A Study on nutritional status of elderly men attending Geriatric Medicine outpatient clinic, Government General Hospital, Chennai using Mini Nutritional Assessment score, Serum Albumin and Serum Prealbumin

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CERTIFICATE

This is to certify that the dissertation entitled "**A Study on nutritional status of elderly men attending Geriatric Medicine outpatient clinic, Government General Hospital, Chennai using Mini Nutritional Assessment score, Serum Albumin and Serum Prealbumin**" is a bonafide work done by Dr BENNY PAUL WILSON, Postgraduate of Geriatric Medicine, Madras Medical College, Chennai in partial fulfillment of the university rules and regulations for award of M.D., Degree in Geriatric Medicine under my guidance and supervision during the academic period from May 2006-2009.

Dr B. Krishnaswamy, M.D.,
Professor & Head of department,
Geriatric Medicine,
Madras Medical College &
Govt. General Hospital,
Chennai – 600 003.

THE DEAN
Madras Medical College &
Govt. General Hospital,
Chennai – 600 003.

DECLARATION

I hereby declare that this dissertation entitled **"A Study on nutritional status of elderly men attending Geriatric Medicine outpatient clinic, Government General Hospital, Chennai using Mini Nutritional Assessment score, Serum albumin and Serum prealbumin"** has been prepared by me under the guidance of **Dr B.Krishnaswamy** M.D., Professor and Head of Department, Geriatric Medicine, Madras Medical College, Chennai in partial fulfilment of the regulations for the award of degree of M.D. Branch XVI (Geriatric Medicine), examination to be held in March 2009.

This study was conducted at Madras Medical College and Government General Hospital, Chennai.

I have not submitted this dissertation previously to any university for the award of any degree or diploma.

Place: Chennai **Signature of the Candidate**

Date:

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LIST OF CONTENTS

INTRODUCTION

Nutrition is a major determinant of individual health, physical and cognitive function, vitality and overall quality of life in any age group. Thus good nutritional status is a vital dimension to the health of an elderly.

Malnutrition in any age group represents the two ends of the nutritional status namely under-nutrition and over-nutrition and is no different in the elderly population. Under-nutrition rather than over nutrition or obesity is probably more common in developing countries like India, though the problem of obesity is fast catching up with the rates of developed countries.

Studies done in developed countries suggest that the prevalence of nutritional status, in hospitalized older adults, protein calorie under nutrition reaches epidemic proportions, with a reported frequency of 32% to 50%. An even higher under-nutrition prevalence of 23% to 85% has been reported in institutionalized, long-term care settings. Among free-living elderly the rate is around 5% to 10%.There are no large population studies reflecting the scenario in India or developing countries.

Nutritional assessment is a frequently forgotten area in the evaluation of the elderly, leading to under recognition of coexisting nutritional disorder. Numerous studies have proven the fact that under-nutrition leads to poor clinical outcomes in hospitalized elderly and impacts quality of life in the institutionalized and the community living elderly.

Nutritional status often worsens during hospitalization or institutionalization, despite efforts to provide adequate calories and protein. The impacts of psychological and social contributions to the regulation of food intake have often been poorly appreciated. Frequently, efforts to increase voluntary consumption of food have not been successful, leading to attempts to involuntarily increase consumption through enteral or parenteral feeding.

The diagnosis of under-nutrition lacks a single gold standard. Assessment of under-nutrition is not simple and is best done through a multidisciplinary approach and evaluation at multiple levels. There are many validated scores for the assessment of nutritional status; Mini nutritional assessment is one of them with good sensitivity and specificity. Simple and cost effective community screening test for nutritional status is yet to be

validated. Many biochemical tests have been studied, serum prealbumin and serum albumin are few of the proteins which have been validated.

The need for a nutrition based study done in the Indian population is evident. With this background, it is prudent to do a study on nutritional status of elderly using Mini nutritional Assessment score and look at the usefulness of biochemical parameters like prealbumin and albumin in assessing malnutrition.

AIMS OF THE STUDY

1) To assess the association between anthropometric parameters used in Mini Nutritional Assessment in comparison with the Mini nutritional assessment score.

2) To assess the correlation and association between serum prealbumin and Mini Nutritional Assessment score.

3) To assess the correlation and association between serum albumin and Mini Nutritional Assessment score.

4) To assess the validity of serum prealbumin and serum albumin as single indicators of under-nutrition in the elderly population using Mini Nutritional Assessment as the gold standard.

REVIEW OF LITERATURE

Under-nutrition in the elderly

Protein energy malnutrition is common in the elderly, but is often overlooked. Studies in the developed countries have shown that up to 15% of the community-dwelling and home bound elderly, between 23% and 62% of hospitalized patients, and up to 85% of nursing homes residents suffer from the condition [1]. There are very few studies done from India and other developing countries assessing the burden of under-nutrition in the geriatric population.

Epidemiological studies have demonstrated that protein energy malnutrition is a strong independent predictor of mortality in the elderly population, regardless of whether they live in the community or in the nursing home or patient in the hospital or have been discharged from the hospital in the last 1 to 2 years [2].The increased mortality in the elderly people who have protein energy malnutrition is increased further in the presence of other comorbid conditions.

Body weight tends to reduce after about age 60 years, and a loss of 5% or more of body weight over several years is not uncommon in the older people. Numerous studies have shown that weight loss in the elderly is associated with poor outcomes. Meta analysis of studies like "The prospective Cardiovascular Health Study" and "Systolic Hypertension in the Elderly Program study" clearly shows the relation between increased mortality and absolute weight loss irrespective of the baseline BMI. In addition, the meta-analysis of the above studies convincingly proved that the patient with initial poor baseline weight (BMI <21) and 1.6 kg per year weight loss had the 20 times mortality rates than the group with normal baseline weight whose weight remained stable [3, 4].

There are numerous causes of under-nutrition. Loss of body weight after the age of 60 years is disproportionately of lean body tissue, predominantly the skeletal muscle. When excessive, this leads to sarcopenia (defined as muscle mass more than two standard deviations below the sex specific young normal mean), which is present in up to 6% to 15% of people who are older than 65 years [5]. Unlike the loss of fat tissue, the loss of skeletal muscle is associated with metabolic, physiologic, and functional

impairments; disability, including increased falls; and increased risk for protein energy malnutrition. As per National Health And Nutrition Examination Survey (NHANES) III study [6], older people who had marked sarcopenia (<5.75 kg skeletal muscle/m^2) were 3.3 times (women) to 4.7 times (men) more likely to have physical disability than were those with low- risk skeletal muscle mass (>6.75 kg/m^2).

The causes of under-nutrition in older people are usually multiple. Healthy aging is associated with a decline in energy (food) intake, the physiological "anorexia of aging" and a reduction in function of homeostatic mechanisms that work in younger people to restore food intake in response to anorectic insults [7].

Diagnosing and assessing Under-nutrition

Identifying older persons at risk and making an early diagnosis provides an opportunity for intervention. Assessment of under-nutrition is not simple and is best done through a multidisciplinary approach and evaluation at multiple levels [1].

Clinical evaluation:

Medical history

Identifying risk factors for malnutrition helps direct further questioning. In one large outpatient study that reviewed patients with weight loss, 18% had a depressive disorder and 58% had a medical illness. Only 24% had no identifiable reason for their weight loss [1,8]. Probing questions should cover the factors that can affect adequate food intake: the presence of anorexia or dietary restrictions, ability to shop for and prepare food, ability to feed oneself, chewing and swallowing difficulties, constipation and diarrhea, and concomitant medical conditions.

Potential oral problems can be identified using the DENTAL (Dry mouth, Eating difficulty, No recent dental care, Tooth loss, Alternative food selection, Lesions) screening tool, a questionnaire that is 82% sensitive and 90% specific [1]. In addition to gastroenterologic dysfunctions, many other chronic illnesses can lead to under nutrition through indirect mechanisms. Dyspnea can significantly interfere with the ability to prepare and ingest

food. This difficulty is particularly significant in persons with advanced chronic obstructive pulmonary diseases and congestive heart failure. Endocrine abnormalities can lead to increased metabolism, as in hyperthyroidism. Chronic inflammatory and infectious conditions lead to cytokine-mediated weight loss.

Medications

Drug side effects can be a major cause of weight loss in older persons. Interfering with appetite, nutrient absorption, and metabolism are among the many known mechanisms. Few of the drugs known to contribute to under-nutrition directly or indirectly are ACE inhibitors, NSAID, Antacids, Anti-arrhythmics, Antibiotics, Anticonvulsants, β Blockers, Calcium Channel Blockers, Digoxin, H_2 Blockers, and Laxatives [1].

Restrictive diets

Hedonic qualities of food decline with age, as olfaction and taste buds decline over the life span. The ability to detect sweet and salty flavors declines first, and food begins to taste sour or bitter [11]. In addition to

restricting food choices, restrictive diets can adversely affect the pleasantness of food. Both mechanisms lead to decreased caloric intake and an increased risk for under-nutrition [9].

Alcoholism

Alcoholism is not a rare condition in older individuals and is inevitably accompanied by poor nutritional status. The CAGE (Have you ever felt you ought to Cut Down on your drinking? Have people Annoyed you by criticizing your drinking? Have you ever felt Guilty about your drinking? Have you ever had a drink first thing in the morning as an ‘‘Eye opener’’?) questionnaire [1] provides a rapid screening tool.

Psychiatric history

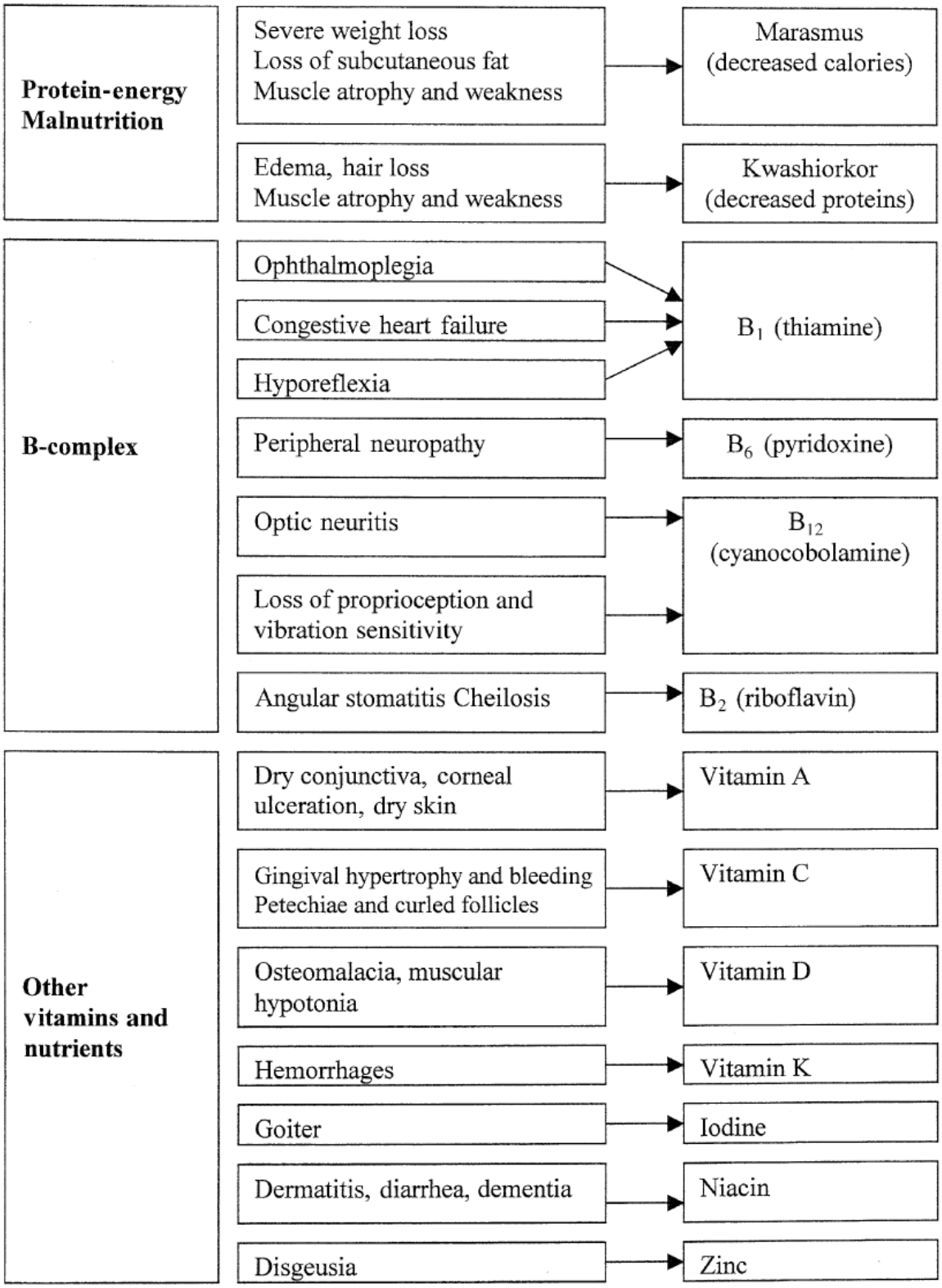
Depression is a common cause of weight loss in the elderly attending outpatient clinics [10] and in nursing homes. Dementia can be associated with failure to remember the need to eat, problems with food preparation, and difficulty shopping. End-stage dementia is associated with swallowing abnormalities and abnormal eating habits such as coprophagia. A recurrence

of anorexia nervosa in old age can lead to intentional weight loss [12]. When anorexia nervosa is suspected, specific questions (ie, the Eating Attitudes Test EAT-26 questionnaire) should be asked to detect its presence [14]. Late-life paranoia can present with well-formed delusions of being poisoned leading to fear of eating. The Folstein Mini Mental Status (MMS) examination [1] and the Geriatric Depression Scale (GDS) should be incorporated in the initial evaluation of older person [11].

Social and functional history

The ability to be independent in the basic and instrumental activities of daily living (ADLs and IADLs) should be determined [1]. Loss of independence is both a risk factor for and an indicator of poor nutrition. Poverty, social isolation, and elder abuse are all potential risk factors for under-nutrition and should be explored.

Physical examination [1]



Anthropometric measurements

Aging is associated with changes in stature, weight, and body composition. Exaggerated changes lead to a significant increase in morbidity and mortality [12]. In addition to the decrease in the fat-free mass that starts by middle age [13], the total fat mass also decreases after age 70 years [13]. This decrease may explain the progressive overall decline in body weight that occurs with aging. After reaching a peak, body weight seems to start decreasing in the fourth or fifth decade in men and a decade later in women. Significant weight loss is a major indicator of poor nutritional status in elderly. It also correlates with increased morbidity and mortality.

Ideally, the patient should be weighed on a well-calibrated scale, wearing light clothing and without shoes. Conditions that may affect the interpretation of weight changes, such as edema, ascites, and loss of body parts, should be considered. Measuring weight in non-ambulatory persons can be difficult and may require special equipment such as wheelchair scales. When available, previous weights should be plotted against time. Based on the data from the Nutritional Screening Initiative (NSI), a loss of more than 5% of body weight in 1 month, of more than 7.5% in 3 months, or

of more than 10% in 6 months is considered significant [20]. In the absence of previously recorded weight, comparison with desirable body-weight charts is recommended. A weight 20% below the desirable weight is considered a marker of poor nutritional status.

The body mass index (BMI) has been established as a useful parameter of over- or underweight [15]. The NSI has established that the normal BMI is between 22 and 27 [15]. The degree of chronic energy deficiency can be further defined according to BMI as mild (BMI < 18.4) or severe (BMI < 16) [1]. Both extremes of BMI confer increased risk of mortality in older persons, resulting in an inverted U-shaped survival curve [1]. Studies have [1] shown increased mortality for persons of all ages with low BMI, but a very low BMI was more lethal in older people.

The loss of height that occurs with the aging process may lead to a misleading increase in BMI. To compensate for this potentially erroneous measurement, a novel index called the height:arm span ratio is being studied. Although height decreases with age, arm span remains fixed throughout life. Thus there is a progressive reduction in the height:arm span ratio with aging.

The arm span can be used to reflect the true length of the body frame in the BMI calculation, producing the body mass–arm span (BMA) value [16].

Other anthropometric tools include the measurement of mid-arm circumference (MAC), measured by a flexible tape and the triceps skin-fold (TSF), measured by a caliper. These measurements provide a crude assessment of fat stores and muscle mass [17].With a new corrected formula, these measurements can be used to calculate mid-arm muscle area (MAMA). Mid-arm muscle area might be an even better indicator than weight loss of mortality risk in elderly men [1]. Unfortunately, the clinical application of all these measurements is limited because of the difficulty in standardizing measurement techniques among practitioners.

Biochemical evaluation

In addition to identifying under-nutrition, biochemical nutritional assessment helps detect micronutrient deficiencies and monitor the efficacy of nutritional interventions. Some laboratory values, such as serum proteins and cholesterol, are used to reflect protein-energy malnutrition; others, such as leptin, are used to reflect total fat stores [18].

Serum proteins

Albumin

Serum albumin levels have long been considered a major measure of malnutrition and the defining value for determining the diagnosis of kwashiorkor. Albumin levels are highly predictive of mortality in the hospital and mortality in the general population [18]. For every 2.5 g/L decrease in serum albumin concentration, there is a 24% to 56% increase in the likelihood of dying [18].

Albumin has a long half-life of approximately 18 days. It functions both to maintain plasma osmotic pressure and to transport substances in plasma. Serum levels of albumin reflect the net result of hepatic synthesis (12–15 g/day), plasma distribution, and protein loss. Over 60% of albumin is present in the extravascular pool and can be mobilized to the intravascular space in periods of stress due to surgery or infection. The functional catabolic rate of albumin is proportional to the size of the extravascular pool, which allows the concentration in the serum to remain relatively constant [18].

Serum albumin can be measured by immunologic or spectrophotometric methods. Bromcresol green overestimates albumin levels at low concentrations and in persons with dysproteinemias due to interference by globulins and acute phase reactants. The bromcresol purple method more closely approximates the immunologic methods in these cases. The dye methods tend to underestimate serum albumin in dialysis patients because of interfering uremic products [18].

With aging, there is possibly a small decline in serum albumin levels (0.8 g/L per decade in persons older than 60 years), but factors other than age per se have never been completely excluded in these studies [19]. Centenarians appear to have significantly lower serum albumin levels than do younger persons [20].

Serum albumin levels often decline rapidly after hospital admission [18]. The rate of fall is too rapid to allow for a nutritional explanation. Two reasons appear to explain this fall: postural changes and cytokines. Altering posture from the upright to the recumbent position produces a decline in serum albumin of 5 g/L. Cytokines such as tumor necrosis factor α, interleukin-2 (IL-2), and IL-6 inhibit albumin production by inhibiting

albumin gene expression [25] and cause a vascular endothelial leak [25], resulting in an increase plasma clearance rate of albumin [18].

Chronic alteration in serum albumin can occur with diseases affecting hepatic production of albumin (liver disease and congestive heart failure) or the rate of albumin loss (nephrotic syndrome and protein-losing enteropathies). Thus, although serum albumin levels remained the gold standard for the diagnosis of protein energy malnutrition, they are a somewhat tarnished standard. Serum albumin in older individuals continues to be useful because of its excellent prognostic ability as a marker of mortality and other poor outcomes such as hip fracture [21]. More studies are needed to determine whether aggressive nutritional replacement in older persons leads not only to the restoration of albumin levels but also to improved outcomes. In severely hypoalbuminemic persons, nutritional replacement often results in a further fall in albumin levels initially as the increase in intravascular osmotic pressure produces an increased influx of fluid from the extravascular space into the intravascular space [18].

Prealbumin

Transthyretin, better known as prealbumin, is a transport protein for thyroxine. Prealbumin (PA) has been used because of its short half-life and superior sensitivity in evaluating acute nutritional change. Because of their long half-lives, downward changes of the concentrations of albumin and transferrin are not seen until prolonged or severe malnutrition is present. The long half-lives also prevent the detection of short-term responses to nutritional support. Prealbumin levels decrease faster than do levels of albumin and transferrin in cases of protein depletion and returns to normal after nutritional repletion [18, 22, 24].

Prealbumin is a stable and symmetrical tetramer composed of four identical subunits [23]. It is normally bound to the retinol-binding protein (RBP) at a 1:1 molar ratio in physiologic pH [18]. This binding is stabilized by the formation of the PA–RBP complex. In addition to thyroxin transport, Prealbumin plays a role in vitamin A transportation via this complex. Prealbumin has the highest proportion of essential to non-essential aminoacids of any protein in the body. It is rich in tryptophan, which plays a

major role in the initiation of protein synthesis. Prealbumin has a small pool and a half-life of 2 days [18].

Prealbumin can be measured directly by using immunologic techniques such as radial immunodiffusion. The normal range has been reported to be 160mg/L to 360mg/L [18]. A Prealbumin level of 50 to 109 mg/L may herald a difficult clinical course if nutritional intervention is delayed or withheld. A value of < 50 mg/L is an indicator of poor prognosis [18,23]. Likewise, failure to increase prealbumin in a situation where 100% of estimated protein need is provided is a reliable indicator of poor outcome [18,23].

Prealbumin levels are expected to increase by 10 mg/L every day with good nutritional repletion. An increase of less than 20 mg/L in 1 week indicates either inadequate nutritional support or inadequate response [18]. Prealbumin levels can be affected by factors other than malnutrition. Prealbumin has been noted to be lower in women than in men in the same age group [25]. Although aging does not affect prealbumin levels in healthy individuals [25,26], it seems that a decrease in prealbumin levels may occur in very old men (90 years), so that their values fall to within the same range

as those in women [20,26]. Decreased prealbumin levels are seen in end-stage liver disease (presumably due to decrease production), inflammation, stress, and iron deficiency. Renal insufficiency and steroid use each causes an increase in serum prealbumin levels. In the presence of such co-morbidities, the trends of prealbumin levels should be used to monitor nutritional status rather than the absolute number [18].

Because of its unique characteristics and its small pool size, prealbumin is a better and more sensitive indicator of acute changes in protein status in both young and old [18,24].

Other biochemical parameters used in nutritional status assessment are listed in the table below [18]

Biochemical Measurement	½ life	Effects of age	Non-nutritional factors affecting levels	Relation to prognosis
Transferrin	9 d	Gradual decrease, lowest levels in Centenarians	Iron deficiency, acute hepatitis,pregnancy, estrogens end-stage liver disease, nephrotic syndrome, neoplasms, antibiotics	Controversial; when coupled with albumin, transferrin may indicate morbidity and mortality
Retinol-binding protein	12 h	Slight decrease in males Slight increase in females	Renal failure Acute hepatic failure End stage liver disease Hypothyroidism Stress Zinc deficiency Vit A deficiency	Similar to prealbumin
Insulin growth factor-I	2–4 h	Decreases by 35–60% between the Fourth and ninth decades	Renal failure, hepatic failure, autoimmune diseases, pregnancy, inflammation, stress	Inversely related to life threatening complications in hospitalized patients
Fibronectin	4 h		Burns, infections, stroke, lipid feeding Formulas	Not established
C-reactive protein	4–6 h	No change	Catabolic states, trauma, sepsis	Decreased levels herald short term survival in hospitalized patients
Interleukins	2–4 h	? Increase, particularly the soluble IL-2	Inflammation, exercise	Increased mortality with increased soluble IL-2 receptor
Cholesterol		Increases between the sixth and ninth decade and then decreases		Ten-fold increase in mortality when less than 120
Leptin		Increases at middle age and declines in old age in females; lower in males than in females and increases throughout the lifespan in males	Hypogonadism	Unknown

Assessment/Screening tools

Several tools have been developed to screen for under-nutrition. Some are designed to be self-assessment tools, whereas others must be administered by health care professionals.

Subjective Global Assessment

The Subjective Global Assessment (SGA) incorporates functional capacity as an indicator of malnutrition and relies heavily on physical signs of malnutrition and on malnutrition-inducing conditions. Because the inclusion of laboratory values did not improve the performance of SGA, they were excluded. The SGA was validated with a reported sensitivity of 82% and specificity of 72% [1,27]. The validation studies showed that the performance of this tool depends on administrator's experience, so its reliability is limited in suboptimal circumstances.

Also, the sensitivity of SGA depends on the physical signs of micronutrient deficiency, which usually become apparent late in the course of the disease. Thus SGA is probably not a useful tool for early detection of

malnourishment and is not practical for use in follow up and monitoring during nutritional support [1,27].

Mini nutritional assessment

The Mini Nutritional Assessment (MNA) is a rapidly administered, simple tool for evaluating the nutritional status of older persons. Few methods of assessment existed before the introduction of the MNA. The MNA was developed through collaboration between the Toulouse University Hospital in France, the Medical School of New Mexico in the United States, and Nestle Research Centre in Switzerland [28]. It was created in the early 1990s by researchers Vellas, Garry, Guigoz, and Albarede as a quick, economical, and noninvasive method of assessing nutritional status of the elderly when they enter hospitals or institutions, and monitoring any nutritional changes during their stay [29].

This evaluation tool consists of 18 items [30] and can be administered by a health care professional in less than 15 minutes, by means of simple measurements and a battery of questions which, when answered, provide a score out of thirty points in order to categorize the nutritional status of the

person assessed. The MNA is administered in two parts. Part 1 is a screening questionnaire. Out of a maximum score of 14, individuals who score ≥12 are considered well-nourished, and do not need further assessment. Individuals who score ≤ 11 are considered at risk for malnutrition, and are given Part 2 of the test, which is an assessment that awards a maximum of 16 points (Appendix 1). On completion of the assessment stage, the score is added back to the screening score to achieve a total MNA score.

Scoring categories are as follows [30]:

- Malnourished: Scoring less than 17 points.
- At risk for malnourishment: Scoring between 17 and 23.5 points.
- Well-nourished: Scoring greater than 23.5 points.

The MNA fulfills many criteria for both screening and diagnostic measures, meaning that it identifies those at risk for nutrition and can be used to determine outcome [31]. It is composed of four major sections [32,33] that include both screening and assessment questions. Each section of the MNA is listed below, and possible scores for each section are listed in parentheses.

- Anthropometric measurements: BMI (0, 1, 2, 3), mid arm circumference (0.0, 0.5, 1.0), calf circumference (0, 1), and weight loss during the last three months (0, 1, 2, 3).

- Global evaluation: independence at home (0, 1), medications taken per day (0, 1), psychological stress or acute disease in the last tree months (0, 1), mobility (0, 1, 2), neuropsychological problems (0, 1, 2), skin lesions or ulcers (0, 1).

- Dietary assessment: number of meals/day (0, 1, 2), consumption of dairy products (0.0, 0.5, 1.0), intake of fruits and vegetables (0, 1), recent decline in food intake (0, 1, 2), Fluid intake (0.0, 0.5, 1.0), mode of feeding (0, 1, 2).

- Subjective self-assessment: Nutritional problems (0, 1, 2), health status compared to people the same age (0.0, 0.5, 1.0).

Validation of the MNA:

Explanation of studies:

The MNA has been validated for use with the elderly by three successive studies. The first study was completed in Toulouse, France in 1991 in 155 elderly nursing home subjects whose nutritional status ranged from very healthy to malnourished. In 1993, a second study was completed in Toulouse with 120 subjects in a similar population. The Albuquerque 1993 study was based in New Mexico, and used 347 independent-living elderly (also 65 years or older), who were already participants in the New Mexico aging process study, to further validate the MNA [30]. The New Mexico Aging Process study was a longitudinal study that examined nutrition and health status in the independent-living elderly over time. In all three studies, both the very frail and the very active were included. Overall, more than 600 individuals were enrolled [30].

The MNA was validated in all three studies by two principle criteria. First, a comprehensive Nutrition Assessment was performed on each participant by a researcher. Anthropometrics were taken, such as height,

weight, body mass index (BMI), and skin fold measurements. An evaluation of diet was accomplished using a diet history, 3-day record, interview, and food frequency checklist. Additionally, the following biological markers were measured and used as the gold standard for nutritional health: albumin, prealbumin, transferrin, retinol-binding protein, C-reactive protein, ceruloplasmin, cholesterol, triglycerides, vitamins A, D, E, B_1, B_2, B_6, B_{12}, folate, copper, zinc, hematocrit, hemoglobin, and blood cell count.

Second, two physicians trained in nutritional assessment independently assessed each patient without knowing their MNA score. Both of the physician assessments and the detailed nutrition assessment were compared to the MNA score received by the patient.

The specificity of the MNA was determined by cross-classification of the two Toulouse studies using equations from the discriminant analysis. These results showed the MNA could correctly identify 70-75% of individuals as normal or malnourished without the use of biochemical indices. The rest of the population (25-30%) fell in the buffer zone between well-nourished and malnourished, and would need biochemical indices or clinical evaluation to classify further. In order to set the threshold values for

the MNA, scores were cross-tabulated with albumin levels of the subjects from the Toulouse studies. All subjects with inflammation, as determined by C-reactive protein >20 mg/L were excluded. In this manner, the scores were determined for well-nourished (>24), at risk for malnutrition (17-23.5), and malnourished (<17).

Study findings:

In both Toulouse studies, there was a strong correlation between several nutritional markers (transthyretin, serum folate, and vitamin D), energy intake, and MNA score in both males and females. Additionally, an association between a low MNA score and mortality at three months and one year was also found. Overall, the test was found to be 96% sensitive (in the ability to detect malnutrition) and 98% specific (in the ability to classify well-nourished correctly).

The New Mexico Ageing Process Study examined the nutritional status of independent-living elderly in America. Half of this study population was between the ages of 75 and 85 yrs (with 10% being older than 85 yrs). Even though this group was independent-living, and therefore,

considered to be healthier than the institutionalized elderly, almost 20% were found to be at risk for malnutrition. The "at risk" group had a lower mean dietary intake than the well-nourished group, yet both albumin levels and BMI were within the normal range [15]. The results of the New Mexico Aging Process Study showed a correlation between a high MNA score (27-30) and successful aging [34].

Importance of MNA:

One advantage of the MNA is that it does not require measurements that are difficult to assess, such as blood values, but MNA score has still been shown to correlate with many aspects of health [38]. Many studies show significantly higher mortality in malnourished elderly when compared to their well-nourished counterparts [27,39]. Studies also show that malnutrition, as determined by the MNA score, is very predictive of mortality compared to seniors classified at risk or well-nourished by the same tool [28]. In community dwelling elderly, the MNA can detect risk of malnutrition while albumin and BMI are in the normal range and life style characteristics are associated with nutritional risk. In outpatients and hospital patients, the MNA is predictive of outcome and cost of care. In home care

patients and nursing home residents, the MNA is related to meal patterns and chronic conditions. It has been successfully used to monitor nutritional interventions. Importantly it is very sensitive & specific [40, 41, 42, 43, 44], and reproducible [45] method for the assessment of malnutrition in the elderly.

Following are the Sensitivity and specificity value of MNA as compared with other assessment methods in various other studies.

	Sensitivity	**Specificity**	**References**
Clinical Status	96	98	Guigoz Y et al. 1995 (19)
Detailed nutritional assessment	90	88	Visvanathan R et al. 2004 (30)
SGA	97	54	Read JA et al. 2005 (33)
PEM (anthrop, Alb, Prealbumin)	73	31	Wikby K et al. 2006 (35)

Comparison of MNA with serum prealbumin and albumin

Prealbumin:

Vellas B, Guigoz Y et al in a study (Relationships between nutritional markers and the mini-nutritional assessment in 155 older persons) compared other nutritional marker with MNA. In that study, there was high correlation

between serum prealbumin and MNA (coefficient of correlation of 0.82) with significant difference in three nutritional groups of MNA ($p<0.01$). Study showed serum had a sensitivity and specificity of 98% and 87% respectively in comparison with MNA. The conclusion of the study states that serum prealbumin is a good indicator of nutritional status in the elderly [36].

Similar study done in the above 75yrs of age in Spanish population (Ruiz-Lopez et al) prealbumin did not show good correlation (coefficient of correlation of 0.52) with MNA in comparison with above study with sensitivity and specificity of 79% and 63% respectively. Study showed there was significant difference in mean prealbumin values between the malnourished group and the other two groups ($p<0.05$) but not between the "at risk" and the well nourished group. This study showed that the prealbumin is poor indicator of nutritional status in above 75years population [35].

In the study done by Langkamp-Henken B, Hudgens J et al showed that in the presence of inflammation, no correlation is observed between the MNA and prealbumin, as it is a negative acute phase reactant [37], and

measuring inflammatory markers like CRP [48] along with prealbumin is recommended to further investigate the presence of an active inflammatory response before planning treatment [46,47].

Albumin:

In the Vellas B, Guigoz Y et al study there was good correlation (coefficient of correlation of 0.68) of serum albumin levels in comparison with MNA with mean prealbumin levels showing significant difference in each nutritional status groups ($p<0.05$), with sensitivity of 75% and specificity of 68% [36].

In the study by Ruiz-Lopez et al, in the age group above 75yrs showed, poor correlation (coefficient of correlation of 0.36) between MNA and albumin, with no significant difference in mean albumin levels in each MNA groups. Study concluded that serum albumin is poor indicator of nutritional status in the elderly above the age of 75years [35].

MATERIALS AND METHODOLOGY

Setting

Outpatient clinic of the Department of Geriatric Medicine, Madras Medical College and Government General Hospital, Chennai

Ethical Committee Approval

Clearance obtained from the Institutional Ethical Committee of Madras Medical College as per the meeting held on 10th September, 2008.

Study Design

Non-randomized cross sectional study followed by validation of screening test

Period of study

September 2007 to September 2008

Study population

100 male patients attending the outpatient clinic in Department of Geriatric Medicine, Madras Medical College and Government General Hospital, Chennai

Inclusion criteria

Elderly male 65yrs and above

Exclusion criteria

1) Female patients
2) Subjects with Chronic Renal Failure
3) Subjects with inflammatory conditions like any acute infections and connective tissue disorder
4) Subjects with fluid overload states like congestive cardiac failure, nephrotic syndrome, and renal failure.

5) Subjects with severe liver disease

6) Subjects on steroids

7) Subjects critically ill

8) Subjects unable to stand because of disability

Details of the study

Totally 154 male subjects attending geriatric medicine outpatient department were enrolled to the study. The subjects initially underwent thorough clinical examination to rule out conditions listed in the exclusion criteria's. The out patient records of the patient were scrutinized for the same. All subjects had got their ECG and renal function tests done.

100 subjects were selected for the purpose of the study after excluding those who did not meet the criteria. Each subject was administered Mini Nutritional Assessment (MNA) score (appendix 1).

As part of anthropometric assessment of MNA every subject's weight and height was measured. Weight was measured to the nearest kilogram by using a clinical weighing machine and height was measured using a

stadiometer to the nearest mm. Body mass index was calculated using the formula:

$$BMI = \text{weight [kg]} / (\text{height in meters})^2$$

A flexible tape was used to measure the Mid Arm Circumference (MAC). The mid-point of the arm was determined by measuring the distance between the acromial surface of the scapula (bony protrusion surface of the upper shoulder) and the olecranon process of the elbow (bony point of the elbow on the back of the arm). The mid-point was marked with a black marker. The tape measure was then positioned at the previously marked mid-point on the upper arm and tightened snugly, but not tight enough to cause indentation of the skin. Measurements were taken to the nearest mm, repeated twice and the average was recorded.

For the measurement of calf circumference, the subject was asked to lie in a supine position, with one knee bent at a 90º angle while their foot rested on the bed. The largest circumference of the calf was subjectively selected and measured around this area to determine the calf circumference i to the nearest mm. Measurements were repeated twice, and the average of the two measurements was recorded.

Subject or the relative were questioned accordingly for the answer for the questions from 4 to 18 in the MNA and corresponding score were awarded following the scoring system. Mini mental score and Geriatric depression score were also applied for the purpose of answer to question 9. The total score out of 30 was obtained by adding points for each question.

Venous blood sample of 6ml was collected from all subjects for the purpose of estimating serum albumin and serum prealbumin. Serum albumin was estimated using spectrophotometric method. Reference value for this method is 3.5g% to 5g%. Serum prealbumin was estimated using immunoturbimetric method. Reference value for this method is 20mg% to 40mg%.

The data were collected, compiled, analysed and relevant statistical tool applied.

RESULTS AND ANALYSIS

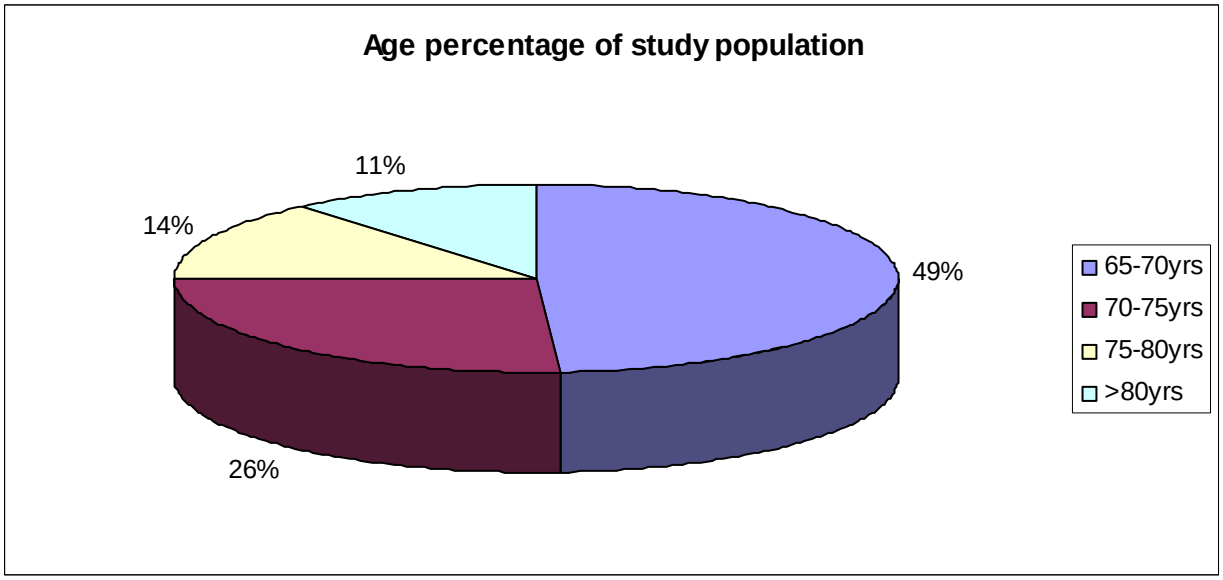
An aggregate of 100 male subjects were part of the study. Out of them, 31 subjects were identified as malnourished (MNA score less than 17), 36 subjects were at risk of malnutrition (MNA score from 17 to 23.5) and rest 33 were well nourished (MNA score more or equal to 24)

Table 1: Nutritional status groups and frequency

MNA Score Interval	Frequency
Malnourished (<17)	31(31%)
At risk for malnutrition (17-23.5)	36(36%)
Well nourished (>=24)	33(33%)

Table 2: Age distribution

Age Interval	Freq	MNA<17 n=31	MNA (17-23.5) n=36	MNA>24 n=33
65-70	49(49%)	14(45%)	13(36%)	22(66%)
70-75	26(26%)	6(19%)	12(33%)	8(24%)
75-80	14(14%)	7(23%)	7(19%)	0(0%)
>80	11(11%)	4(13%)	4(12%)	3(10%)

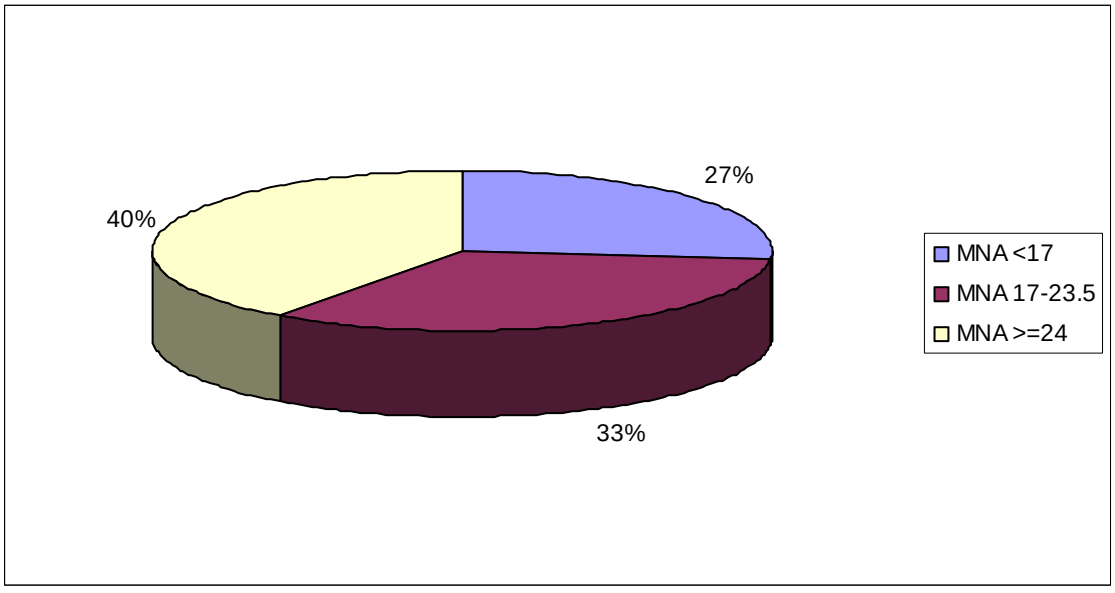


Majority of subjects in the study population were from the age group 65 to 70yrs. 25% of the study population were above the age of 75yrs.

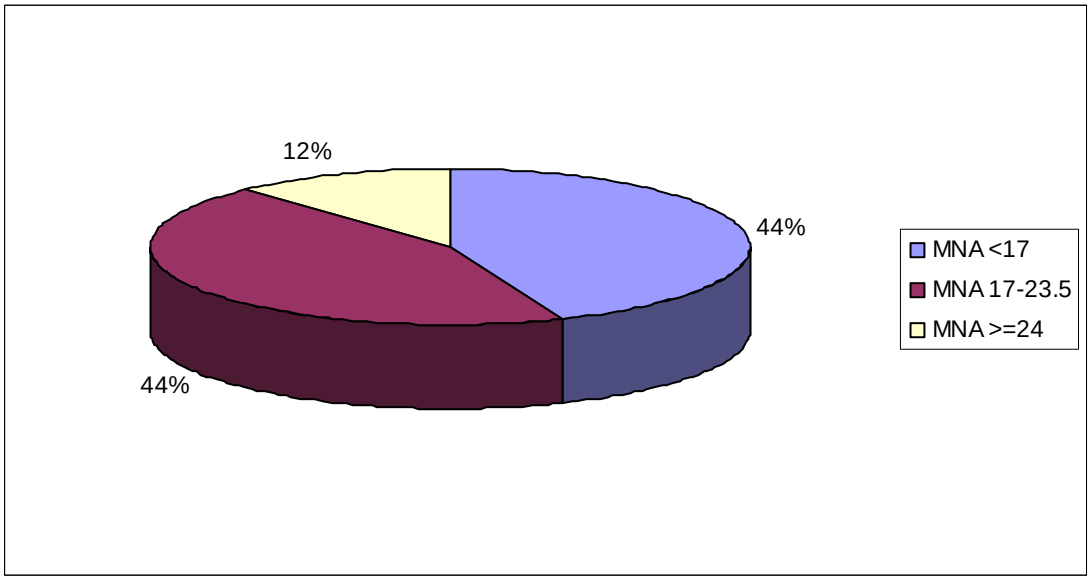
Table 3: Percentage of malnourished, at risk and well nourished in age groups 65-75yrs and above 75yrs

MNA Score/Age groups	65-75yrs	>75yrs
MNA <17	20(27%)	11(44%)
MNA 17-23.5	25(33%)	11(44%)
MNA >=24	30(40%)	3(12%)

65-75yrs age group



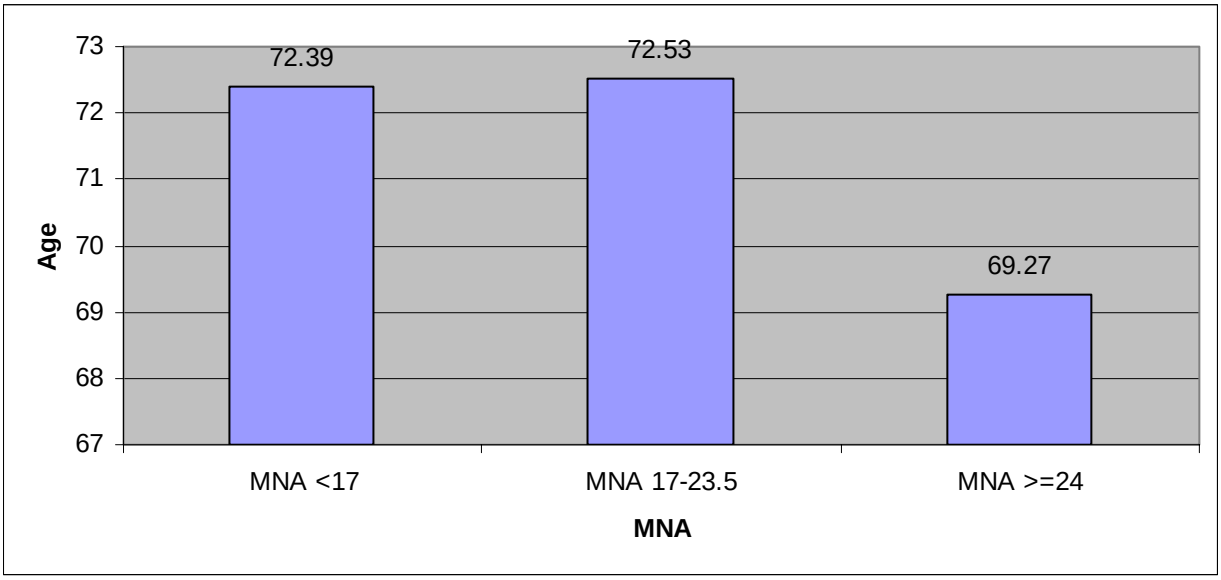
Above 75yrs age group



The proportion of malnourished in 65 to 75 years is less than that of above 75 years. (27% vs. 44%)

Table 4: Mean age in each MNA group

	Age (years)		P value ANOVA
	Mean	S.D	
Malnourished (<17) n=31	72.39	6.93	NS p=0.14
At risk for malnutrition(17-23.5) n=36	72.53	5.94	
Well nourished (>=24) n=33	69.27	4.69	

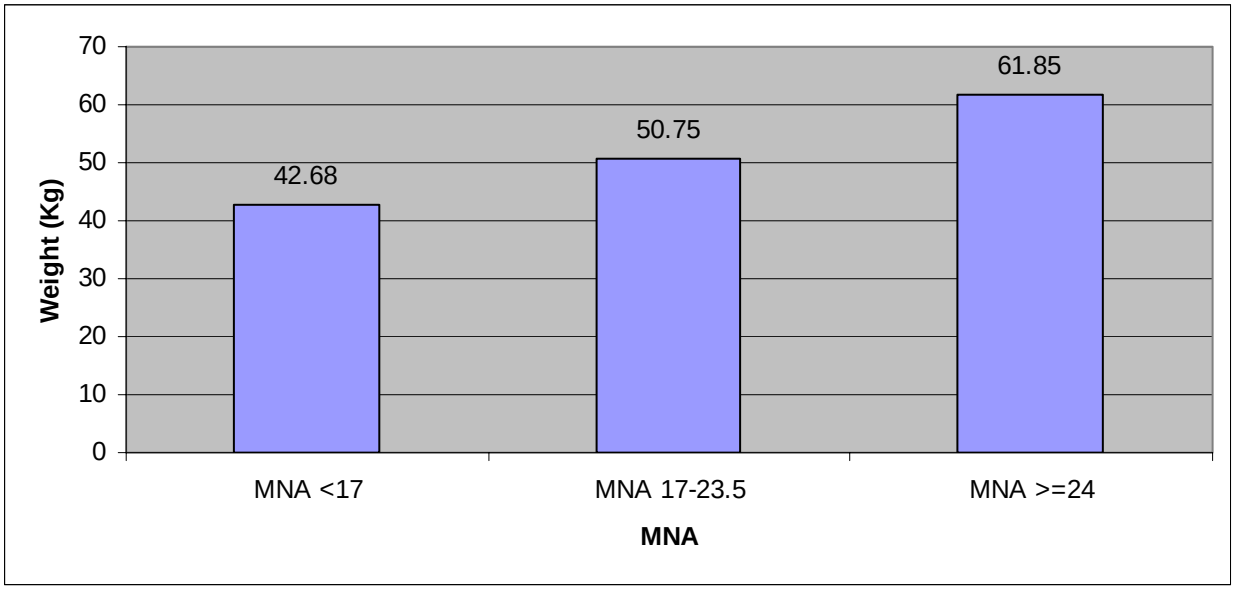


There was no significant difference in mean age (yrs) between the three groups of nutritional status.

The lowest and highest age in the study group was 65yrs and 95yrs respectively.

Table 5: Mean weight in each MNA group

	Wt (kg)		P value ANOVA
	Mean	S.D	
Malnourished (<17) n=31	42.68[a]	6.77	<0.05[*]
At risk for malnutrition(17-23.5) n=36	50.75[b]	6.90	
Well nourished (>=24) n=33	61.85[c]	7.79	

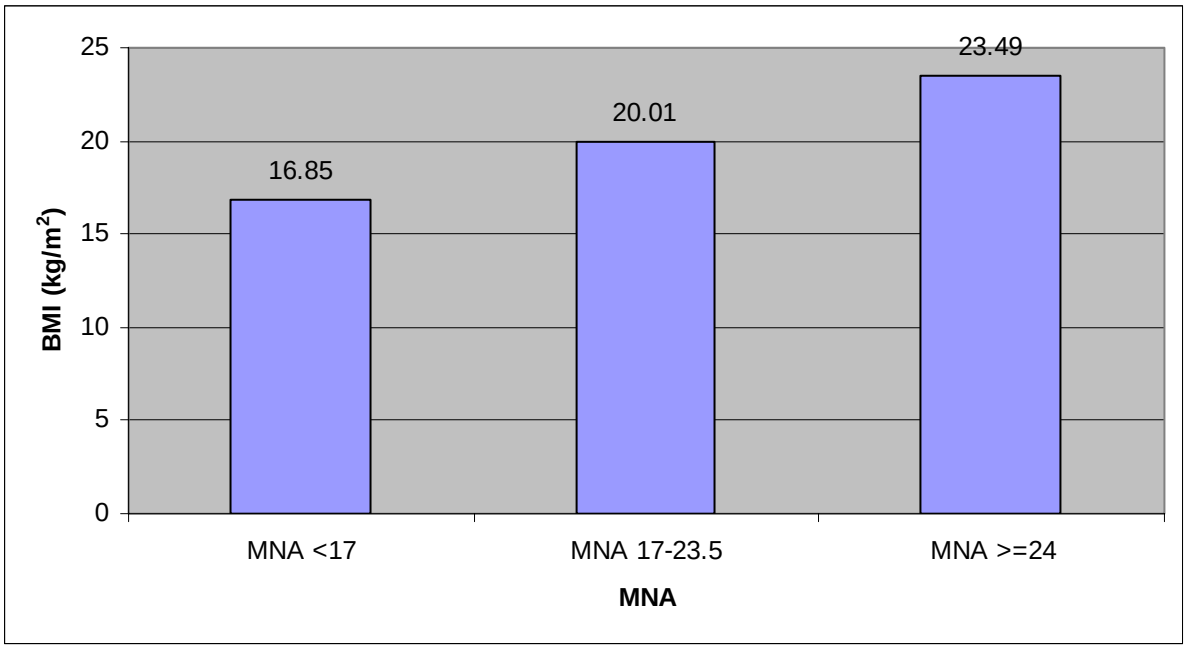


There was significant difference in mean weights between the three groups of nutritional status ($p < 0.05$).

The lowest and highest weight recorded in the study group was 32kgs and 72kgs respectively.

Table 6: Mean Body Mass Index in each MNA group

	BMI (kg/m^2)		P value ANOVA
	Mean	S.D	
Malnourished (<17) n=31	16.85[a]	1.82	<0.001**
At risk for malnutrition(17-23.5) n=36	20.01[b]	2.11	
Well nourished (>=24) n=33	23.49[c]	2.04	

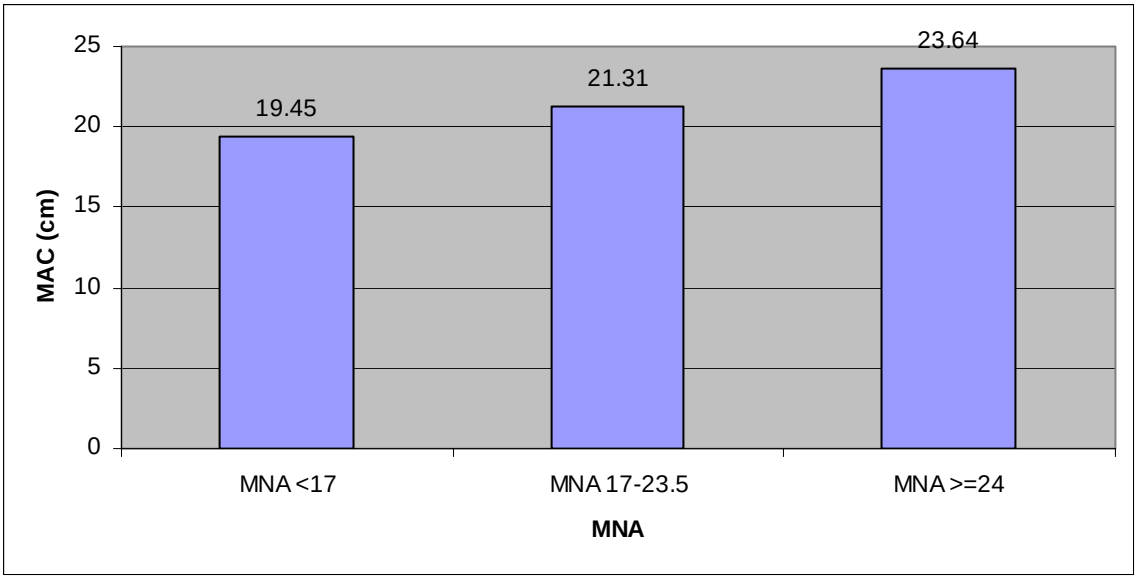


There was significant difference in mean Body Mass Indices between the three groups of nutritional status.

The lowest and highest BMI recorded in the study group was 13.7 and 28.8 respectively.

Table 7: Mean Midarm Circumference in each MNA group

	MAC (cm)		P value ANOVA
	Mean	S.D	
Malnourished (<17) N=31	19.45[a]	1.77	<0.05*
At risk for malnutrition(17-23.5) N=36	21.31[b]	1.35	
Well nourished (>=24) N=33	23.64[b]	1.78	

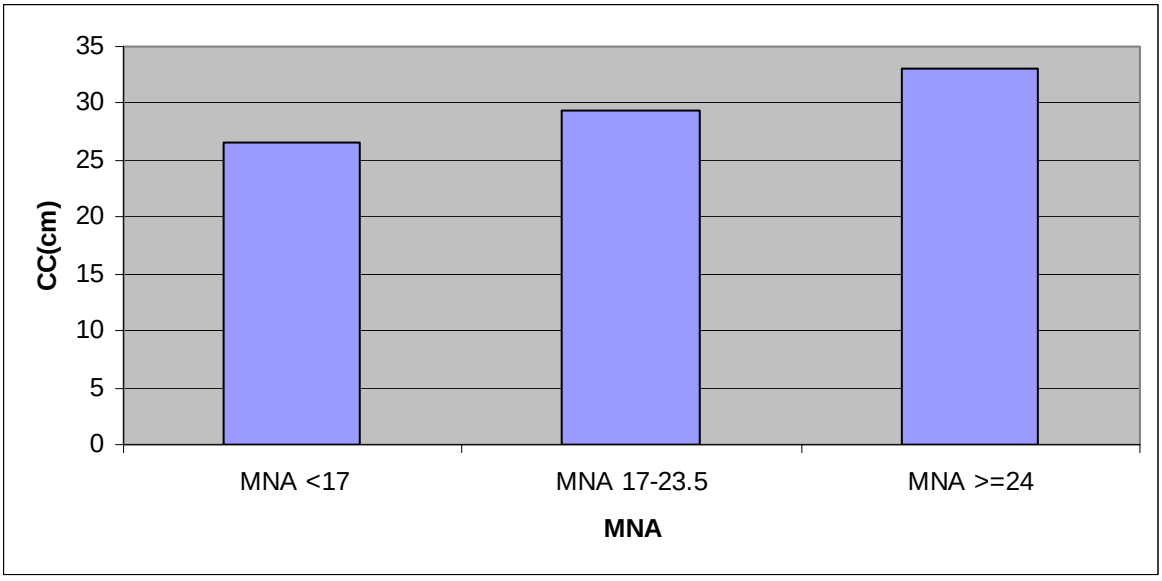


There was no significant difference in the mean Midarm circumferences between "at risk" group and well nourished group. There was significant difference in malnourished group compared with other two groups.

The lowest and highest recorded Midarm circumferences in the study group was 16cms and 27cms respectively.

Table 8: Mean calf circumferences in each MNA group

	CC (cm)		P value ANOVA
	Mean	S.D	
Malnourished (<17) n=31	26.52[a]	1.99	<0.05*
At risk for malnutrition(17-23.5) n=36	29.42[b]	2.26	
Well nourished (>=24) n=33	33.02[b]	2.59	

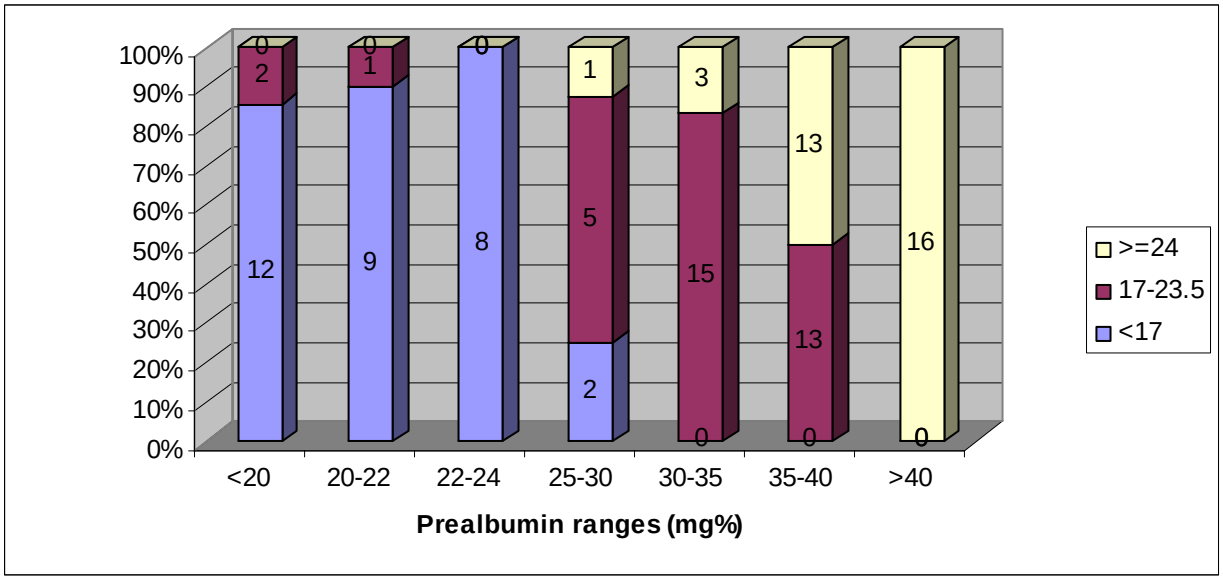


There was no significant difference in the mean calf circumferences between "at risk" group and well nourished group. There was significant difference in malnourished group compared with other two groups.

The lowest and highest recorded calf circumferences in the study group was 23cms and 38cms respectively.

Table 9: Serum Prealbumin compared to MNA scores

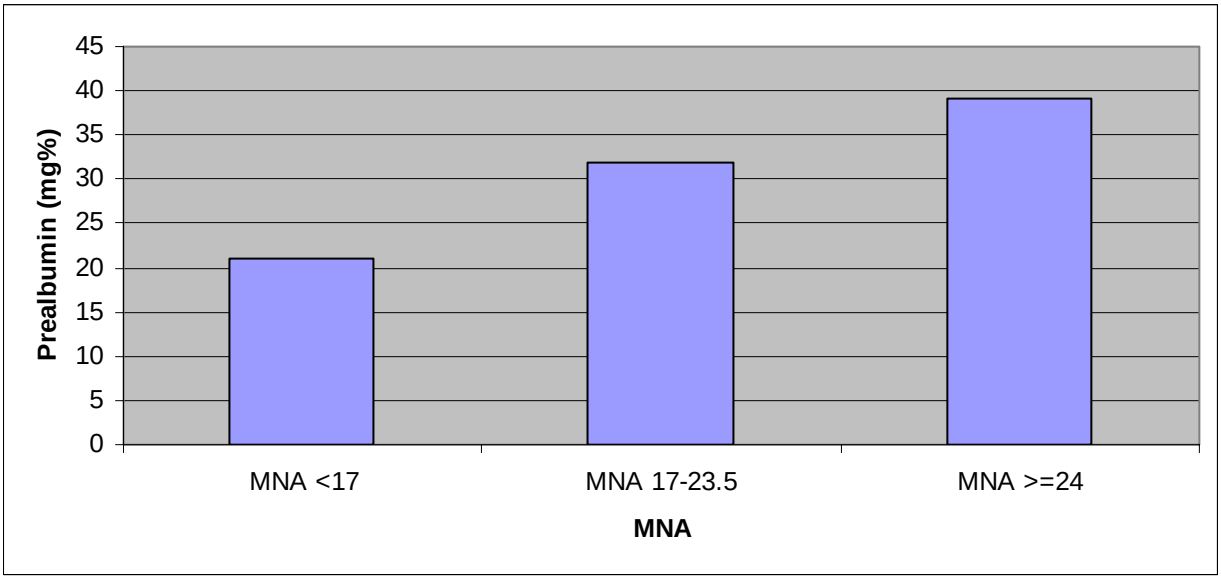
MNA Score/prealbumin(mg%)	<20	20-22	22-24	25-30	30-35	35-40	>40
Malnourished (<17) (n=31)	12	9	8	2	0	0	0
At risk for malnutrition(17-23.5) (n=36)	2	1	0	5	15	13	0
Well nourished (>=24) (n=33)	0	0	0	1	3	13	16



The above data showed that the subjects with serum prealbumin levels more than 40 mg% were all are well nourished and the majority of subjects with prealbumin less than 20 mg% were malnourished. Majority of subjects below the range of 25-30mg% of prealbumin were malnourished.

Table 10: Mean prealbumin in each MNA group

	PREALBUMIN (mg%)		P value ANOVA
	Mean	S.D	
Malnourished (<17) (n=31)	21.01[a]	2.89	<0.001[**]
At risk for malnutrition(17-23.5) (n=36)	31.87[b]	5.07	
Well nourished (>=24) (n=33)	39.16[c]	3.40	

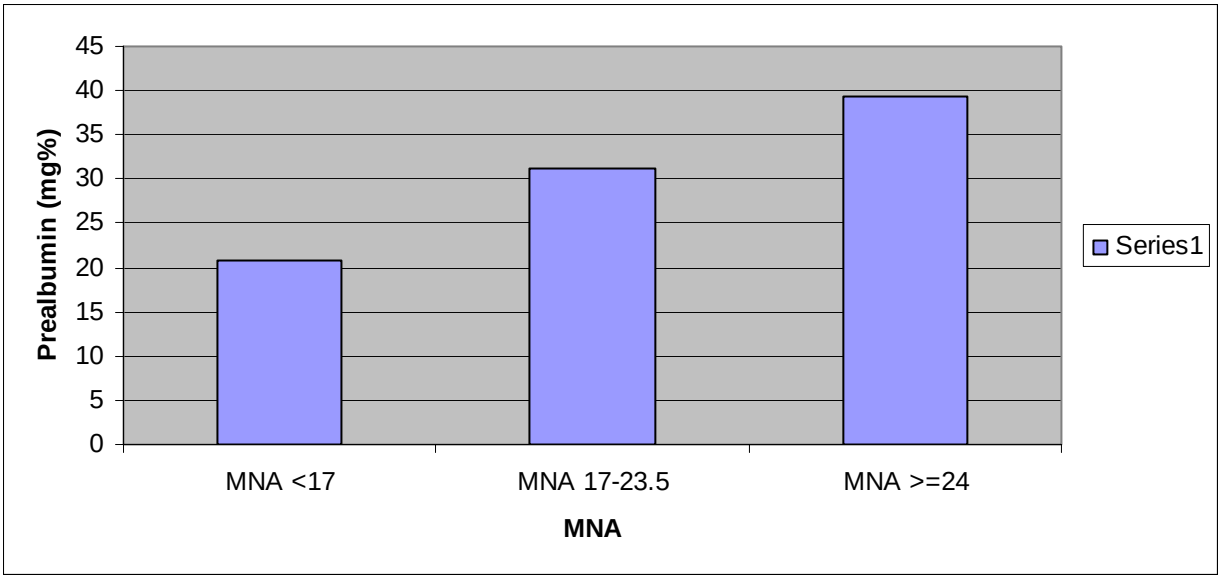


There was significant difference in mean Prealbumin(mg%) between the three groups of nutritional status.

The lowest and highest recorded Prealbumin in the study group was 17.6mg% and 45mg% respectively.

Table 11: Mean serum prealbumin(mg%) in each group of MNA in subjects above the age of 75yrs

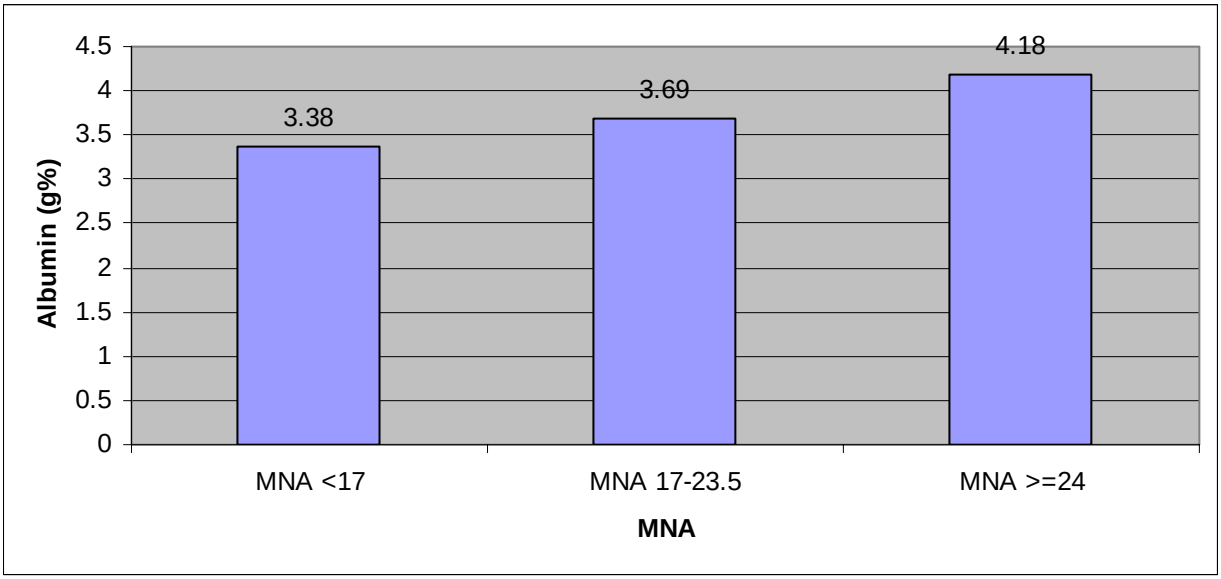
	PREALBUMIN (mg%)		P value
	Mean	S.D	
Malnourished (<17) (n=11)	21.65[a]	2.26	<0.001[**]
At risk for malnutrition(17-23.5) (n=11)	33.82[b]	5.87	
Well nourished (>=24) (n=3)	36.70[b]	3.39	



There was no significant difference in the mean prealbumin levels between "at risk" group and well nourished group. There was significant difference in malnourished group compared with other two groups. The lowest and highest recorded prealbumin in the study group was 18.2mg% and 40.5mg% respectively.

Table 12: Mean serum albumin(gm%) in each MNA group

	ALBUMIN (g%)		P value ANOVA
	Mean	S.D	
Malnourished (<17) (n=31)	3.38[a]	0.23	<0.001[**]
At risk for malnutrition(17-23.5) (n=36)	3.69[b]	0.26	
Well nourished (>=24) (n=33)	4.18[c]	0.35	

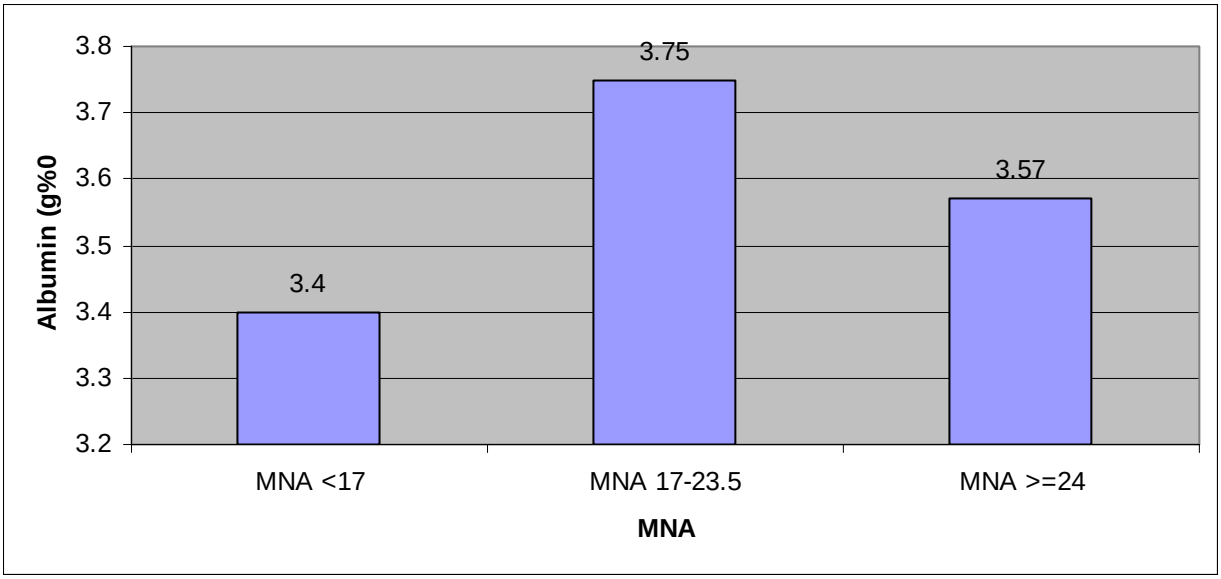


There was significant difference in mean albumin(g%) between the three groups of nutritional status.

The lowest and highest recorded albumin in the study group was 2.8g% and 4.8g% respectively.

Table 13: Mean serum albumin in each MNA group in subjects above the age of 75yrs

	ALBUMIN (g%)		P value ANOVA
	Mean	S.D	
Malnourished (<17) (n= 11)	3.40	0.15	NS P=0.12
At risk for malnutrition(17-23.5) (n=11)	3.75	0.40	
Well nourished (>=24) (n=3)	3.57	0.42	



There was no significant difference in mean albumin(g%) between the three groups of nutritional status.

The lowest and highest recorded albumin in the study group was 3.1g% and 4.6g% respectively.

Table 14: Correlation coefficient compared to MNA

	BMI	MAC	CC	Prealbumin	Albumin
Correlation Coefficients	0.82	0.76	0.79	0.89	0.79

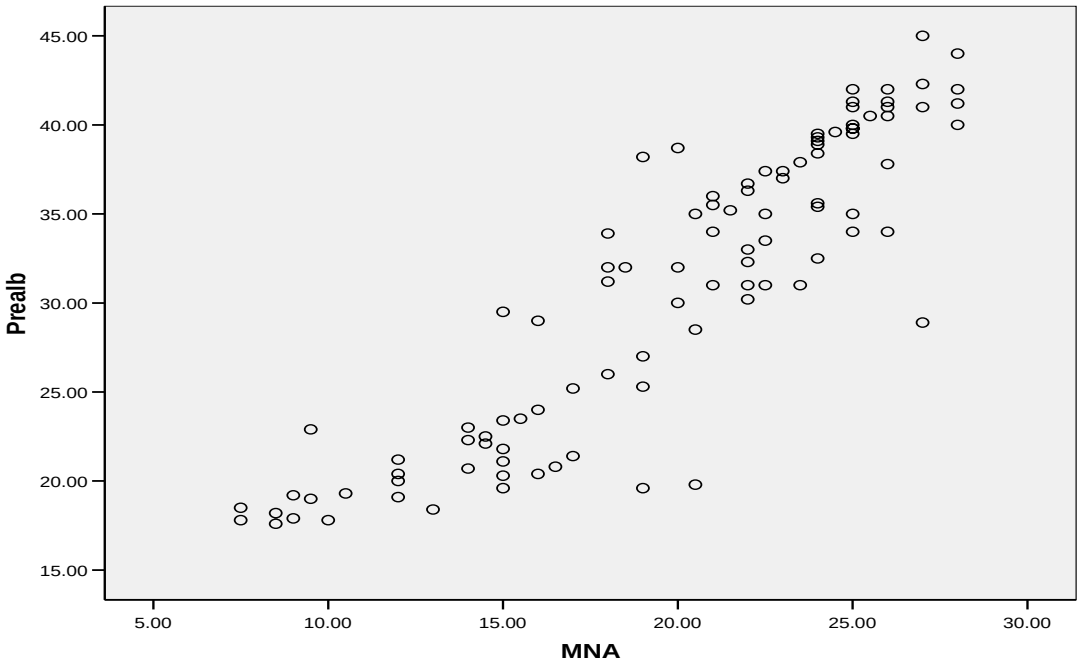
Table 15: Correlation coefficient compared to MNA in subjects above the age of 75yrs

	BMI	MAC	CC	Prealbumin	Albumin
Correlation Coefficients	0.59	0.73	0.46	0.81	0.45

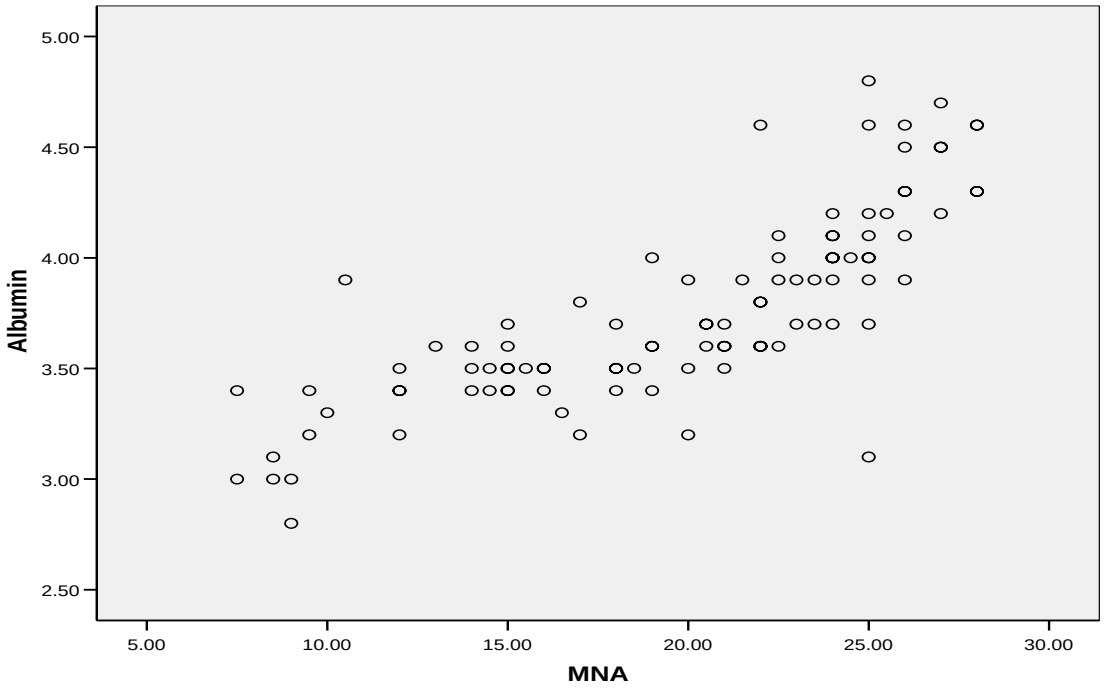
The above data showed that good correlation exists between MNA and the anthropometric and biochemical parameters.

In the subjects, aged more than 75 years the correlation coefficients between MNA and BMI, Calf circumference and albumin were found to be reduced, whereas the MAC and prealbumin correlation coefficient were found to be remaining constant.

Scatter diagram Prealbumin versus MNA



Scatter diagram Albumin versus MNA



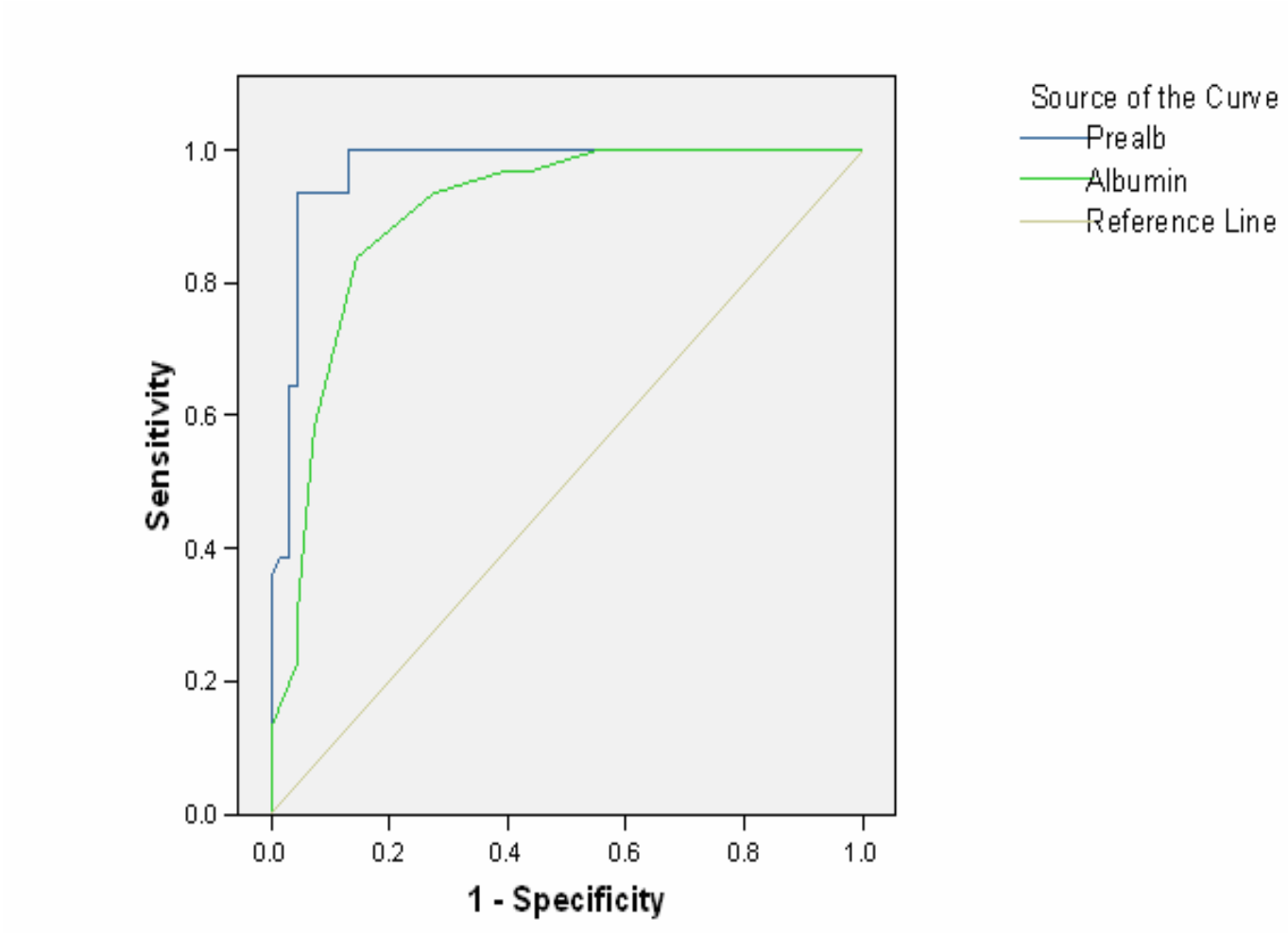
Validation of prealbumin and albumin

For the purpose of validation of prealbumin and albumin, the study population was divided into undernourished, i.e. MNA score less than <17 and nourished, i.e. MNA score >= 17.

Undernourished	31
Nourished	69

As there are no studies published on standard normal values of preabumin in Indian population. For this reason a ROC curve was utilized. With positive result being MNA< 17, negative result MNA >= 17, ROC curve was plotted so that desired sensitivity and specificity can be obtained and also corresponding cut off values for serum prealbumin and albumin derived.

ROC curve[**]



[**]Coordinates of the curve (appendix 2)

ROC (Receiver Operating Characteristic) curve is computer generated curve obtained when **Sensitivity** is plotted against (**1- Specificity)**.

Table 16: Serum prealbumin cut offs values derived from ROC curve taking MNA <17 (undernutriton) as positive result

Conditions	Cut off value	Sensitivity	Specificity
Maximum sensitivity Maximum specificity	< 24.60	93%	95%
As a screening tool Maximum sensitivity	< 29.75	100%	87%
As a diagnostic tool Maximum specificity	< 19.45	64%	100%

Table 17: Serum albumin cut offs values derived from ROC curve taking MNA <17 (undernutriton) as positive result

Conditions	Cut off value	Sensitivity	Specificity
Maximum sensitivity Maximum specificity	< 3.55	83%	85%
As a screening tool Maximum sensitivity	< 3.95	100%	45%
As a diagnostic tool Maximum specificity	< 3.05	13%	100%

DISCUSSION

Study population

Sex:

This study was done only in males because biochemical parameters especially serum prealbumin is not standardized in the Indian population and studies have shown that women have lower values of serum prealbumin than in men of the same age group. In addition, the anthropometric measurement cut offs used in the MNA have not been standardized in the Indian population.

Age:

The subjects selected in study population are above the age of 65 yrs, even though the cut off age according to WHO for geriatric population in developing countries is taken as 60 yrs. This is because published studies are mainly from developed countries where the age cut off for geriatric population is above 65 yrs. The majority of the patients in the study

population were between the age group of 65 to 70 yrs (49%) reflecting the population attending the geriatric outpatient department (Table 2).

Analysis of the results

In this study by using MNA, 31% of subjects were found to be malnourished, 36% subjects at risk of malnutrition and 33% of subjects well nourished [Table 1].

The percentage of malnourished in the age group above 75yrs was 44% compared to 27% in the below 75 age group suggesting that the prevalence of malnutrition increases with age [Table 3].

There was no difference in the mean ages between each nutritional status groups ($p=0.14$). Thus, age was not a confounding factor in this study [Table 4].

Analysis of parameters included in the MNA vs MNA Categories

1) Weight:

There was significant difference in mean weights between the three groups of nutritional status ($p < 0.05$). Thus, weight can be used as measure of nutritional status assessment [Table 5].

2) Body Mass Index:

There was significant difference in mean BMI between the three groups of nutritional status. ($p < 0.001$) with BMI being significantly low in the malnourished group. Thus BMI can be used as measure of nutritional status assessment [Table 6]. This proved the usefulness and relevance of BMI as part of MNA scoring. The correlation coefficient of BMI with MNA for the study population was 0.82 compared to 0.59 in the above 75yrs. The BMI measurement in above 75 yrs is not as valuable as in the below 75 yrs [Table 14, Table 15].

3) Midarm Circumference:

There was no significant difference in the mean Midarm circumferences between “at risk” group and well nourished group. There was significant difference in malnourished group compared with other two groups.($p<0.05$)[Table 7]. MAC can detect under-nutrition but not “at risk” group. This is probably due to high cut off for MAC which was used in the study which is not appropriate as the cut off value would have been lower if corrected for the Indian population. MAC has a good correlation with MNA in both study population and above 75yrs. [Table 14, Table 15]

4) Calf Circumference:

There was no significant difference in the mean calf circumferences between “at risk” group and well nourished group. There was significant difference in malnourished group compared with other two groups ($p<0.05$).[Table 8].This is probably due to high cut off for calf circumference which was used in MNA which is not appropriate as the cut off value would have been lower if corrected for the Indian population. The correlation coefficient of calf circumference with MNA for the study

population was 0.79 compared to 0.46 in the above 75 yrs. The calf circumference measurement in above 75yrs is not as valuable as in the below 75 yrs. [Table 14, Table 15] and not useful in identifying "at risk" group but can detect under-nutrition.

The Body Mass Index had the best significance value followed by Midarm Circumference and Calf Circumferance justifying its use in the MNA scoring system. The parameters used in MNA are based on western population. The anthropometric measurement cut offs used in MNA, especially BMI, MAC and Calf circumference needs to be revised and standardized for application in the Indian population.

Serum prealbumin compared with MNA scores

Reference value for quantitative turbimetry serum prealbumin assay is 20mg% to 40mg%. Subjects with serum prealbumin levels more than 40 mg% were all are well nourished and the majority of subjects with prealbumin less than 20 mg% were malnourished (87%) and rest were at risk for malnutrition.

There was significant difference in mean prealbumin(mg%) between the three groups of nutritional status.($p<0.001$) in the study population and in the above 75yrs age group. Serum prealbumin has a good correlation with MNA in both study population and above 75yrs. [Table 14, Table 15], indicating that serum prealbumin is a good indicator of nutritional status in elderly.

Serum albumin compared with MNA scores

Significant difference in mean albumin(g%) between the three groups of nutritional status ($p<0.001$) in the study population was observed but not in the age group above 75 yrs of age. Serum albumin has a good correlation with MNA in study population but correlation coefficient drops in the above 75 yrs age group [Table 14, Table 15], indicating that serum albumin is a not a good indicator of nutritional status in elderly above the age of 75 yrs. Decline in serum albumin levels (0.8 g/L per decade in persons older than 60 yrs) [22] may possibly be the reason for poor value of serum albumin as nutritional status indicator in elderly above 75 yrs of age.

Validation of serum prealbumin in comparison with MNA

As there is no Indian population based standard normal values for serum prealbumin, ROC curve was used to derive the sensitivity and specificity of prealbumin levels and in turn the cut off values.

Maximum sensitivity and specificity obtained was 93% and 95% with cut off of < 24.60mg%. Sensitivity (98%) of prealbumin in Vellas B, Guigoz Y et al study was higher than what was obtained in this study [Table 16]. But specificity obtained in this study is higher than what was obtained in index study. (95% in this study vs 87% in Vellas B, Guigoz Y et al study).

For the purpose of using serum prealbumin as screening test in the community level cut off value obtained was <29.75mg% with a specificity 87%. Thus, serum prealbumin < 29.75mg% can be used to pick elderly with under-nutrition in the community level for further confirmatory work up of malnutrition and its management.

Validation of serum albumin in comparison with MNA

Using ROC curve the <3.55g% of albumin was obtained as cut of value with maximum sensitivity (83%) and specificity (85%) [Table 17]. In comparison with Vellas B, Guigoz Y et al study, the sensitivity and specificity obtained in this study were higher.

For the purpose of using it as screening test the cut off value obtained was 3.95mg% with a poor specificity of 45%. Thus, use of albumin in community level as screening test is questionable.

CONCLUSION

Mini nutritional assessment is a good indicator of nutritional status but needs modification in the cut off ranges in its anthropometric parameters (Body Mass Index, Midarm circumference, and Calf circumference) for application in the Indian population.

The anthropometric measurements (Body Mass Index, Midarm circumference, and Calf circumference) are essential and good components of the of the Mini nutritional assessment scale.

Serum albumin is an adequate measure of nutritional status in the elderly but its role in the 75yrs and above population is questionable. Its role in the use in the community screening of the elderly population is not strong as the specificity is low.

Serum prealbumin is a good indicator of malnutrition as compared with MNA. It is a good measure of nutritional status in all age groups of elderly population. There is need for standardization of prealbumin levels based on Indian population. Role of prealbumin as screening test showed excellent results with high specificity.

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Proforma (appendix 1)

Mini nutritional assessment

Last name: _____ First name: _____ Middle initial: ____ Sex: ___ Date: _____
Age: _____ Weight (kg): _____ Height (cm): _____
Complete the form by writing the points in the boxes. Add the points in the boxes, and compare the total assessment to the malnutrition indicator score.*

Anthropometric assessment **Points**

1. Body mass index (weight in kg ÷ height in m2):
   a. <19 = 0 points
   b. 19 to <21 = 1 point
   c. 21 to <23 = 2 points
   d. >23 = 3 points ☐

2. Midarm circumference:
   a. <21 cm = 0 points
   b. 21 to ≤22 cm = 0.5 point
   c. >22 cm = 1 point ☐

3. Calf circumference:
   a. <31 cm = 0 points
   b. ≥31 cm = 1 point ☐

4. Weight loss during past 3 months:
   a. >3 kg = 0 points
   b. Does not know = 1 point
   c. 1 to 3 kg = 2 points
   d. No weight loss = 3 points ☐

General assessment

5. Lives independently (not in nursing home or hospital):
   a. No = 0 points
   b. Yes = 1 point ☐

6. Takes more than three prescription drugs per day:
   a. Yes = 0 points
   b. No = 1 point ☐

7. Has suffered psychologic stress or acute disease in the past 3 months:
   a. Yes = 0 points
   b. No = 1 point ☐

8. Mobility:
   a. Bed-bound or chair-bound = 0 points
   b. Able to get out of bed or chair, but does not go out = 1 point
   c. Goes out = 2 points ☐

Points

9. Neuropsychologic problems:
   a. Severe dementia or depression = 0 points
   b. Mild dementia = 1 point
   c. No psychologic problems = 2 points ☐

10. Pressure sores or skin ulcers:
   a. Yes = 0 points
   b. No = 1 point ☐

Dietary assessment

11. How many full meals does the patient eat daily?
   a. One meal = 0 points
   b. Two meals = 1 point
   c. Three meals = 2 points ☐

12. Selected consumption markers for protein intake:
   a. At least one serving of dairy products (milk, cheese, yogurt) per day:
      yes no
   b. Two or more servings of legumes or eggs per week:
      yes no
   c. Meat, fish or poultry every day:
      yes no
   0 or 1 yes answers = 0 points
   2 yes answers = 0.5 point
   3 yes answers = 1 point ☐

13. Consumes two or more servings of fruits or vegetables per day:
   a. No = 0 points
   b. Yes = 1 point ☐

14. Decline in food intake over the past 3 months because of loss of appetite, digestive problems, or chewing or swallowing difficulties:
   a. Severe loss of appetite = 0 points
   b. Moderate loss of appetite = 1 point
   c. No loss of appetite = 2 points ☐

Last name: _____ First name: _____ Middle initial: ____ Sex: ___ Date: _____
Age: _____ Weight (kg): _____ Height (cm): _____
Complete the form by writing the points in the boxes. Add the points in the boxes, and compare the total assessment to the malnutrition indicator score.*

Dietary assessment, continued		**Points**
15. Cups of fluid (eg, water, juice, coffee, tea, milk) consumed per day (1 cup = 8 oz):		
a. <3 cups	= 0 points	
b. 3 to 5 cups	= 0.5 point	☐
c. >5 cups	= 1 point	
16. Mode of feeding:		
a. Needs assistance to eat	= 0 points	
b. Self-fed with some difficulty	= 1 point	☐
c. Self-fed with no problems	= 2 points	
Self-assessment		
17. Does the patient think that he or she has nutritional problems?		
a. Major malnutrition	= 0 points	
b. Moderate malnutrition or does not know	= 1 point	☐
c. No nutritional problem	= 2 points	
18. How does the patient view his or her health status compared with the health status of other people of the same age?		
a. Not as good	= 0 points	
b. Does not know	= 0.5 point	
c. As good	= 1 point	☐
d. Better	= 2 points	
Assessment total (maximum of 30 points):		☐*

Serum prealbumin(mg%):

Serum albumin(g%):

ROC curve coordinates (appendix 3)

Coordinates of the Curve

Test Result Variable(s)	Positive if Less Than or Equal To[a]	Sensitivity	1 - Specificity
Prealb	16.6000	.000	.000
	17.7000	.032	.000
	17.8500	.097	.000
	18.0500	.129	.000
	18.3000	.161	.000
	18.4500	.194	.000
	18.7500	.226	.000
	19.0500	.258	.000
	19.1500	.290	.000
	19.2500	.323	.000
	19.4500	.355	.000
	19.7000	.387	.014
	19.9000	.387	.029
	20.1500	.419	.029
	20.3500	.452	.029
	20.5500	.516	.029
	20.7500	.548	.029
	20.9500	.581	.029
	21.1500	.613	.029
	21.3000	.645	.029
	21.6000	.645	.043
	21.9500	.677	.043
	22.2000	.710	.043
	22.4000	.742	.043
	22.7000	.774	.043
	22.9500	.806	.043
	23.2000	.839	.043
	23.4500	.871	.043
	23.7500	.903	.043
	24.6000	.935	.043
	25.2500	.935	.058
	25.6500	.935	.072
	26.5000	.935	.087
	27.7500	.935	.101
	28.7000	.935	.116
	28.9500	.935	.130
	29.2500	.968	.130
	29.7500	1.000	.130
	30.1000	1.000	.145
	30.6000	1.000	.159
	31.1000	1.000	.217
	31.6000	1.000	.232
	32.1500	1.000	.275
	32.4000	1.000	.290
	32.7500	1.000	.304
	33.2500	1.000	.319
	33.7000	1.000	.333
	33.9500	1.000	.348
	34.5000	1.000	.391
	35.1000	1.000	.435
	35.3000	1.000	.449
	35.4500	1.000	.464
	35.5500	1.000	.478
	35.8000	1.000	.493
	36.1500	1.000	.507
	36.5000	1.000	.522
	36.8500	1.000	.536
	37.2000	1.000	.551
	37.6000	1.000	.580
	37.8500	1.000	.594
	38.0500	1.000	.609
	38.3000	1.000	.623
	38.5500	1.000	.638
	38.8000	1.000	.652
	39.0000	1.000	.667
	39.2000	1.000	.681
	39.4000	1.000	.696
	39.5500	1.000	.725
	39.7000	1.000	.739
	39.9000	1.000	.768
	40.2500	1.000	.797
	40.7500	1.000	.826
	41.1000	1.000	.870
	41.2500	1.000	.884
	41.6500	1.000	.913
	42.1500	1.000	.957
	43.1500	1.000	.971
	44.5000	1.000	.986
	46.0000	1.000	1.000
Albumin	1.8000	.000	.000
	2.9000	.032	.000
	3.0500	.129	.000
	3.1500	.161	.014
	3.2500	.226	.043
	3.3500	.290	.043
	3.4500	.581	.072
	3.5500	.839	.145
	3.6500	.935	.275
	3.7500	.968	.391
	3.8500	.968	.435
	3.9500	1.000	.551
	4.0500	1.000	.667
	4.1500	1.000	.739
	4.2500	1.000	.797
	4.4000	1.000	.855
	4.5500	1.000	.899
	4.6500	1.000	.971
	4.7500	1.000	.986
	5.8000	1.000	1.000

Abbreviations (appendix 4)

BMI	:	Body Mass Index
CC	:	Calf Circumference
MAC	:	Midarm Circumference
MNA	:	Mini Nutritional Assessment
PA	:	Prealbumin
ROC	:	Reciever Operating Characteristics

Master Chart (appendix 5)

Name	Age	Sex	Wt (kg)	Ht (m)	BMI	MAC (cm)	CC (cm)	MNA Score	Prealbumin (mg%)	Albumin (g%)
Abdul Sukur	74	M	56	1.63	21.0772	24	30	22.5	31	3.9
Ananadhan	66	M	60	1.57	24.34176	25	35	27	45	4.7
Anand	67	M	56	1.54	23.61275	24	33	25	41	3.9
Anandan	69	M	57	1.63	21.45357	22	30	22.5	33.5	3.6
Antony	74	M	62	1.58	24.83576	23	34	25	39.8	4.0
Arumugam	65	M	35	1.58	14.02019	17.5	24	8.5	17.6	3.0
Arunachalam	66	M	72	1.72	24.33748	25	38	28	41.2	4.6
Balakrishnan	71	M	62	1.58	24.83576	24	34	25	41.3	4.0
Chandrasekhar	70	M	51	1.55	21.22789	22	32	22	33	3.6
Chandrasekhar	66	M	70	1.73	23.38869	23.5	34	24	38.9	4.1
Chellapan	66	M	70	1.62	26.67276	26	35	28	40	4.3
Chimulu	75	M	57	1.67	20.43817	24	31	14	20.7	3.6
Chinnadurai	71	M	58	1.57	23.53037	24	33	26	34	4.1
Chinnaraj	65	M	36	1.47	16.65973	20	24	10.5	19.3	3.9
Chinnasamy	67	M	48	1.47	22.21297	21.5	31	23.5	37.9	3.7
Chokkalingam	65	M	68	1.56	27.94214	27	36	25	39.5	4.2
Dhanasekhar	66	M	70	1.56	28.76397	27	37.5	28	44	4.6
Durai	70	M	69	1.76	22.27531	23.5	32	25.5	40.5	4.2
Durairaj	72	M	56	1.64	20.82094	22	29	16	29	3.5
Duraisamy	66	M	56	1.58	22.4323	21	31	19	19.6	3.6
Ganesan	65	M	42	1.5	18.66667	23	28	15	21.8	3.7
Ganesan	67	M	61	1.69	21.3578	22	31	21	35.5	3.6
Gnanavel	68	M	52	1.53	22.21368	23	33	25	35	3.7
Gopal	77	M	45	1.61	17.36044	20.5	27	20.5	19.8	3.7
Gopal	70	M	60	1.78	18.937	19.5	28	15	29.5	3.5
Gopalakrisnan	70	M	38	1.54	16.02294	19	27	12	19.1	3.4

Gopalasamy	74	M	67	1.7	23.18339	22	32	24	35.4	4.0
Govindan	65	M	67	1.59	26.50212	26	37	28	42	4.3
Harikrishnan	71	M	71	1.75	23.18367	23	32	26	37.8	4.6
Iqbal	68	M	62	1.59	24.52435	24	33.5	25	40	4.1
Iruchan	70	M	47	1.48	21.45727	23	28	25	39.8	4.8
Iyyadurai	75	M	45	1.72	15.21092	22	27.5	22.5	35	4.0
Jagannathan	65	M	67	1.73	22.38631	23	33	27	41	4.5
Jeyachandran	72	M	62	1.75	20.2449	20.5	29	20.5	28.5	3.6
Kadar Basha	81	M	44	1.58	17.62538	20	27	21	36	3.7
Kamalakannan	70	M	61	1.67	21.87242	21	30	21	31	3.5
Kandasamy	68	M	53	1.54	22.34778	22.5	31	23	37.4	3.7
Kannan	79	M	42	1.59	16.61327	18	27	8.5	18.2	3.1
Krishnasami	66	M	72	1.69	25.2092	26	35	26	41	4.5
Kumar	65	M	56	1.58	22.4323	23	31	23	37	3.9
Kumaraguru	75	M	53	1.58	21.23057	20	29	17	21.4	3.2
Kumarasamy	75	M	46	1.52	19.90997	19.5	27	18	26	3.4
Mani	79	M	42	1.54	17.70956	20	29	14.5	22.5	3.4
Mani	67	M	49	1.63	18.44255	19	27	15.5	23.5	3.5
Manickam	74	M	59	1.68	20.9042	21	32	22	32.3	3.6
Mariappan	81	M	43	1.56	17.6693	18	26	15	23.4	3.5
Muniappa	75	M	43	1.62	16.3847	18.5	26	15	21.1	3.4
Munirathinam	76	M	56	1.64	20.82094	22.5	31	21.5	35.2	3.9
Murugan	83	M	52	1.58	20.83	20	28	24	35.6	3.7
Muthu	68	M	42	1.48	19.17458	19.5	26.5	24	39.3	4.1
Nagaraj	82	M	61	1.63	22.95909	22	31	26	40.5	3.9
Nandagopal	74	M	43	1.58	17.2248	17.5	25.5	10	17.8	3.3
Natesan	67	M	45	1.62	17.14678	18	25	15	19.6	3.4
Neelakandan	72	M	52	1.53	22.21368	20.5	32	26	41.3	4.3
Pachaiappan	69	M	41	1.5	18.22222	20	27	14	22.3	3.5
Pachaipillai	68	M	64	1.69	22.40818	24	32	24	32.5	4.2
Padmanabhan	84	M	36	1.42	17.8536	18.5	25	14	23	3.4

Palani	67	M	39	1.54	16.44459	18.5	25	9	17.9	3.0
Palanivel	69	M	60	1.65	22.03857	23.5	33	26	42	4.3
Pandian	69	M	50	1.57	20.2848	20.5	28	20	30	3.5
Pandurangan	69	M	51	1.62	19.43301	20	28.5	16	20.4	3.4
Paramasivam	72	M	48	1.69	16.80613	22	25	9	19.2	2.8
Penchalaiah	73	M	45	1.48	20.54419	21	32	20.5	35	3.7
Periyandavar	65	M	35	1.5	15.55556	19.5	25	7.5	18.5	3.4
Ponnuswamy	69	M	45	1.57	18.25632	22	30	15	20.3	3.6
Ponnuswamy	76	M	46	1.62	17.52782	19	27	16	24	3.5
Ponraj	80	M	60	1.63	22.58271	23.5	32	25	34	3.1
Raja	71	M	45	1.58	18.02596	21	28	18.5	32	3.5
Rajamani	70	M	40	1.42	19.83733	19.5	28	18	32	3.7
Rajan	73	M	56	1.66	20.32225	22	31	22	31	3.6
Rajasekhar	68	M	45	1.72	15.21092	19	28	9.5	19	3.2
Rajendran	78	M	50	1.6	19.53125	21	28	18	33.9	3.5
Ramalingam	71	M	48	1.56	19.72387	21	30	20	32	3.9
Raman	66	M	63	1.61	24.30462	23.5	32	24	39.1	4.0
Rangan	82	M	42	1.64	15.6157	18.5	24	21	34	3.6
Rashid Khan	69	M	42	1.62	16.00366	19	26	12	20.4	3.4
Rathinam	92	M	36	1.58	14.42077	19	24.5	22	36.3	4.6
Ravindran	68	M	54	1.54	22.76944	23	33	24	38.4	3.9
Rudrakoti	70	M	32	1.53	13.66996	19	23	7.5	17.8	3.0
Sadasivam	67	M	42	1.64	15.6157	17	25	12	20	3.2
Sakthivel	78	M	38	1.56	15.61473	16	24	9.5	22.9	3.4
Sambasivam	95	M	40	1.56	16.43655	21	26	16.5	20.8	3.3
Sambasivam	69	M	52	1.62	19.81405	22	28	18	31.2	3.5
Selvam	76	M	43	1.52	18.6115	21	29	22	36.7	3.8
Selvaraj	67	M	62	1.6	24.21875	24.5	35	25	42	4.6
Sengalvarayan	75	M	43	1.72	14.53488	20.5	29	14.5	22.1	3.5
Senthil Kumar	65	M	64	1.74	21.13886	21.5	32	24.5	39.6	4.0
Srinivasan	82	M	36	1.58	14.42077	19	28	13	18.4	3.6

Srinivasan	65	M	33	1.53	14.09714	19	24	12	21.2	3.5
Srinivasan	68	M	57	1.63	21.45357	25	35	23.5	31	3.9
Srinivasan	68	M	62	1.67	22.23099	22	31	19	38.2	4.0
Subramani	70	M	48	1.55	19.97919	20.5	28	19	25.3	3.6
Subramani	69	M	63	1.67	22.58955	23	34	27	28.9	4.2
Subramani	87	M	39	1.53	16.66026	20	26	20	38.7	3.2
Subramanian	65	M	57	1.68	20.19558	21	29	22	30.2	3.8
Thanickachalam	69	M	45	1.51	19.73598	21	31	19	27	3.4
Velu	72	M	51	1.52	22.0741	23	31	17	25.2	3.8
Venu	68	M	72	1.72	24.33748	25.5	35	27	42.3	4.5
Venugopal	66	M	50	1.56	20.54569	24	29	24	39.5	4.0
Yusuf	67	M	52	1.53	22.21368	23	31	22.5	37.4	4.1