaire method was just as reliable as the three day weighment method and recommended the oral questionnaire method as the more suitable of the two methods for the computation of dietary intake of individuals in the clinic and field.

Swaminathan (1999) also found that the interview questionnaire method was as good as the commonly used weighment method for estimating dietary pattern and nutrient intake level of communities belonging to low socio economic group and there was a good agreement between the two methods to assess the intake of minerals, vitamin A and proximate principles.
Szostak (1994) opined that a combination of different methods provides more reliable information than the use of a single method, but cautioned against such usage unless standardization of such methods are done by international organizations to be used in nutritional epidemiological studies.

Paired t – test results for both the 24 hour recall and seven day record provide about equally accurate estimates of the mean intake and that regression validity suggested that the recall is prone to over reporting and under reporting Gerovitz et al., (1978).

Borreli et al., (1989) observed that the agreement accuracy among three dietary assessment methods namely diet history, 24 hour recall and 3 day record was poor. While Posner et al., (1992) found that the estimate of group mean intake for 24 hour recall and 3 day record were with difference of less than 10 percent for most of the nutrients.

Crawford et al., (1994) concluded that errors in food reporting and quantification can vary with the type of dietary methodology and that agreement between observed and reported intake from 3 day food records made it the best overall choice.

Diet surveys by weighment and 24 hour recall methods were compared by a case study in Hyderabad, India by Rahman and Visweswara Rao (2000). Results indicated that in general there is under estimation of dietary intake in 24 hour recall compared to actual weighment of food items. But it was concluded that most of the food items and nutrients show an agreement between the two methods of diet survey with a few exceptions among the overall population and different income groups.

2.3.4.1 Computing dietary requirements of elderly.

Several surveys have been conducted to assess the nutritional needs of elderly, but only limited information can be inferred from these studies.

Confounding factors such as socio economic status of survey participants, rural and urban differences, life setting and sample size, limit the ability to compare and compile the results from several studies. Also individual differences in levels of
physical activity, presence of a range of degenerative diseases and effect of drugs on nutrient utilization may affect the dietary needs of the elderly.

Therefore nutritional recommendations for the elderly have been derived mainly by extrapolation of data from younger adults. However recent studies (Boston Nutritional Status Survey (BNSS); New Mexico Ageing Process Study (NMAPS) and Euronut-Seneca Cross Sectional Survey) as reported by Hartz et al., (1992), Gary et al., (1992) and De Groot et al., (1991) have shed more light on the specific needs of the elderly in the West.

\[ a) \text{ Energy} \]

However the nutrient requirements for elderly in India have not been specifically worked out. Assumptions based on energy expenditure suggest that calorie intake may be decreased when compared to young adults.

The requirement of other nutrients for the elderly are recommended based on whether or not the nutrient is a function of energy intake. The reduction in energy requirements on ageing is attributed to the decrease in Basal Metabolic Rate (BMR) due to reduction in muscle mass tissues and physical activity. The ICMR (1989) recommends a 25% reduction in calories for the elderly than the RDA of a sedentary adult. The calorie requirement suggested for Indian elderly men is 1800 kcal and that for elderly women is 1400 kcal. Further it is recommended that the calorie intake should be adjusted to maintain constant body weight.

Hagopian (2009) reported that energy restriction retards ageing process in humans and prolongs life, due to decreased production of free radicals reducing oxidative stress and resultant improvement in functioning of organ systems. But Russel and Suter (1993) estimated that when energy intake is lower than 1200 Kcal/day it becomes difficult to meet the requirements of vitamins and minerals. Also COMA report (1992) pointed out the increased energy requirements of some older people who have long standing chronic illnesses or are suffering from dementia.

Nevertheless, Roberts and Young (1993) have shown an underestimation of the amount of energy expenditure required for routine physical activities associated with daily living. They have calculated a ratio of 1.75 between Total energy
expenditure and Resting energy expenditure. Saltzman and Roberts (1996) demonstrated impaired capacity possibly associated with increased body fat, for energy expenditure to adapt to short term changes in energy intake.

Pending final resolution of these issues the WHO (2002) suggested that the energy requirements of old age appear to be 1.4 to 1.8 times multiples of BMR to maintain body weight at different levels of physical activity. Levels of physical activity that result in energy requirements in the higher end of the range are desirable for reducing mortality and morbidity.

\[ b)\text{ Calcium} \]

Several large scale intervention studies have been completed in an attempt to arrive at calcium requirement for older persons based on the effect of calcium intakes on bone mineral loss (Prince, 1991 and Polley, 1987).

Dawson and Hughes (1990) suggested in the presence of adequate vitamin D nutrition, calcium intakes in the range of 800 to 1200 mg/day has a beneficial effect on bone mineral density of the femur, neck and lumbar spine and a reduction in fracture rates.

WHO (2002) reports indicate that high calcium intakes have the potential benefit of reduced blood pressure and decreased risk of colon cancer though data are insufficient to know for certain. Based on turnover studies by ICMR (1989), Pasricha and Thimmayamma (2000) recommended 880 mg and 865 mg calcium intake for elderly men and women respectively.

\[ c)\text{ Protein} \]

The results of various studies on protein balance are difficult to compare since different nitrogen balance formulas were used and different assumptions applied. Campbell and Evans (1985) assessed nitrogen balance data from four studies on older persons and determined that the overall protein requirement for older persons is $0.91 \pm 0.04\text{g/kg per day}$. This is higher than the $0.75\text{ g protein/kg per day}$ recommended by FAO (1996).
Castenada (1995) in a study assessing long term adaptation to marginal protein intakes in 12 older women (66 to 79 years). All women on lower protein intakes (0.45 g/kg/day) were in negative nitrogen balance and when nitrogen equilibrium was established, there was a decline decline in body cell mass by 8 percent. In contrast, women eating higher protein (0.92 g/kg/day) showed increased muscle mass and IGF-I levels, suggesting that this level of protein intake was more than adequate.

Campbell and Evans (1985) via regression analysis from both low and high protein diets estimated a mean protein requirement of 0.78 g/protein/kg. WHO (2002) suggested an average of 0.9-1.1 g/kg per day as beneficial for older persons. ICMR(1989) has also adopted the above recommendations and suggested 60 gm and 50 gm protein per day as the RDA for Indian elderly men and women.

d) Fats

FAO/WHO joint expert consultation on fats and oils in Human Nutrition (1994) suggested that except where overweight and obesity are problems there is no further health benefit from restricting fat calories in older persons beyond 30% for sedentary and 35 percent for active older persons.

Robinson and Lawler (1992) has also documented that fat restriction to 30 to 35 percent of calories with preference given to sources of fat high in PUFA is beneficial in old age. ICMR (1989) has also suggested the RDA of fat to be 50 gm and 40 gm respectively for Indian elderly men and women. The fat recommended is to contain at least 20 percent PUFA.

e) Folate

Macrocytic anaemia and serum folate values were used as markers of folate levels in elderly for a long time (Jagargarstad, 1979 and Rosenberg ,1992). More recently, as reported by Selhub (1993) homocysteine levels have come to widespread use as a folate marker. The Boston Nutritional Status Survey (Rosenberg and Miller, 1992) identified 15% of older persons having deficient folate levels (<5µg/ml). There is also interest in the role of homocysteine as an
atherogenic agent (Framingham heart study, 1993). The RDA for folate for Indian elderly has not been specified by the ICMR (1989).

f) **Riboflavin**

Boisvert and Russel (1993) studied riboflavin depleted older persons and gradually repleted them with increasing amounts of dietary riboflavin. The slope of urinary riboflavin excretion rose sharply when intake was 1.1mg/dl which was identical in younger adults. This contradicts earlier assumptions that riboflavin requirements diminish in older people.

g) **Vitamin B₁₂**

The absorption of protein bound vitamin B₁₂ is poor in older people. However Carmel (1988) reported that absorption of crystalline vitamin B₁₂ proceeds normally in the elderly. Many of the patients with malabsorption of protein bound vitamin B₁₂ had atrophic gastritis, a prevalent condition affecting 10 to 30% of those over 60 (Hurwitz, 1997 and Krasinki, 1986).

The mechanism of protein bound vitamin B₁₂ absorption in atrophic gastritis involves both maldigestion of the food protein - vitamin B₁₂ complex in the stomach and uptake of any free vitamin B₁₂ by the large number of bacteria that proliferates in the lower part of the stomach (Suter, 1991).

However there is no evidence that once absorbed vitamin B₁₂ is metabolized differently in older persons than in younger people.

h) **Iron**

WHO (2002) indicated that iron absorption is not affected by ageing. Serum ferritin levels in older persons are difficult to interpret since inflammation can elevate serum ferritin (Yip and Dallman, 1988). Since iron is a pro-oxidant, WHO(2002) recommended additional research on whether there is progressive body iron accumulation with ageing and on possible linkages between iron status and chronic disease. On the assumption that there are no excessive iron losses, WHO (2002) has recommended 10 mg/day for older men and women. But the ICMR (1989) taking into account factors like poor quality of average Indian diet which contains non-haem iron mostly and the use of substances that lower iron
absorption like phytates, tannins, antacids, EDTA and calcium and phosphate salts, (Lowenstein, 1990) recommended the RDA of iron for Indian elderly man and woman to be 42 mg and 38 mg per day respectively (Pasricha and Thimmanyamma, 2000).

i) Vitamin C

Many studies have reported age related declines in serum ascorbic acid concentrations however, the pharmokinetics of a 500 mg oral dose of vitamin C is no different between older and younger men (Blanchard, 1990). High vitamin C blood levels and / or intakes have been associated with a lower prevalence of senile cataract, higher HDL - cholesterol concentrations and lower incidence of coronary artery disease (Jialal et al., 1990 and Nyyssonen et al., 1997). WHO (2002) reports indicated that an intake level of 60 to 100 mg / day to be adequate in older people. However, ICMR (1989) recommendations for Indian elderly are fixed at 40 mg / day.

2.3.5 Non invasive assessment methods

Use of valid and reliable tool to assess nutritional status has been absent in most of the geriatric assessment programme. Simple and rapid screening tests are however in use in comprehensive geriatric assessment of cognitive problems (Chumlea, 1996). Rubenstein (1997) reported that the use of well-validated instruments makes geriatric assessment more reliable and easier. The rapid assessment tool, the MNA(Mini Nutritional Assessment) was validated in two populations of elderly (Toulouse 91 and Toulouse 93). The results showed that MNA test can accurately assess the nutritional status of elderly as normal, borderline (at risk) or undernourished. Both normal and malnutrition classification were the same as those obtained using the nutritional clinical assessment by a physician, with comprehensive clinical files.

While the normal or well nourished group showed normal value for haemoglobin or albumin, the assessment of malnourished subjects corresponded to low serum albumin (Ferguson et al., 1993). Malnutrition in the elderly has been associated with greater susceptibility to infection, longer stay at hospital and higher morality (Tjani, 2000).
The Mini Nutritional Assessment (MNA), which is composed of simple measurements and brief questions that can be completed in about 10 minutes was designed and validated to provide a rapid assessment of the nutritional status of frail elderly people in order to facilitate nutrition intervention (Guigoz and Vellas, 2002).

The MNA has been validated on elderly population (>600 people) ranging in age from 65 to 90 years and above, from the very frail to the very active, in three successive studies (i) a study set on 155 elderly subjects from very healthy to severely malnourished elderly patients of Toulouse. (ii) Discriminatory potential of the MNA on 120 elderly subjects from the frail to the healthy elderly of Toulouse. (iii) A complementary validation study in a different cultural context on non-institutionalized elderly people from New Mexico Aging Process study (Guigoz and Vellas, 1995).

The specificity of the MNA was performed by cross-classification of the two populations (Toulouse 1993 and Toulouse 1991) using equations from the discriminant analysis. These results showed that for these two studies, the MNA without biochemical indices could definitely classify 70 to 75 percent of elderly people as normal or undernourished.

A study conducted by Chumlea (1996) at National Institute of Health on over 24 men and 37 women on the validation of MNA found that the MNA is an acceptable screening method for classifying the nutritional status of elderly subjects.

A study conducted to investigate the relationship between osteoporosis and nutritional status as determined by MNA by Salminen et al., (2006), in an elderly female population, showed that MNA scores indicating risk of malnutrition were more associated with coexisting diseases and medications than with the women's risk of having osteoporosis. Another study revealed that there is an association between BMD as assessed by DEXA and nutritional status indicated by the MNA questionnaire (Gerber, 2003).
A study conducted at two private nursing homes in Spain to assess the nutritional status (Lopez et al., 2003), revealed that MNA test could identify the older people with the risk of malnutrition.

The researchers of Japan, evaluated the MNA test as a screening tool for malnutrition in the Japanese elderly population (Akner and Cederholm, 2001) from which it was concluded that MNA was a useful screening tool for identifying Japanese elderly with malnutrition or at risk of malnutrition.

Another study conducted in Finland among 270 house care elderly patients by Soini et al., (2004), to assess their nutritional status using MNA suggested that MNA is a useful tool in identifying malnutrition. Horn (2005) also reported that MNA provides an advantage over using visceral proteins in screening and assessing nutritional status of elderly with pressure ulcers.

The aim of determining validity is to assess how precise the screening tools are in identifying malnutrition among patients. The precision of a screening tool is compromised by the large-scale implementation and use by staffs, who have got only minimal training in nutrition (Burden et al., 2001).

Assessing the validity of a tool is hampered by the lack of one golden standard to determine nutritional status. Markers used for this validation can be subject to criticism (Burden et al., 2001). Initially the MNA was developed for and validated in relatively healthy elderly for assessing nutritional status. Later a shortened version of the MNA was derived for use as a quick screening tool. The MNA screening form has 98 percent sensitivity, 100 percent specificity and 99 percent diagnostic accuracy for predicting under nutrition (Henken et al., 2005).

MNA was developed and validated among the elderly for detecting protein energy malnutrition (Guigoz and Vellas, 2002). It fulfilled the criteria of nutritional evaluation like sensitivity, specificity, cost and targeting to a specific group (Rush, 2004). It has now been translated by specialists into more than 15 languages and is freely available. The MNA allows physicians and health professionals to make a rapid and reliable evaluation of the nutritional status of elderly patients, to recognize those at risk of nutritional problems (Irvin et al., 1999).