DIETARY INTAKE OF THE INSTITUTIONALISED ELDERLY

by

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SUMMARY

Dementia occurs in about 2.4 per cent of persons aged 65 to 69 years but in 22 per cent of those aged 80 years and over (Kay et al., 1964 and 1970). The importance of these observations is emphasized by the increasing proportion of the population reaching old age. This brings an increasing demand on health care facilities and long term residential care.

The causes of dementia are unknown. It has been suggested that one of the changes in dementia is a reduction in the cholinergic, serotoninergic and other transmission systems.

Preliminary studies by Lehmann (1979) suggested that a proportion of old people may not absorb tryptophan (a precursor of serotonin) normally and that this is associated with dementia. This is of considerable potential interest in relation to diet because primary dietary lack, or a failure to absorb certain nutrients, might contribute to the aetiology of the disease.

The possible effect of nutrition on brain function in the elderly and on the dementing process, is confounded by the fact that dementing old people have often been in hospital for sometime and have become institutionalised. Any deficiency in the provision of
food and its nutrient content may therefore affect mental state as well as physical well being.

Dietary intakes of 23 patients with senile dementia and 12 residents in part III accommodation were compared to those of healthy community controls of similar age. The patients with senile dementia had lower mean intakes of energy, protein, fibre, ascorbic acid and nicotinic acid. The poor dietary intake of ascorbic acid was reflected in lower levels of plasma ascorbic acid.

Both patients and controls had low intakes of folic acid, yet only in patients was a lower level of red cell folate shown.

Dietary intakes of thiamin were similar between the groups, yet one third of the patients had intakes below the recommended daily amount (DHSS, 1979).

These results are of interest when investigating the effect of nutrition on mental performance.

The group of residents had significantly lower mean intakes of ascorbic acid, thiamin, pyridoxin, vitamin B12, folic acid, nicotinic acid, protein and iron, copper and zinc.
These findings were reflected in lower circulating levels of ascorbic acid and folic acid in the residents.

In both cases the poor dietary intakes for patients and residents was partly attributed to inadequate portion size and for residents poor menu design.

There is no clear evidence that any nutritional deficiency is found specifically in patients with senile dementia, though there are suggestions that folic acid deficiency may play a role in the development of the condition.

A preliminary investigation into the effect of vitamin supplementation on patients with dementia showed an improvement in mental function over a two month period, for those on active preparation. However, the results did not reach a level of significance and it is suggested that a longer period of supplementation on a larger group of patients with early dementia is necessary.

The association between ageing, senile dementia and nutritional status merits further investigation in the light of nutritional inadequacies both in patients and residents in part III accommodation.

There is a need for a total reappraisal of the provision of food to the elderly in institutions.
DEDICATION

To Matthew, for understanding
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## Contents

Summary i
Dedication iv
Acknowledgements v
Contents vi
List of Tables x
List of Figures xi

### Chapter 1: Introduction

1.1. Senile Dementia 1
   1.1.a. General Considerations 2
   1.1.b. Clinical Features of Senile Dementia 4
   1.1.c. Aetiology of Dementia 6
   1.1.d. Brain Changes in Dementia 7
     - 1.1.d.i. Structural 7
     - 1.1.d.ii. Biochemical 8
     - 1.1.d.iii. Cholinergic System 9
     - 1.1.d.iv. Other Neurotransmitters 9
   1.1.e. Substrate Control of Neurotransmitter Synthesis 10
   1.1.f. Control of Tryptophan Entry into the Brain 11
   1.1.g. Tryptophan and Dementia 14
   1.1.h. Treatment of Dementia using Precursors of Neurotransmitters 15
     - 1.1.i. Malnutrition and Alzheimer's Disease 16
   1.2. Nutritional Studies in the Elderly 17
     - 1.2.a. General Aspects 17
     - 1.2.b. Normal Values for the Elderly 18
       - 1.2.b.i. Elderly 21
       - 1.2.b.ii. Institutionalised Elderly 21
     - 1.2.b.iii. Body Weight 22
     - 1.2.b.iv. Brain Function 23
   - 1.3.c. B Vitamins 24
     - 1.3.c.i. Elderly 24
     - 1.3.c.ii. Mental Disturbance 25
   - 1.3.d. Folic Acid 26
     - 1.3.d.i. Measurements of Folate Intake 26
     - 1.3.d.ii. Folic Acid Status in the Elderly 28
     - 1.3.d.iii. Folic Acid Status and Dementia 29
   - 1.3.e. Vitamin B12 status 30
     - 1.3.e.i. Elderly 30
     - 1.3.e.ii. Mental State 31
   - 1.3.f. Vitamin C 32
     - 1.3.f.i. Status in the Elderly 32
     - 1.3.f.ii. Status in Psychogeriatrics 33
     - 1.3.f.iii. Destruction of Vitamin C in Cooking 35
   - 1.3.g. Vitamin D Status 36
   - 1.3.g.i. The Elderly 36
   - 1.3.g.ii. The Psychogeriatric Patient 36
   - 1.3.h. Zinc and Copper Nutriture in the Elderly 37
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3.i. Calcium and Magnesium Status</td>
<td>39</td>
</tr>
<tr>
<td>1.3.i.i. The Elderly</td>
<td>39</td>
</tr>
<tr>
<td>1.3.i.ii. Dementia</td>
<td>39</td>
</tr>
<tr>
<td>1.4. Nutritional Studies in Dementia</td>
<td>40</td>
</tr>
<tr>
<td>1.5. The Present Study</td>
<td>41</td>
</tr>
<tr>
<td>Chapter 2. Methodology</td>
<td>43</td>
</tr>
<tr>
<td>2.1 Design of Study</td>
<td>44</td>
</tr>
<tr>
<td>2.1.a. Ethical Approval</td>
<td>46</td>
</tr>
<tr>
<td>2.2. Selection of Subjects</td>
<td>46</td>
</tr>
<tr>
<td>2.2.a. Patients with Senile Dementia</td>
<td>46</td>
</tr>
<tr>
<td>2.2.b. Healthy Control Subjects</td>
<td>47</td>
</tr>
<tr>
<td>2.2.c. Residents in part III accommodation</td>
<td>48</td>
</tr>
<tr>
<td>2.3. Dietary Assessment</td>
<td>48</td>
</tr>
<tr>
<td>2.3.a. Three Day vs Seven Day Weighed Intake</td>
<td>51</td>
</tr>
<tr>
<td>2.3.b. Three Day Intakes for Control Group</td>
<td>53</td>
</tr>
<tr>
<td>2.3.c. Calculations of Composite Menu Items</td>
<td>53</td>
</tr>
<tr>
<td>2.4. Procedure of Dietary Assessment</td>
<td>54</td>
</tr>
<tr>
<td>2.4.a. Patients in Hospital and Residents in part III accommodation</td>
<td>54</td>
</tr>
<tr>
<td>2.4.a.i. Apparatus</td>
<td>58</td>
</tr>
<tr>
<td>2.4.a.ii. Measurement</td>
<td>58</td>
</tr>
<tr>
<td>2.4.a.iii. Method of Weighing</td>
<td>59</td>
</tr>
<tr>
<td>2.4.b. Subjects Living at Home</td>
<td>61</td>
</tr>
<tr>
<td>2.4.b.i. Method of Weighing</td>
<td>62</td>
</tr>
<tr>
<td>2.5. Analysis of Dietary Intake</td>
<td>63</td>
</tr>
<tr>
<td>2.5.a. Vitamin Calculations from the McCance and Widdowson Food Tables</td>
<td>65</td>
</tr>
<tr>
<td>2.5.b. The Vitamin C content of Potato in Hospitals</td>
<td>66</td>
</tr>
<tr>
<td>2.5.b.i. Reagents</td>
<td>66</td>
</tr>
<tr>
<td>2.5.b.ii. Standardisation of Dye Solution</td>
<td>68</td>
</tr>
<tr>
<td>2.5.b.iii. Method</td>
<td>68</td>
</tr>
<tr>
<td>2.5.b.iv. Potato Samples</td>
<td>69</td>
</tr>
<tr>
<td>2.5.b.v. Timing</td>
<td>69</td>
</tr>
<tr>
<td>2.5.b.vi. Assay Procedure</td>
<td>70</td>
</tr>
<tr>
<td>2.5.b.vii. Calculation</td>
<td>71</td>
</tr>
<tr>
<td>2.6. Interpretation of the Data</td>
<td>71</td>
</tr>
<tr>
<td>2.7. Programme of Dietary Investigation</td>
<td>73</td>
</tr>
<tr>
<td>Chapter 3 Comparison of Dietary Intakes of Patients with Senile Dementia and the Intakes of the Healthy Elderly at Home</td>
<td>75</td>
</tr>
<tr>
<td>3.1. Introduction</td>
<td>76</td>
</tr>
<tr>
<td>3.1.a. Assessment of Nutritional Status</td>
<td>77</td>
</tr>
<tr>
<td>3.2. Selection</td>
<td>77</td>
</tr>
<tr>
<td>3.2.a. Patients</td>
<td>77</td>
</tr>
<tr>
<td>3.2.b. Controls</td>
<td>78</td>
</tr>
<tr>
<td>3.3. Procedure</td>
<td>81</td>
</tr>
<tr>
<td>3.3.a. Patients</td>
<td>81</td>
</tr>
<tr>
<td>3.3.b. Controls</td>
<td>81</td>
</tr>
<tr>
<td>3.4. Results</td>
<td>82</td>
</tr>
<tr>
<td>3.4.a. Observations</td>
<td>82</td>
</tr>
<tr>
<td>3.4.a.i. Patient Group</td>
<td>82</td>
</tr>
<tr>
<td>3.4.a.ii. Control Group</td>
<td>83</td>
</tr>
<tr>
<td>3.4.b. Intakes</td>
<td>85</td>
</tr>
<tr>
<td>3.4.b.i. Fluid</td>
<td>85</td>
</tr>
<tr>
<td>3.4.b.ii. Energy</td>
<td>87</td>
</tr>
</tbody>
</table>
3.4.b.iii. Protein 89
3.4.b.iv. Fat 90
3.4.b.v. Carbohydrate 91
3.4.b.vi. Fibre 92
3.4.b.vii. Tryptophan 93
3.4.c. Vitamin Intakes 93
3.4.c.i. Vitamin C 93
3.4.c.ii. Thiamin 98
3.4.c.iii. Riboflavin 99
3.4.c.iv. Nicotinic Acid 99
3.4.c.v. Pyridoxin 100
3.4.c.vi. Vitamin B12 101
3.4.c.vii. Folic Acid 101
3.4.c.viii Vitamin D 103
3.4.c.ix. Vitamin A 103
3.4.d. Intakes of Minerals 104
3.4.d.i. Calcium 104
3.4.d.ii. Magnesium 106
3.4.d.iii. Iron 106
3.4.d.iv. Zinc 107
3.4.d.v. Copper 108
3.5. Discussion 108
3.5.a. Energy 108
3.5.b. Fluid 111
3.5.c. Fibre 113
3.5.d. Vitamins and Minerals 114
3.5.e. Tryptophan 127

Chapter 4 Comparison of the Dietary Intakes of Residents in part III accommodation and the Intakes of Healthy Elderly Persons at Home 132
4.1. Introduction 133
4.1.a. Assessment of Nutritional State 134
4.2. Selection of Subjects 135
4.2.a. Residents 135
4.2.b. Controls 137
4.3. Procedure 138
4.3.a. Residents 138
4.3.b. Controls 139
4.4. Results 139
4.4.a. Observations 139
4.4.a.i. Residents 139
4.4.a.ii. Control Group 140
4.4.b. Intakes 142
4.4.b.i. Fluid 142
4.4.b.ii. Energy 142
4.4.b.iii. Protein 145
4.4.b.iv. Fat 145
4.4.b.v. Carbohydrate 146
4.4.b.vi. Fibre 147
4.4.b.vii. Tryptophan 148
4.4.c. Vitamin Intakes 148
4.4.c.i. Vitamin C 150
4.4.c.ii. Thiamin 150
4.4.c.iii. Riboflavin 153
4.4.c.iv. Nicotinic Acid 153
4.4.c.v. Pyridoxin 154
## Tables

### Chapter 2
- 2.1. Comparison of Three Day and Seven Day Weighed Intake
- 2.2. Recipe Breakdown of Cottage Pie
- 2.3. Recipe Breakdown of Muesli

### Chapter 3
- 3.1. Ages of Patients with Senile Dementia and Health Controls
- 3.2. Times of Meals at Two Hospitals
- 3.3. Fluid Intakes of Patients and Controls
- 3.4. Intakes of Energy, Protein, Fat and Carbohydrate in Patients and Controls
- 3.5. Intakes of Fibre in Patients and Controls
- 3.6. Intakes of Tryptophan in Patients and Controls
- 3.7. Vitamin Intakes of Patients and Controls
- 3.8. Destruction of Ascorbic Acid in Potato served at Whitchurch Hospital
- 3.9. Mineral Intakes of Patients and Controls

### Chapter 4
- 4.1. Ages of Residents and Healthy Controls
- 4.2. Times of Meals at Four Local Authority Homes
- 4.3. Fluid Intakes of Residents and Control Subjects
- 4.4. Dietary Intakes of Energy, Protein, Fat and Carbohydrate in Residents and Controls
- 4.5. Dietary Intakes of Fibre
- 4.6. Mean Dietary Intakes of Tryptophan in Residents and Controls
- 4.7. Vitamin Intakes of Residents and Controls
- 4.8. Mineral Intakes of Residents and Controls
Figures

Chapter 2
2.1. Standardisation of 2,6dichlorophenol-indolphenol against ascorbic acid solution
2.2. Programme of Dietary Investigation

Chapter 3
3.1. Comparison of Vitamin C Intakes in Patients and Controls
3.2. Comparison of Folic Acid Intakes in Patients and Controls
3.3. Comparison of Iron Intakes against Age
3.4. Vicious Circle of Malabsorption and Poor Nutritional State

Chapter 4
4.1. Comparison of Vitamin C Intakes in Residents and Controls
4.2. Comparison of Folic Acid Intakes in Residents and Controls

Chapter 5
5.1. The Vicious Circle of Poor Nutritional State and Impaired Mental Function

Appendix A
A.1. Mental Test Score
A.2. Higher Neurological Function Test
A.3. Hare Scale
Chapter 1

INTRODUCTION
1.1. **SENILE DEMENTIA**

1.1.a. **General Considerations**

Dementia is one of the oldest diseases known to man. It is characterised by a progressive deterioration of the whole personality. Even today, little is known about the underlying causes of this disease. It is progressive with an average life expectancy after diagnosis of approximately seven years.

One in ten of all people over the age of 65 years has some form of organic brain disease, that is of the two types of dementia, multi-infarct dementia and degenerative disorders.

One quarter of all demented patients have multi-infarct dementia, a condition in which there are small multiple infarcts within the brain (Marsden and Harrison, 1972). The degenerative disorders include senile and presenile dementias, the latter covering Picks, Jakob-Creutzfields and Alzheimers Diseases.

The distinction between Alzheimer's Disease and senile dementia is usually made by age. Patients having Alzheimer type degenerative brain changes before the age of 65 years are said to have Alzheimer's Disease. Patients over 65 years of age with senile dementia have
typical Alzheimer pathology and are said to have senile dementia of the Alzheimer type (SDAT).

Admission rates to hospital for senile dementia exceed those for all other psychoses combined and the demands made by elderly demented patients on hospital and residential facilities exceed those from all other forms of disability in old age (Kay et al., 1970; Christie, 1982).

The increasing proportion of elderly people is one of the greatest social problems of our time. The average age of people in Great Britain has doubled in 150 years and at present more than half of the population reach the age of 70 years, with half of the female population reaching the age of 75 years. The 1981 census showed that in the county of South Glamorgan 17% of the population was over 65 years and in the capital, Cardiff, 18% of the population were of pensionable age, which was 8% more than in 1971. In Britain, about 2.4% of persons between the ages of 65 and 69 years suffer from dementia. The figure rises to 22% for those aged 80 and more (Kay et al., 1964; 1970).

Senile dementia is two to three times more common in women than in men. Some of this sex difference may reflect the tendency for women to live longer and to represent a larger share of the population at risk for the condition.
Death usually occurs 6-12 years after the onset of dementia, although an occasional patient may have a rapidly progressive course and die within a year (Cummings and Benson, 1983). What was once passed off as an inevitable consequence of ageing has now become a matter of real concern.

1.1.b. Clinical Features of Senile Dementia

SDAT is slowly progressive, whereas patients with arteriosclerotic dementia show a sudden decline (Blessed, 1980). The symptom most commonly noted early in the course of the disorder is impaired memory for recent events. This problem may manifest itself as an inability to perform tasks that require the incorporation of new information, in repeatedly asking the same questions or in difficulty in remembering a shopping list of 2 - 3 items. There may be word-finding difficulty in spontaneous speech, disorientation in time and place, inability to handle finances, or becoming lost in a familiar environment.

Changes in non-cognitive behaviour vary among patients. There is diminished concentration, and sleep disturbance. The latter is manifested as nocturnal confusion where the patient wakes in the early hours of the morning and acts as if it were daytime. Some patients show increased motor activity and agitation,
while others become increasingly sedentary. This increased activity may be put forward as a cause of the striking terminal loss of weight that occurs during the course of dementia. Adequate food intake, endocrine factors and hypothalamic pathology have yet to be explored as the possible reasons for the weight loss.

Initially the change in behaviour and character may be concealed by the patient or relatives, attributed to the normal course of ageing and a fear of institutionalisation.

Another symptom that invariably occurs is double incontinence and this increases the burden of nursing the patient for relatives and the degree of distress for the patient.

The clinical diagnosis of dementia is extremely difficult, as many patients with senile dementia may show reactive depression so that affective disorder with pseudodementia may be confused with pseudodepression with dementia (Blessed, 1980). A number of tests of intellectual performance have been developed to differentiate between those that are functionally ill and those with organic brain disease.

Blessed and colleagues have produced various papers on their mental test score (Roth, Tomlinson and Blessed, 1966; Blessed, Tomlinson and Roth, 1968; Tomlinson,
Blessed and Roth, 1970) which differentiates between acute brain syndrome, functionally ill patients and patients with senile dementia.

Diagnosis with the test has shown a good correlation with the decline in intellect and degenerative brain changes in post mortem brain. In their work on a group with degenerative changes, two thirds had a pathological diagnosis of Alzheimer's Disease, of the remaining 30%, 10% had normal brains and the others a mixed pathology.

The diagnosis of senile dementia is far from accurate, it is based on recognition of the characteristic clinical features and is confirmed by demonstrating the typical cortical changes post mortem.

1.1.c. Aetiology of Dementia

The aetiology of the disease is unknown. It is often regarded as the result of premature ageing. Of the several explanations that have been offered, the suggestion is that it is due to disordered immune function, or to a viral function are the forerunners. A substantial number of families in which Alzheimer disease is inherited as a Mendelian dominant trait, have been described (Cook et al., 1979). Behan and Feldman (1970) have found serum protein abnormalities
in 66 per cent of patients with senile dementia. The abnormalities included decreased albumin and increased alpha antitrypsin, alpha 2 macroglobulin and hepatoglobin fractions.

A viral aetiology has been proposed but to date it has not been possible to transmit Alzheimer's Disease by inoculating experimental animals with tissue from the brains of affected patients.

Biochemical investigations have concentrated on the levels of neurotransmitters and related metabolites in the brain and body fluid.

1.1.d. Brain Changes in Dementia

1.1.d.i. Structural

Senile dementia is due to a rapid increase in the rate of death of brain cells for reasons which are not fully understood. It pursues an unremitting course from impairment of the higher abilities to virtual disintegration of the intellect and a state of incoherent incontinence.

The brains of patients who have died with dementia are atrophic often weighing less than 1000g. The atrophy is most pronounced in the temperoparietal and anterior
frontal regions (Tomlinson, 1980). On histologic examination, the neurones of the cerebral cortex in Alzheimer's disease, show striking changes. The neuronal changes include neurofibrillary tangles, senile plaques and granulovacular degeneration. It must be noted that identical changes occur in the ageing brain unaccompanied by dementia, although these changes are less abundant than in the brains of demented patients (Tomlinson, 1980).

Arteriosclerotic dementia can sometimes be differentiated from senile dementia by consideration of previous medical history, that is by hypertension, vascular disease. However, the exact type of dementia can only be diagnosed by pathological examination.

1.1.d.ii. Biochemical

Neurochemical analysis of post mortem brain and cortical biopsy tissue samples has contributed to an improved understanding of the selectivity of neuronal degeneration. Bowen et al. (1977) began a systematic search for biochemical changes in the autopsy brain of histologically confirmed cases of Alzheimer's disease. These workers found meaningful biochemical data could be obtained relating to level of neurotransmitters.
1.1.d.iii. Cholinergic System

From comparisons between the cholinergic system in Alzheimer's disease, other mental disorders and normal old age, evidence has been obtained of specific involvement of the cholinergic system in Alzheimer's disease (Perry and Perry, 1980). Abnormalities in the enzymes involved in acetylcholine metabolism correlate with the extent of Alzheimer neuropathological changes. This work suggested that decreased choline acetyltransferase (CAT) activity may be particularly associated with the progress of Alzheimer's disease. However, it is not yet established whether reduced CAT activity may be an earlier or later change in the disease process although in this respect, comparisons between alterations in CAT and other cholinergic activities, as a function of increasing plaque numbers indicated that the loss of CAT may occur at an earlier stage of Alzheimer type pathology (Perry and Perry, 1980).

1.1.d.iv. Other Neurotransmitters

The original finding concerning neurotransmitters in Alzheimer's disease was of reduced levels of homovanillic acid (HVA) in the basal ganglia (Gottfries et al., 1968). In a later study Gottfries et al. (1969) found that the levels of HVA in the basal
ganglia were related to the degree of dementia according to the rating scale.

There is evidence (Cross et al., 1981) of a reduction of dopamine B-hydroxylase activity in parts of the central nervous system of some Alzheimer patients.

Adolfsson et al. (1979) reported a negative correlation between brain function and the levels of noradrenaline in brain tissue, that is the more pronounced the intellectual impairment, the lower the levels of noradrenaline.

There is a significant reduction in the aspects of the serotonergic system. Temporal lobe samples from patients with Alzheimer disease contained less 5-hydroxytryptamine and its metabolites than paired control samples (Bowen et al., 1983).

1.1.e. Substrate Control of Neurotransmitter Synthesis

All neurotransmitters whose synthesis is known to be influenced by precursor availability are produced from compounds that must be obtained, in whole, or in part from the diet.

Like other nutrients, the precursors of neurotransmitters are stored in the organism within...
very large metabolic pools, in the form of tissue proteins and membrane lecithins; thus failure to consume the precursors for short periods causes relatively small decreases in their plasma levels beyond those observed after a normal overnight fast.

The rates of formation of several brain neurotransmitters depend on the availability to the brain of their precursor molecules. Hence, the formation of serotonin and acetylcholine in brain neurones depend on the uptake from the blood of tryptophan and choline respectively.

Significant amounts of these neurotransmitter precursors are provided to the body daily in the diet and thus the diet readily affects their blood levels and also, the levels in the blood of other compounds that influence precursor uptake into the brain. Therefore, food intake can modify brain uptake of tryptophan and choline and can affect the rate of synthesis of the monoamines and acetylcholine.

As administration of the precursor alone can readily influence brain functions thought to be in part controlled by neurones utilizing the transmitter, diet may ultimately be shown to influence brain function via this precursor mechanism.

Consumption of a meal that includes foods rich in
protein or lecithin can increase plasma tryptophan, choline or tyrosine concentrations as much as several fold for short periods of time. If the meal lacks lecithin, it will have no effect on plasma choline, if it lacks protein it will actually lower plasma levels of most of the amino acids because of the insulin secretion it elicits (Hirsch et al., 1978; Fernstrom et al., 1979).

1.1.f. Control of Tryptophan Entry into the Brain

Tryptophan plays an important role in the function of the nervous system. As one of the essential amino acids, tryptophan is necessary for the synthesis of proteins and peptides, and is the precursor of one of the biogenic amine neurotransmitters, 5-hydroxytryptamine - 5HT (serotonin).

The transport of the large neutral amino acids across the blood brain barrier is competitive between the individual amino acids. The entry of circulating tryptophan into the brain can be accelerated either by raising plasma tryptophan levels or by lowering plasma levels of other large neutral amino acids (Fernstrom & Wurtman, 1971). This increases the plasma tryptophan ratio, that is the ratio of the concentration of tryptophan to the sum of the isoleucine, phenylalanine, valine and tyrosine, thereby facilitating the flux of
tryptophan into the brain. As brain tryptophan levels are raised so the saturation of tryptophan hydroxylase increases and this controls the rate at which neurones synthesize serotonin.

Tryptophan circulates in the plasma bound to albumin and because of this, tryptophan levels do not fall after insulin secretion. When insulin is secreted, plasma levels of non-esterified fatty acids (NEFA) fall because insulin facilitates the uptake of NEFA into fat producing cells. As the NEFA molecules are stripped off the circulating albumin (to which most are normally bound) the affinity of albumin for tryptophan increases substantially. Therefore plasma levels of bound tryptophan rise and the fall in the level of free tryptophan is proportionate to the decline in the other aromatic amino acids.

The net effect of any meal on the plasma tryptophan ratio will be the result of two processes. Firstly, the post-prandrial secretion of insulin (which lowers the blood levels of the branch chain neutral amino acids, but not tryptophan) and secondly the passage into the circulation of some of the amino acids in dietary protein. If a given meal contains about 10% protein the net increase in plasma tryptophan will be proportionate to that in the other large neutral amino acids, the plasma tryptophan ratio will thus remain unchanged, as will brain tryptophan and serotonin.
With increasing age there is a degeneration of some of the intestinal villi and therefore a decrease in the surface area of the gastrointestinal mucosa (Warren et al., 1978). It follows that the absorptive capacity may be reduced in the elderly. Lehmann (1979) has suggested that because of the nutritional needs of the intestinal mucosa, a period of malnutrition could lead to a loss of a proportion of the carrier sites for amino acids. A combination of events, decreased absorptive area, and a loss of carrier sites and lack of food could decrease the supply of amino acids to the body. The brain is an avid user of amino acids and inadequate supplies could lead to functional dementia. If prolonged, biochemical dysfunction could progress to structural damage. In Lehmann's experience, giving a high protein diet with tryptophan supplements restored the gastrointestinal absorption to normal levels and reduced the dementia in a group of patients (Lehmann et al., 1981).

Shaw et al. (1981) produced results showing that fasting concentrations of plasma tryptophan were lower in senile dementia than in controls. The tryptophan ratio, whether of free or total tryptophan was lower in
senile dementia than in controls. Their work confirmed Lehmann's finding that a small group of patients may be marginally but noticeably improved by amino acid feeding.

1.1.h. Treatment of Dementia using Precursors of Neurotransmitters

Investigations of the effects of administering precursors of neurotransmitters known to be reduced in dementia, have produced mixed results.

The differences seem to be due to the difficulty in the selection of patients having SDAT on purely clinical grounds (Gottfries, 1980).

Lewis et al. (1978) treated a group of patients with senile dementia in a double blind trial. Those given l-dopa showed improvement on behaviour rating and significant changes on the intellectual rating scale. A similar study by Adolfsson et al. (1978) showed an improvement in several psychological functions but no positive effects on memory. However, Parkes et al. (1974) and Kristensen et al. (1977) failed to produce any positive changes in mental function after administration of l-dopa.

Similarly, the administration of large doses of choline
(Boyd et al., 1977) or phosphatidylcholine - lecithin (Etienne et al., 1978) has yielded poor results despite the fact that animal studies show that when large doses of these precursors of acetylcholine are given, the level of the neurotransmitter does increase in the brain (Cohen & Wurtman, 1976).

It has been suggested that ageing and dementia may be related to a deficiency of folic acid and vitamin B12 (Read et al., 1965; Hurdle and Picton-Williams, 1966; Carney, 1967; Shulman, 1967; Sneath et al., 1973).

The rate limiting step in the synthesis of the catecholamines and serotonin is the hydroxylation of the amino acids and as folate is a co-factor in this process (Grahame-Smith, 1967) a deficiency of folate could be the cause of the disturbed monoamine turnover. Shaw et al. (1971) found no clinical improvement of patients with dementia on treatment with folate, but it was suggested that the period of the study, i.e. 24 weeks, may have been too short.

1.1.i. Malnutrition and Alzheimer's Disease

Leyton (1946) reported that intellectual impairment was amongst the effects of slow starvation and Skellerud (1985) suggested that cerebral atrophy in dementia was caused by severe undernutrition. Thygessen et al.
(1970) and Gibberd and Simmonds (1980) have described former concentration camp prisoners and Far East prisoners of war who had developed a type of dementia with cerebral atrophy that occurred many years after their liberation. This they attributed to the prolonged severe undernutrition suffered by the prisoners.

The association of mental illness with reduced food intake has been described by many, especially in association with dementia (Exton-Smith, 1971; Asplund et al., 1981; Lonergan et al., 1975).

1.2 NUTRITIONAL STUDIES IN THE ELDERLY

1.2.a. General Aspects

The elderly are especially prone to the possible effects of nutritional insufficiency. The diets of many persons in this age group are often inadequate in vitamins, minerals and protein. There have been numerous nutritional surveys of the healthy elderly at home.

Exton-Smith (1978) summarised the following factors that lead to nutritional deficiencies in the elderly. They fall into two groups - primary and secondary. Primary ones are:- social isolation, ignorance,
physical disability, mental disturbance, iatrogenic factors and poverty. Secondary factors were impaired appetite, masticatory insufficiency, malabsorption, alcoholism, drug dosage and increased requirements.

1.2.b. 'Normal' Values for the Elderly.

The problem with any study of nutritional status of elderly subjects is what normal values should be used in comparison to the group under investigation. A 'normal' elderly person would be judged to be an individual with the minimum of degenerative change, leading a full active life style and on no medical treatment. This type of person produces the normal value to which all other elderly persons are compared.

However, in many nutritional studies of the elderly, intakes are judged against the recommended daily allowances (RDA) (DHSS, 1979a). These figures 'represent a judgement of the average requirement plus a margin of safety' (DHSS, 1979a). The estimate of 'average requirement' is derived from studies on young adults. The RDA of vitamins for the elderly is the same as that for young adults, except in the case of thiamin, which is the same relative to energy. The suitability of these figures for elderly subjects is therefore suspect.
In the case of energy the recommended amount for the elderly is based on estimates of the average rate at which activities decline and the diminution in energy expenditure, associated with the physical infirmities of old age. However, many individuals maintain a majority of activities in old age and their calorie requirements are not reduced (Exton-Smith, 1978).

Watkin (1957) and Horwitt (1953) found the minimum protein needs of healthy adults do not increase with advancing years. Body protein mass declines progressively with age in human subjects and this alone should lead to a reduced need for dietary protein.

Young and Hill (1978) have found that requirements for two amino acids (threonine and tryptophan) are similar in elderly subjects compared to young adults, when expressed per unit of body weight.

The protein and amino acid needs of adult man have been based almost entirely on the metabolic N balance approach. The adequacy of this approach has not been carefully studied (Young and Hill, 1978) and there is a need for the development of new and functional approaches for determining nutrient requirements.
1.3. NUTRITIONAL SURVEYS OF THE INSTITUTIONALISED ELDERLY

Asplund et al. (1981) reported that malnutrition is widespread throughout different hospital departments. Their investigation into the nutrition was prevalent in long-stay patients. Unfortunately, Asplund presented data on 9 patients only out of 91 studied and on these they investigated energy and protein intake only. Nutritional assessment was based on anthropometric measurements along with measurements of albumin and transferrin. The sensitivity of these as an estimation of malnutrition is low (Young and Hill, 1978). Vir and Love (1979a) compared the nutrition of institutionalised and non-institutionalised elderly persons. Nutrient intake was higher for the elderly living at home. Their results showed clinical deficiency was rarer but subclinical deficiency was prevalent.

Griffiths et al. (1966) in their investigations of nutritional status and old age found 41% of old people deficient in vitamin C and 59% of them deficient in thiamin on entry into hospital.

Dietary intakes of elderly patients in Graylingwell Psychiatric Hospital, Chichester, measured by Dickerson et al. (1974) pointed clearly to an adequate diet. The deficiencies that did emerge, the authors felt, could
have been rectified by more careful menu planning.

1.3.b. Protein and Energy Intakes

1.3.b.i. Elderly

In the D.H.S.S. survey (1972) 88 of the 879 elderly participating in the investigation had energy intakes below the recommended daily amount. Of the 88, eight were considered to have protein-energy malnutrition. Macleod et al. (1974a) investigated the elderly at home and found that the amounts of energy and protein consumed regularly exceeded the D.H.S.S. recommended amounts.

1.3.b.ii. Institutionalised Elderly

Both McLennan et al. (1975) who studied long stay patients and Asplund et al. (1981) who investigated psycho-geriatric patients found energy and protein intakes similar to Macleod et al. (1974a) who measured intakes of the elderly at home. However, Vir and Love (1979a) found energy intakes in the institutionalised elderly to be well below the RDA.

MacLennan et al. (1975) suggested that the adequate protein intakes should not lead to complacency as Munro
(1981) discussed evidence for negative nitrogen balance in the elderly who were consuming intakes of protein over 40g per day. MacLennan suggested that low protein intakes may cause low enzyme activity and reduced lean body mass.

1.3.b.iii. Body Weight.

Morgan and Hullin (1982) investigated the body composition of some chronic mentally ill patients. The average weight of elderly patients with schizophrenia and affective disorders was less than those of healthy elderly subjects. However, this could not be due to the drugs that are used for the treatment of schizophrenia and affective disorders, as these drugs tend to produce weight gain. Patients who showed some biochemical evidence of malnutrition (low plasma concentration of albumin or vitamins C or D) weighed less and had less body fat than others. However, the low plasma vitamin levels were associated with diminished amounts of body fat and not of fat free mass and therefore were attributed by Morgan and Hullin (1982) to energy rather than protein depletion. Morgan and Hullin did not investigate the intake of nutrients in their patients. The assumption of adequate protein intake yet inadequate energy intake seems sound, with reference to Vir and Love (1979a), Asplund et al. (1981) and McLennan et al. (1975). However, it would
have been valuable to have dietary intake confirmed, as the work was completed in Leeds and is separated by three years from the Vir and Love study which was completed in Belfast, another area of the British Isles.

1.3.b.iv. Brain Function

Perhaps of importance is the fact that the central nervous system is one of the more demanding users of amino acids in the body and has a prodigious turnover of them in brain proteins. Any failure in the supply of amino acids as described earlier may lead to a disruption in function of the brain. Another tissue requiring a rich supply of amino acids is the lining of the gastrointestinal tract and with increasing age there are degenerative changes in the mucosa (Warren et al., 1978). The surface area of the gut is therefore reduced due to a degeneration of the villi, causing a likely reduction in amino acid absorption. Therefore, a situation could arise in which an ageing mucosa with reduced absorptive capacity with reduction of food intake could lead to a failure of nutrients to reach the brain in adequate amounts and this could initiate a confusional state with further reduction in food intake, perpetuating a vicious circle.
The various dietary surveys that have been conducted in the elderly have produced similar estimates of thiamin intake (DHSS, 1972; 1979b; Macleod et al., 1974b; Lonergan et al., 1975). In relation to total energy intake, the thiamin intake of the elderly is equal to that of the general population (DHSS, 1972). This study also found that those with evidence of thiamin deficiency as judged by a high TPP (thiamin pyrophosphate-coenzyme essential for transketolase activity) effect did not have a low thiamin intake. This led the DHSS panel to question whether a high TPP effect reflects thiamin deficiency. A problem of all transketolase assays is that the apoenzyme is unstable, so that in longstanding deficiency the TPP effect may not be so high as to reflect the full severity of the deficiency and measurement of absolute enzyme activity is necessary to assess the full extent of the thiamin deprivation (Thurnham, 1985).

In the DHSS survey (1979b) mean intakes of riboflavin of a large number of old people were below that officially recommended. In this DHSS survey thirty per cent of the subjects had biochemical levels indicative of deficiency.
1.3.c.ii. Mental Disturbance

Gould (1959) suggested that many organic psychiatric states (including acute alcoholic psychoses, post operative confusional states, as well as some cases of dementia) are due to a disturbance in brain metabolism. His theory suggested that 'toxins' effected the enzyme systems of the neurones and that to overcome them and by-pass various metabolic pathways, high blood levels of B vitamins were necessary.

Prior to Gould, Krawieki et al. (1957) demonstrated that there was some memory improvement in seven out of twenty-five male patients with senile dementia following intra-muscular injections of 'Parentovite' only three of the twenty five showed an improvement on the placebo. However, assessment of memory in the severely demented patient is neither an easy nor a precise process.

Kershaw (1967) found no evidence of thiamin or nicotinic acid deficiency in patients with senile dementia. Carney et al. (1979) reported that thiamin and pyridoxine deficiency was common in 154 newly admitted psychiatric patients but in agreement with Kershaw there was no evidence of thiamin or nicotinic acid deficiency in alcoholics or patients with confusional states.
Katakity et al. (1983) carried out a longitudinal study of the effects of a food supplement in elderly hospitalised patients. Biochemical evidence of thiamin deficiency was present in 9 out of the 12 patients studied. The authors observed 3 patients who developed acute confusional state along with pneumonia. The thiamin pyrophosphate activation values, a specific indication of thiamin status (Brin, 1964) declined progressively with treatment and the confusional state of the patients also declined. Katakity concluded that mental confusion and thiamin deficiency are linked.

1.3.d. Folic Acid

1.3.d.i. Measurement of Folate Intake

Intakes of folic acid cannot at present be determined with accuracy due to technical difficulties in the determination of the folic acid content of different foods (Bates et al., 1982). At present there is no current recommendation for folate intake in the U.K. The availability of the various forms and conjugates of folic acid to man is poorly understood because of the conjugase inhibitors, binders and unknown factors (Retief, 1969; Tamura and Stokstad, 1973). The minimum adult requirement of pure folic acid has been quoted at 50ug per day (Herbert, 1968).
The Food and Agriculture Organisation (1974) recommended an intake of 200ug per day for adults. American recommendations are for 400ug per day (Food and Nutrition Board, 1980). This recommendation may be over generous (Flodin, 1980) because of the lack of knowledge of availability of folate in foods.

The folate content of the diet has been reported to vary from 30-1381ug per day in different studies (Food and Nutrition Board, 1980) but this may reflect the use of different assay conditions and food tables as well as dietary fluctuations.

Two studies completed in 1980, used the McCance and Widdowson Food Tables (Paul and Southgate, 1979). Thomas (1980) investigated the nutritional intake of elderly patients in a large psychiatric hospital. The mean intake of folate was 162ug per day. A study of elderly people living in their own homes in Sunderland (Bates et al., 1980) revealed an average intake of 125ug per day.

Dietary intakes estimated from older editions of food tables may give underestimated results due to changes in assay technique (Rodrigues, 1978). Bates et al. (1982) discussed the problem of assay techniques for measurement of available folate in foods.
1.3.d.ii. Folic Acid Status in the Elderly

The problem for the clinician is the lack of a reliable indicator of folate deficiency. Batata et al. (1967) investigated a group of patients newly admitted to a geriatric department. They found a large proportion with low serum folic acid concentrations and reduced serum B12 levels without evidence of megaloblastic anaemia. An enquiry into the diet of patients led the workers to believe that the majority had low intakes (assessed from food tables, which as discussed earlier can be unreliable) although there seemed to be no lack in the availability of food, but only small quantities were eaten. A verbal indication however is an unreliable indicator of food intake especially when taken from elderly patients who are in the foreign and strange environment of the hospital.

The use of serum levels as an indicator of deficiency is also doubtful in Batata's study, as they reflect daily dietary fluctuations and a group of elderly people may well have had a poor dietary intake prior to admission to hospital.

Red cell folate levels are a more reliable measurement. Bates et al. (1980) in a study of elderly patients found that erythrocyte folic acid concentrations correlated significantly with folate intakes.
1.3.d.iii. Folic Acid Status and Dementia

Dietary intakes of folate in the institutionalised elderly have been found to be repeatedly below the RDA (Vir and Love, 1979a; MacLennan et al., 1975; Dickerson et al., 1974). However, as described above both the food tables and the RDA may give an overestimated figure.

Wells (1965) suggested that folic acid may have a considerable functional importance in cerebral metabolism. The link between folate and monoamines, and poor folate status being the possible cause of disturbed monoamine levels has been discussed previously.

Anand (1964) described a patient with megaloblastic anaemia, myelopathy, impairment of memory and moderate dementia of frontal lobe types, who improved on all aspects after commencing folate therapy. Similarly, Strachan and Henderson (1967) showed an improvement in the mental state of two patients with senile dementia following folate treatment. Sneath et al. (1973) reported cases of dementia due to folic acid deficiency. However, as stated earlier Shaw et al. (1971) found no clinical improvement when using folate treatment in patients with dementia.

Folate deficiency is said to be the commonest vitamin
deficiency in man (Herbert, 1967). Folate deficiency in patients with dementia could be attributed to a low intake of folate due to their inability to take an adequate amount of folate-containing foods, in a poorly designed menu. The explanation offered by Sneath et al. (1973) is that dementia leads to poor dietary intake and in turn folate deficiency. However, it cannot be excluded that folate deficiency may itself lead to impaired mental function.

However, until the ambiguities which at present surround the measurement of folate intakes and the assessment of requirements, can be resolved some caution is needed in interpreting intakes by direct comparison with published dietary recommendation. It would seem more reliable to compare intakes against previous studies noting calculation technique, or comparing intakes and blood levels of particular groups against similarly aged controls.

1.3.e. Vitamin B12 Status

1.3.e.i. Elderly

True dietary deficiency of vitamin B12 is exceedingly rare in Britain. It is doubtful whether subclinical B12 deficiency exists. The requirements for vitamin B12 are very small and it is found in all foods of
animal origin. The DHSS survey (1979b) found several persons who appeared malnourished and in poor health, who also had low serum B12 concentration. Serum B12 levels tend to decline with age (Burr, 1985) and a lower value may be a marker for biological ageing, particularly of the G.I. tract.

1.3.e.ii. Mental State

Deficiency of vitamin B12 causes pernicious anaemia. In pernicious anaemia a brain lesion occurs which is essentially degeneration of the white matter of the cerebrum and spinal cord, because of this Strachan and Henderson (1967) advocated the routine examination of all psychiatric patients for pernicious anaemia. However, Herbert (1968) proved that B12 deficiency often occurred in the absence of anaemia and he concluded that a B12 screening procedure would pay for itself within a psychiatric hospital.

Vitamin B12 deficiency according to Shulmann (1967) should be considered in the differential diagnosis of all patients with unexplained confusional states, pre-senile and senile dementias. Cole and Prchal (1984) reported low serum B12 levels in association with Alzheimer type dementia in comparison to other forms of dementia and healthy controls. There was no association between serum B12 and haematological state. The deficiency of vitamin B12 may have arisen from
malabsorption or metabolic disturbance consequent to the disease. In 1967, Shulmann supplemented five patients with senile dementia, with B12 via injection, but failed to bring about any significant change in mental state.

1.3.f. Vitamin C

1.3.f.i. Status in the Elderly

Exton-Smith (1968) claimed that in the elderly, subclinical deficiency of folate and vitamins C and D were the most common. Vitamin C intakes have been found to be lower in women than in men and particularly low in Scotland where 5% of the elderly have been found to take less than 10mg per day (Macleod et al., 1974b).

Griffiths et al. (1967) found residents of welfare homes and geriatric wards to have low ascorbic acid levels and Kataria (1965) reported a poorer vitamin C status in those living in large hospitals compared to those living at home.

According to Bartley et al. (1953) a diet deficient in vitamin C produces minimal plasma ascorbic acid levels in four weeks, whereas leucocyte ascorbic acid levels take twelve weeks to reach a minimum level.
Schorah et al. (1983) noted that plasma vitamin C levels, apart from being reduced by a poor dietary intake, are also affected by season (Schorah et al., 1979), smoking (Brook and Grimshaw, 1968) and possibly drugs (Briggs and Briggs, 1972).

Schorah et al. (1983) showed higher plasma ascorbic acid levels in females than males, despite similar diets. There seems to be a physiological difference in the metabolism or retention of the vitamin in the two sexes.

Milne et al. (1971) measured vitamin C intake and leucocyte ascorbic acid levels in 487 elderly people in Edinburgh. The low vitamin C intakes they found suggested that vitamin C supplements were needed by older people, especially during the winter months.

1.3.f.ii. Status in Psychogeriatrics

Experimentally induced lack of vitamin C has produced personality changes, including 'hysteria' and depression (Hughes, 1982). One possible link between mood and lack of vitamin C is the reduction in activity of dopamine B hydroxylase which has been thought to cause depression in scurvy. This enzyme is ascorbic acid dependent and converts 3,4dihydroxyphenylethylamine to noradrenaline, a
neurotransmitter known to be reduced in dementia (Adolffson et al. 1979). Thus the link between vitamin C and some neurotransmitters makes ascorbic acid of interest when investigating the nutritional state of patients with senile dementia since, as indicated earlier, the biogenic amine pathways are not normal in this condition.

Vitamin C is often found to be deficient in the elderly, particularly the psychogeriatric patients as they are usually long term admissions and particularly susceptible to institutional catering deficiencies.

Taylor (1968) showed that vitamin C levels of patients in a psychiatric ward were lower than levels of people in their own homes. In contrast, Dickerson et al. (1974) showed that dietary intakes of vitamin C were adequate in a group of psychiatric patients.

Schorah et al. (1983) investigated the plasma vitamin C concentration of patients in a psychiatric hospital. Values were lower in those with senile dementia and these patients largely contributed to the 32 per cent having plasma concentrations below the lower limit of normal.

The problem in achieving adequate vitamin C intakes for patients within large institutions is the vulnerability of the vitamin in the cooking and food service.
practices that operate within hospitals.

1.3.f.iii. Destruction of Vitamin C in Cooking

Black et al. (1983) analysed the vitamin C content of foods and compared them to the calculated values taken from food tables. These workers found that for the majority of foods mean analytical values were close to both the DHSS and current McCance and Widdowson (Paul and Southgate, 1979) food table values. The main exceptions were canned potatoes, cauliflower and spring cabbage. The latter two items were found to be higher than the values in the McCance and Widdowson food tables. The samples however were analysed immediately after preparation and cooking of the vegetables.

In 1963, Platt et al. showed losses of 45-60 per cent of vitamin C from peeled potatoes that were soaked overnight, a common practice in many hospital catering departments. Cabbage and Brussels Sprouts lost 64% of their vitamin C in cooking. Eddy (1963) in a survey of hospital food showed potatoes to be the largest provider of vitamin C in the hospital diet. Potatoes are often mashed for psychogeriatric patients which will increase vitamin C destruction (Eddy, 1963). The destruction of vitamin C in institutional cooking must be borne in mind when attempting to interpret results of vitamin C intake in the hospitalised person.
1.3.g. Vitamin D Status

1.3.g.i. The Elderly

The mean dietary intake of vitamin D for the elderly has been found to be around 2.5ug/day (Lonergan et al., 1975; MacLeod et al., 1974b). The DHSS recommendations (1979) have stated that no dietary sources may be necessary for those sufficiently exposed to sunlight.

Hodkinson et al. (1973) and Lawson (1981) suggest that sunlight is a more important source than dietary vitamin D. Vitamin D status in summer is governed by the amount of exposure to the sun, and even in the winter months when vitamin D is not formed by the sun, vitamin D status is maintained through stores of the vitamin. Therefore ultraviolet light is the primary factor in vitamin D status (Lawson, 1981).

Osteomalacia is common in the elderly and it has been attributed to the lack of sunlight, particularly for the elderly in urban communities (Eddy, 1974) and the poor diet of the elderly (Hodkinson et al., 1973).

1.3.g.ii. The Psychogeriatric Patient

Surveys of selected populations have shown a
significant lowering of vitamin D intake in long stay geriatric patients (Corless et al., 1975) and the housebound elderly (Macleod, 1974b).

According to the DHSS report (1979) the amount of vitamin D which should be allowed for people who are housebound is 10ug per day. This would therefore apply to the majority of institutionalised elderly, especially psychogeriatrics.

Vir and Love (1979a) investigated the diets of the institutionalised elderly and the mean intakes of vitamin D fell below the recommended level. In the same study calcium intakes were seen to be adequate. It may be postulated that in the absence of adequate vitamin D the sufficient intake of calcium may not be utilised and this could therefore be a contributing factor to the development of osteomalacia in these patients.

Due to the lack of mobility and sunlight, the patient with senile dementia is particularly at risk for poor vitamin D status.

1.3.h. Zinc and Copper Nutriture in the Elderly

Flint et al. (1981) found 21% of a group of elderly people living in the community and 85% of a group of
elderly institutionalised patients to be receiving less than the RDA of 15mg per day as suggested by the U.S.A. Food and Nutrition Board (1980).

Plasma zinc is lowered in elderly people. In an investigation of 20-80 year olds Lindemann et al. (1971) noted that plasma zinc levels decline with age. However, Vir and Love (1979b) found no decline in plasma zinc with age, but they dealt primarily with the older section of the population.

Gershoff et al. (1977) concluded from his work on rats that any variation in vitamin intake affects zinc and copper content of the hair. This work has yet to be duplicated in humans. It is interesting to develop the theory that poor vitamin status in the institutionalised population would cause poor zinc status. However, little work has been completed on trace metals in dementia.

The gross loss of neurones that occurs in senile dementia has been linked to the metal, zinc. Most of the enzymes primarily concerned with DNA replication are zinc metalloenzymes. It is suggested by Burnett (1981) that dementia may represent the cascading effects of error-prone or ineffective DNA handling enzymes in neurones, which have an age-associated loss in the ability to make zinc available for insertion into the newly synthesized enzymes though little is
known about such processes.

Little work has been done on intakes of copper in the elderly. Serum copper levels have been found to be higher in the elderly (Harman, 1965). Copper is a co-factor of the enzymes dopamine B hydroxylase and tyrosinase and may therefore play a role in the control of blood and tissue levels of biogenic amines.

1.3.i. Calcium and Magnesium Status

1.3.i.i. Elderly

Older et al. (1980) found calcium intakes in a group of elderly orthopaedic patients to be adequate due to the amounts of milk consumed.

Lonergan et al. (1975) found calcium intakes to reach 75% of the RDA in a group of elderly persons in Edinburgh.

Mean intakes of calcium for both elderly men and women in the DHSS (1979b) survey were above the RDA.

1.3.i.ii. Dementia

Little work has been done on calcium status in
dementia. Nutritional studies previously quoted (Vir and Love, 1979a; Thomas, 1980; Dickerson et al. 1974) have all found intakes of calcium to be above the recommended daily amount in the institutionalised elderly. Hypercalcaemia has been reported to produce memory deficits and personality changes which are two of the striking changes that occur in senile dementia (Lindemann et al., 1982). This author also documented that acute magnesium deficiency can result in mental changes but no suggestion has been made concerning the metal's involvement in the aetiology of the condition of dementia.

1.4. NUTRITIONAL STUDIES IN DEMENTIA

The results of studies into the nutrition of the elderly at home or in institutions show numerous nutrient deficiencies, but as shown earlier, few investigators have taken a group consisting of patients with senile dementia for investigation. This is surprising considering the numerous links between nutritional state and mental function.

The DHSS report (1979b) showed that elderly people scoring less than 13 on the mental test score (Blessed et al., 1968) had lower intakes of protein, energy, iron and vitamin C.
Exton-Smith (1971) has also associated mental illness with reduced intake particularly in patients suffering from dementia.

The fact that dementia occurs in the elderly and that people with dementia become long stay patients in large psychiatric hospitals, complicates the nutritional picture, as shown in the literature quoted in this chapter.

The inter-relationship between nutritional status, tryptophan intake, serotonin production and brain function has been investigated by many (Fernstrom and Wurtmann, 1971), however, their relationship in dementia is not fully understood. It is hoped that this thesis will explore the relationship between these factors.

1.5. THE PRESENT STUDY

The present study was designed to assess the nutritional state of elderly patients with senile dementia, in comparison to their healthy free living contemporaries in the community.

The various nutrients known to be at risk in the elderly population, both those at home and those in institutions, was investigated, with particular
reference to those nutrients known to influence brain function and those previously implicated in the aetiology of dementia.

The work presented in this thesis is of the dietary intake data. Biochemical and psychometric investigations are presented to complement the dietary findings.
Chapter 2

METHODOLOGY
2.1 DESIGN OF STUDY

Of the many methods available for the investigation of nutritional status the method chosen by an investigator must be carefully matched to the proposed study. As mentioned earlier, to achieve accurate estimates of nutritional state, there should be assessment of both dietary intake and biochemical analysis of nutrient status for each subject.

In the present study, the subjects under investigation contain a group of patients with senile dementia of Alzheimer type. It was therefore necessary to include a third assessment which was that of psychometric testing.

To investigate nutritional state of a group of patients with dementia it is necessary to select control groups with which comparisons can be made. As stated earlier, use of 'normal' parameters with which to assess results obtained from investigations cannot be accurately applied to the elderly group. This can lead to poor interpretation of results. For the purpose of this study a control group of free living healthy elderly residents in the community with no history of mental disturbance was employed. The second group under investigation was of elderly residents in part III accommodation, a group which was closely aligned to the hospital psychogeriatric population and a mid way
stepping stone for those elderly people who have a slow decline of mental function and drift from their own homes into social services homes for the elderly, then in the later stages to the long stay units of psychogeriatric hospitals.

The project was completed in Cardiff, using two psychiatric hospitals, social services part III accommodation and the elderly residents of the city of Cardiff, as the groups under investigation.

Mental state of all subjects was investigated. Details of the tests used are given in appendix A.

Biochemical tests of nutrient status were completed by my colleague Dr. K.O. Chung-a-on. Details of tests used for biochemical analysis of nutrients is given in Appendix B.

It was proposed that the study should comprise of an assessment of mental state, followed by an assessment of dietary intake and biochemical analysis of nutrient level. All subjects were to give informed consent and in the case of patients with SDAT, consent was given by relatives or staff acting in 'loco parentis'.
2.1a. Ethical Approval

The present study was approved by the Ethical Committee of the University of Wales College of Medicine, and the control subjects gave their informed consent to participation in the study.

The residents of part III accommodation also gave their consent and the study was approved by the Social Services Department of South Glamorgan County Council.

2.2 SELECTION OF SUBJECTS

2.2.a. Patients with Senile Dementia

It was necessary to obtain a group of patients with senile dementia who were on minimum drug treatments and had no evidence of any physical ailments. Patients who were on drugs known to affect nutritional state, e.g. anticonvulsants and vitamin D (Stamp et al., 1972) were excluded.

Patients with senile dementia were selected by an experienced psychogeriatrician (Dr. E. Sweeney) on the basis of their history, clinical characteristics and performance on the mental test score (Blessed et al., 1968) and the higher neurological function scale (Wilde, 1971) (Appendix A).
When consent had been given for their inclusion in the study, each patient had a full blood count taken and a complete biochemical screen, including liver function test, electrolytes, thyroid function, random blood sugar. A physical examination was also carried out and patients were accepted only if there were no signs of physical illness.

Any subjects suspected of having multi infarct dementia on the basis of medical history were excluded.

2.2.b. Healthy Control Subjects

The control subjects were carefully selected from volunteers who responded to an advertisement in the local press. They were all healthy ambulant individuals who, at the time of the investigation were not taking any drugs.

All control subjects underwent a full biochemical screen similar to that given to the patients. They were also questioned about their previous state of health. Each subject completed the mental test score and test of higher neurological function successfully, thereby eliminating those with any degree of senile memory loss.

Each control gave informed consent and was paid £10 for
2.2.c. Residents in Part III Accommodation

Each resident gave their consent to take part in the study and were selected from the list of residents for those on minimum drug treatments.

Again, each resident underwent a biochemical screen and medical history was taken from medical notes held in the home.

Rating tests were completed by a psychiatrist. The test used was the Hare Scale (Hare, 1978) (Appendix A).

2.3. DIETARY ASSESSMENT

The usual aim of any dietary survey is to discover the habitual intake of individuals. There are several methods available including the precise weighing method, weighed inventory, diet diary, diet history and diet recall and questionnaire. The choice of method is influenced by several factors: the likely response rate, accuracy and the cost of the method per subject. Generally the more accurate the method, the greater the cost, degree of subject cooperation required, and lower response rate (Pehily, 1983).
The weighed intake method is where the subject is provided with a set of scales that will take a dinner plate with food and sensitive to record the slightest addition of meal items. Subjects have to weigh all foods served at their meals and all items wasted. Pekkarinen (1970) and Marr (1971) recommended the use of a seven day weighed inventory taking in the weekend variation of meal patterns as being the most accurate.

Black (1981) also concluded that a seven day weighed intake adequately assesses the usual intake of a majority of individuals and is the method of choice in many research investigations where nutritional measurements are to be related to biochemical and other measurements, on a clinical basis.

However, in the same paper (Black, 1981) the author stresses the importance of being able to assess the intake with reasonable confidence of accuracy. Nelson and Nettleton (1980) reported that although the weighed intake is the most accurate, it has the poorest cooperation and is likely to produce a biased sample (more literature and numerate people) and more likely to effect normal eating patterns. However, they agreed with Fehily (1983) that a group of paid volunteers would be highly motivated and produce a more accurate response rate.
Chalmers et al. (1952) noted that interest and accuracy on recording, decreases if a dietary weight record is extended beyond three days. In cases where dietary pattern is monotonous a 2-4 day record provides practically all the information of a seven day record (Cellier and Hankin, 1963).

Vir and Love (1978) adopted a weighed record method taken over three days in their investigation into dietary intake of elderly people, because interest and therefore accuracy for a weighed intake procedure over seven days decreases more rapidly in an elderly population.

In the present study, where the subjects are all elderly, the majority aged 75 and over, it would have been unreasonable to request them to weigh their food intake over a seven day period.

It would therefore seem that for a hospital population where menus are cyclical, three consecutive weekdays would be adequate for assessment. The assessment of the elderly at home would also be adequately achieved by using the three day method, providing a weekend day was included in the three days to give a true indication of variation of intake.
2.3.a. Three versus Seven Day Weighed Intake

Dietary pattern was constant for both the hospital group of subjects and for those in social services accommodation, as both establishments operated a cycle menu. Three consecutive weekdays was thought for this study to be accurate. It was necessary to check this procedure and the hospital daily intake was calculated over seven days for seven subjects and this was compared to a calculated daily intake from three days assessment on consecutive weekdays. The results are show in Table 2.1. The seven day intake was separated from the three day assessment by one week. The mean calculated intake of energy and the various nutrients showed no significant differences between the seven day and three day measurements. It was therefore decided to adopt a three day intake for patients and for the residents, who also operated a menu cycle of similar design to the hospital.

The three days finally chosen for assessment were Monday, Tuesday and Wednesday. Each Wednesday a roast meat was served on the hospital menu which was repeated on the menu every Sunday (there was no choice menu) therefore effectively making Wednesday a typical 'weekend' meal.

The patient group had few relatives and were seldom visited, either at weekends or on weekdays. Therefore
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Number of participants</th>
<th>unit</th>
<th>Mean intake over 7 days</th>
<th>Mean intake over 3 days (Mon-Wed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre</td>
<td></td>
<td>g</td>
<td>7.8</td>
<td>10.2</td>
</tr>
<tr>
<td>Energy</td>
<td></td>
<td>kcal</td>
<td>1492</td>
<td>1560</td>
</tr>
<tr>
<td>Protein</td>
<td>7</td>
<td>g</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>g</td>
<td>55</td>
<td>59</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td></td>
<td>g</td>
<td>190</td>
<td>202</td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
<td>mg</td>
<td>2450</td>
<td>2463</td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
<td>mg</td>
<td>1984</td>
<td>1866</td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
<td>mg</td>
<td>804</td>
<td>691</td>
</tr>
<tr>
<td>Magnesium</td>
<td>7</td>
<td>mg</td>
<td>166</td>
<td>159</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
<td>mg</td>
<td>6.0</td>
<td>7.1</td>
</tr>
<tr>
<td>Copper</td>
<td></td>
<td>mg</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Zinc</td>
<td></td>
<td>mg</td>
<td>5.8</td>
<td>6.6</td>
</tr>
<tr>
<td>Vitamin A</td>
<td></td>
<td>ug</td>
<td>523</td>
<td>590</td>
</tr>
<tr>
<td>Vitamin D</td>
<td></td>
<td>ug</td>
<td>1.39</td>
<td>0.9</td>
</tr>
<tr>
<td>Thiamin</td>
<td></td>
<td>mg</td>
<td>0.65</td>
<td>0.7</td>
</tr>
<tr>
<td>Riboflavin</td>
<td></td>
<td>mg</td>
<td>1.15</td>
<td>1.34</td>
</tr>
<tr>
<td>Nicotinic Acid</td>
<td>7</td>
<td>mg</td>
<td>17.7</td>
<td>16.8</td>
</tr>
<tr>
<td>Vitamin C</td>
<td></td>
<td>mg</td>
<td>29.5</td>
<td>23.1</td>
</tr>
<tr>
<td>Vitamin E</td>
<td></td>
<td>mg</td>
<td>2.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td></td>
<td>mg</td>
<td>0.67</td>
<td>0.69</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td></td>
<td>ug</td>
<td>2.17</td>
<td>2.86</td>
</tr>
<tr>
<td>Folic Acid</td>
<td></td>
<td>ug</td>
<td>105</td>
<td>117</td>
</tr>
<tr>
<td>Pantothenic Acid</td>
<td></td>
<td>mg</td>
<td>2.9</td>
<td>2.0</td>
</tr>
</tbody>
</table>

All subjects were female
foods often brought into hospital by visitors as 'special treats' did not alter the diet at weekends.

2.3.b. Three Day Intakes for the Control Group

The choice of a three day intake for the patient group meant that the control group also had to weigh their food over three days.

Fehily (1983) reported that paid volunteers are highly motivated and produce a more accurate response. Our control subjects therefore received remuneration for their help in the project.

Due to the average age of the healthy control group it was hoped that the use of paid volunteers completing a three day weighed intake would produce results with reasonable confidence of accuracy. To overcome the weekend variation of daily intakes, controls included one weekend day in their three day weighings.

2.3.c. Calculations of Composite Menu Items

Both of the hospitals used the D.H.S.S. publication Recipes for Use in N.H.S. Catering (DHSS, 1979c) for menu items. All dishes that were on the menu and had been made up from recipes were broken down into
percentages of constituent items. Table 2.2 shows a breakdown of a recipe from the N.H.S. Catering Recipe Book (DHSS, 1979c) for cottage pie.

Similarly, for the subjects monitoring their own food intake any dish composed of a number of ingredients was calculated in terms of it's component foods with the aid of a recipe supplied for that dish. Many individuals made cakes etc., to their own recipes and it was therefore necessary to be able to convert homely measures, such as a cup of flour into grams for the purpose of calculating the nutrient content.

Table 2.3 shows a breakdown of the constituents of muesli made up by one of the controls to his own recipe.

2.4. PROCEDURE OF DIETARY ASSESSMENT

2.4.a. Patients in Hospital and Residents of Old Peoples Homes

The nurses and staff of both hospitals and the part III accommodation were taught the principles of the weighed intake procedure. Whenever possible the participants in the study were instructed and encouraged to report anything eaten or drunk at times neither observer nor staff were available to make a note of it. This was
Table 2.2

Recipe breakdown of cottage pie

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantity</th>
<th>Percentage</th>
<th>Weight of each item in 50g cottage pie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stewing beef</td>
<td>2.5kg</td>
<td>33</td>
<td>16.5g</td>
</tr>
<tr>
<td>Flour</td>
<td>190g</td>
<td>2.5</td>
<td>1.25g</td>
</tr>
<tr>
<td>Onions</td>
<td>435g</td>
<td>5.7</td>
<td>2.85g</td>
</tr>
<tr>
<td>Dripping</td>
<td>250g</td>
<td>3.3</td>
<td>1.6g</td>
</tr>
<tr>
<td>Carrots</td>
<td>60g</td>
<td>0.8</td>
<td>0.5g</td>
</tr>
<tr>
<td>Peeled Potatoes</td>
<td>3.2kg</td>
<td>42</td>
<td>21g</td>
</tr>
<tr>
<td>Breadcrumbs</td>
<td>250g</td>
<td>3.3</td>
<td>1.65g</td>
</tr>
<tr>
<td>Margarine</td>
<td>125g</td>
<td>1.6</td>
<td>0.8g</td>
</tr>
</tbody>
</table>
### Table 2.3
Recipe breakdown of a Muesli mixture which was a favourite of one of the controls

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantity</th>
<th>Percentage</th>
<th>Weight of each item in each 20 grams eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porridge oats</td>
<td>100g</td>
<td>17.4</td>
<td>3.5</td>
</tr>
<tr>
<td>All Bran</td>
<td>100g</td>
<td>17.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Bemax</td>
<td>75g</td>
<td>13</td>
<td>2.6</td>
</tr>
<tr>
<td>Raisins</td>
<td>100g</td>
<td>17.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Demarara sugar</td>
<td>75g</td>
<td>13</td>
<td>2.6</td>
</tr>
<tr>
<td>Walnuts</td>
<td>50g</td>
<td>8.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Dried apricots</td>
<td>75g</td>
<td>13</td>
<td>2.6</td>
</tr>
</tbody>
</table>
most successful in the homes for the elderly which was fortunate, as many candidates drank squash etc. late at night, whereas the patients were too confused to understand and in fact to even take a biscuit or drink on their own.

When the observer was not present on the ward or in the home, staff noted anything taken between meals. Scales were left for them to weigh cakes or biscuits that were taken.

Cups of tea and coffee were weighed on three different occasions and a mean value for milk, tea and coffee were estimated. Sugar was noted by teaspoonfuls of each participant. This procedure with beverages seemed to be sufficient, as the degree of consistency in service was good between different members of staff. Measurement was aided by the use of uniform crockery for each ward and home. Cups, for example, contained the same total volume of fluid.

It was a similar technique for glasses of squash. On one ward the squash was made up in a jug and once more a percentage of undiluted squash had to be calculated for each glassful.

Once the principles of the technique had been explained to all and the standards had been set, it was possible to commence the weighed intake.
2.4.a.i. **Apparatus**

The scales used were Salter Letter Scales (model 511). The top weight was 900 grams measured in 5g divisions. These divisions were clearly marked in black type and the gram scale was the outermost one on the dial and therefore easier to read.

2.4.a.ii. **Measurement**

Foods were weighed at the point of service. This varied between hospitals and between the hospital and residential homes. At Whitchurch Hospital, the meals were served from a bulk trolley on the ward. This meant that all the individual weighing took place on each ward, whereas at the Royal Hamadryad Hospital, the meals were plated up in the main kitchen. Thus, in this hospital plates had to be randomly selected and marked for each patient that was taking part in the study. Gravies and sauces were served at ward level and were weighed on the plate immediately prior to service.

In the residential homes, meals were also plated in the main kitchen, but as the kitchens were adjacent to the dining rooms in all homes, plates did not have to be marked. Each resident had their allocated place at a table and tables were served in a set order and strict rotation around the table. Each resident was therefore
served individually.

The observer did not interfere with meal service and aimed to be as inobtrusive as possible. Those staff who normally served meals continued to do so, with no aid from the dietitian, thus eliminating bias. However, the effect of any changes in procedure on the size of portion due to having a dietitian present cannot be dismissed. Fortunately because of the menu cycle and the set ordering procedure, it was not possible to alter menus and therefore the content of the diet.

2.4.a.iii. Method of Weighing

The dietitian weighed the plate or dish and noted the weight. Each item making up the meal was added to the plate and the weight recorded after each addition. This procedure was followed for each subject. Plates of the same size were not assumed to be the same weight and were weighed separately on each occasion. The weight of each item being presented to the participant was obtained by subtracting the weight of the plate from the total weight recorded.

The consumption of each meal was observed personally especially for patients suffering from senile dementia, where stealing and dropping of food was common. Any
food dropped was retrieved and weighed. It was not possible to measure all stolen food accurately. Any food that was stolen by the patients was taken from them, as was the ward operational policy.

Food remaining at the end of a meal was weighed, first total wastage and then each item of the remaining food. Finally, the plate was reweighed. From the results the total amount of food wasted was calculated. Inedible waste, e.g. bone, was removed from the calculation.

Where patients had played with their meal, mixing two or three meal items, care was taken to try and separate the items. Gravies and sauces were the most difficult to assess as waste, because for instance patients would mix gravy and potato. It was therefore assumed that the gravy covered equal amounts of food items and the waste was taken as a proportion.

A complete record was made of the food and drink consumed over the three days. Biscuits, crackers and sweets etc., were weighed straight from the packet. Care had to be taken by both observer and staff that such items, given to residents and patients, were eaten. Many patients suffering from senile dementia tend to 'hoard' 'goodies' of this kind, and a discrete search had to be made to check that food had not been hidden.
2.4.b. Subjects living at Home

As all the subjects had volunteered to take part in the investigation it was a much simpler task to teach the individual how to use the scales and make notes of food and drink consumed. Each participant was taught by the same person. Emphasis was placed on noting everything the subject ate during the three day period, no matter how trivial it seemed to the person making the record. Strict instruction was given concerning the purpose of the investigation and that the information required was knowledge of what was normally eaten and that everything taken had to be 'confessed' i.e. they were not to feel embarrassed if they thought the investigator would be shocked at some of the things eaten.

When subjects were asked at the end of the weighing period what they found to be the most difficult part of the procedure, it was the problem of wanting to alter their diet in some way.

The participant established 'standards' for cups of tea and coffee by weighing the first three cups of tea and coffee each day. From these, average values were calculated and used throughout the three days. All participants were encouraged to use the same type of cup for each beverage, for example, the use of a cup constantly, rather than switching from a cup to a mug.
As for patients and residents, the composition of any dish for which a recipe had been used was calculated from the proportion of the ingredients and the quantity of the dish eaten, exact amounts of each ingredient that was consumed could be calculated.

The subjects were very enthusiastic and willing to help and cooperate, and they had the scales always at hand. The subjects were encouraged to weigh all foods.

2.4.b.i. Method of Weighing

Each participant was provided with a set of Salter Letter Scales (Model 511) as described previously. The procedure of weighing foods was taught by the investigator. The principle was the same as that followed for the patients, where the foods were weighed at the point of service.

The participants were encouraged to serve all the family's meals as normal, including their own, only placing their plate on top of the scales and noting the weights after each addition of food. In this way the weighing procedure took as little time as possible and hot meals were served.

The procedure was gone through by each participant with the dietitian present, and several different foods were
weighed showing different techniques e.g. bread and butter, breakfast cereal and milk, etc.

The principles of weighing peel, bones etc. and other inedible items were explained. Wastage was very unusual for these subjects, but nevertheless the procedure was explained.

Each subject was visited at least twice during the three day dietary assessment to check on the procedure and to overcome any problems occurring. The first visit always took place on the morning of the first day to check that breakfast had been weighed properly and the results written down correctly. In this way any problems arising at this early stage could be rectified immediately.

2.5. ANALYSIS OF DIETARY DATA

Each food eaten was listed with it's corresponding amount consumed, calculated from the detailed dietary record taken from the subjects. Quantities of the ingredients of composite dishes, calculated as described above were also listed.
The items were coded for computer analysis within seven days to allow any checking of items eaten.

Calculations of energy and nutrient composition were made from the McCance and Widdowson Food Tables (Paul and Southgate, 1979) on the University of Wales College of Medicine Computer, at the University Hospital of Wales.

Files were created for each individual and the three days dietary intake was entered using the table reference number and the weight of each food eaten. Each file entry was checked for any error made in input and the files were stored in queue overnight. Print outs of the results were then received the next morning.

A grand total of the three days dietary intake of all nutrients was received. These grand totals were then divided by three to achieve the average daily intake per day during the three days investigated.

Any water taken during the three days in squash, coffee etc., or by itself was totalled for the three days and then added to the water in the food ingested. This total was similarly divided by three to achieve an average daily intake of water.
2.5.a. Vitamin Calculations from the McCance and Widdowson Food Tables

The McCance and Widdowson Food Tables (Paul and Southgate, 1979) are the most commonly used food tables in the United Kingdom and are often assumed to contain some of the most accurate values for the calculation of the nutrient content of diets. However, several nutrients are known to be difficult to assess. The problems involved in the accurate assessment of biologically available folic acid content of foods have been discussed earlier. There are also problems in the assessment of the vitamin C content of foods. A major problem is its destruction during the storage, preparation, and cooking of food. The McCance and Widdowson Food Tables give values of the vitamin C content for vegetables raw and cooked, however it is difficult to calculate from the tables vitamin C content of vegetables that have been cooked for longer than the time stated in the tables.

This problem was of concern when calculating the vitamin C content of the diet provided in hospitals and residential homes for the participants in the study. Due to food service problems in large institutions, vegetables are often cooked for longer than is necessary and spend a longer time in heated containers prior to service. This is known to reduce the vitamin C content of the food.
In this study the amount of vitamin C lost during the service of potato in the hospitals was measured so that accurate assessment could be made of the vitamin intakes.

2.5.b. The Vitamin C Content of Potato in Hospital

Vitamin C was determined by the titration method as described by the Association of Vitamin Chemists and modified by Mapson (1942).

2.5.b.i. Reagents

6% Metaphosphoric Acid Solution

60g of reagent grade \(\text{HPO}_3\) sticks and 1.8g of disodium ethylenediaminetetraacetate (EDTA) were dissolved without heating in 900 ml of water. This was diluted to 1 litre and stored at 3°C when not in use. Metaphosphoric acid is a suitable extractant for ascorbic acid because it retards the oxidation of the acid by inactivating the catalytic effect of ascorbic acid oxidase and copper. In addition it is a protein precipitant and therefore assists in the removal of enzymatic oxidases, and facilitates clarification of the extract.

EDTA is a very useful chelating agent for divalent
ions, rendering them unavailable for catalytic or 'redox' reactions.

3% Metaphosphoric Acid Solution
500ml of the 6% metaphosphoric acid solution was diluted daily to 1 litre with distilled water.

Ascorbic Acid Standard Solution
100mg of ascorbic acid was dissolved in 3% HPO₃ solution and diluted to 500ml with the same solvent. As this solution is unstable it was used immediately to standardise the dye.

0.025% 2,6,Dichlorophenolindolphenol Solution.
Approximately 50mg of the sodium salt of 2,6,dichlorophenolindolphenol was dissolved in 150ml of hot water containing 42mg of sodium hydrogen carbonate. This was diluted to 200ml with distilled water and cooled prior to use and stored in a brown bottle at 3°C.

The determination of vitamin C in potato was completed in three days, therefore fresh solutions of the reagents were not required.
2.5.b.ii. Standardisation of Dye Solution
(carried out daily)

A range of standards of ascorbic acid solution were prepared containing 0.1 to 10mg of ascorbic acid solution, i.e. a 5ml aliquot of standard ascorbic acid solution was diluted with 5ml of 3% HPO$_3$ to give a solution containing 1mg of ascorbic acid. Each standard was titrated with the dye solution until a pink colour persisted for 15 seconds. If there was a good correlation for the standards the ascorbic acid equivalent could be determined, i.e. the volume of dye solution equal to the amount of ascorbic acid contained in the solution.

2.5.b.iii. Method

The reduced ascorbic acid in the uncooked and cooked potato samples was determined by the 2,6-dichlorophenolindolphenol visual titration method. This method for the measurement of reduced ascorbic acid involves acid extraction of the vitamin from the sample and titration of the extract with a standardised solution of the dye until a pink colour is obtained.

The capacity of an extract of the sample to reduce the standard solution of dye, as determined by titration is
directly proportional to the ascorbic acid content.

Two microburettes (10.0ml) were used; one graduated to 0.1ml and the other to 0.02ml. The latter one was used to obtain the end-point.

The first definite end-point was taken. Before titration 20% acetone was added to the sample to eliminate the effect of any sulphur dioxide that might be present.

2.5.b.iv. Potato Samples

Duplicate samples weighing 10g each of potato were put into glass sample jars containing 10ml of 6% metaphosphoric acid solution. Duplicate samples were taken for raw potato, cooked and served potato.

The main meal only was selected for sampling as the evening meal contained only a small amount of potato.

2.5.b.v. Timing

Samples of potato were taken at various stages in the preparation and service. Raw potato was sampled soon after peeling. The cooked potato was sampled soon after cooking. The cooked potato was sampled as it was
placed in the heated trolley and the final sample was taken as the potato was served at ward level.

2.5.b.vi. Assay Procedure

1. The 10g sample of potato was placed in a jar containing 10ml of 6% metaphosphoric acid. Any large pieces were cut up inside the jar.
2. The mixture was transferred to a glass centrifuge tube. Any residue in the jar was removed by rinsing with 6% metaphosphoric acid solution.
3. The sample was mixed using a 'polytron' to produce a homogenous slurry.
4. The slurry was transferred to a 50ml measuring cylinder and 10ml acetone was added before dilution to 50ml with 6% metaphosphoric acid solution.
5. The solution was divided into two centrifuge tubes and centrifuged.
6. An excess of 5ml of the supernatent was pipetted from each centrifuge tube into a universal glass bottle, and was stored at 3°C, overnight.
7. A 10ml aliquot was taken from the universal bottle and pipetted into a conical flask.
8. The flask contents were titrated against a standardised solution of 2,6,dichlorophenolindolphenol till a faint pink colour persisted for 15 seconds.
2.5.b.vii. Calculation

From the standardisation of the dye solution against the standard ascorbic acid solution produced a graph from which the titration values can be calculated to obtain the amount of vitamin C in the potato samples.

The standardisation of the dye solution is shown in Figure 2.1.

2.6. INTERPRETATION OF THE DATA

All results of the mean dietary intakes were compared against the recommended daily amount (RDA) for that nutrient as laid down by the D.H.S.S. (1979a). Where no U.K. R.D.A. was available the U.S.A. recommendations were applied (Food and Nutrition Board, 1981).

All biochemical levels of nutrients stated were compared against the ranges and limits of normal as stated for each particular assay technique.

All of the psychometric results were interpreted against the levels of achievement of the control groups.
Figure 2.1
Standardisation of the 2,6 dichlorophenolindolphenol against the ascorbic acid solution

mg Vitamin C/100ml

mls of 2,6 dichlorophenolindolphenol
2.7. PROGRAMME OF DIETARY INVESTIGATION

Two to three weeks before the dietary investigation, the psychiatrist and dietitian visited the patients, residents and controls to complete psychometric tests, biochemical screen and physical examination on all those who had given their consent.

Once results were returned and checked to exclude all of those with any physical ailments, the dietary investigation was planned for three consecutive days (as described in Figure 2.2). On day 3 a urine sample was obtained for the determination of N-methyl nicotinamide. On day 4 the participant was kept in a fasting state until the blood samples was taken (It was planned that the latest time the blood sample would be taken was at 9.30 a.m.).

During the lead up to the dietary investigation the participants were visited regularly by the dietitian (DT). The dietitian was also present when all the blood samples were taken so that a constant procedure was followed. In this way the participants became familiar with her, thus preventing any confusion arising from her presence over the period of investigation.
Programme of dietary investigation

2 or 3 weeks
prior to diet trial

<table>
<thead>
<tr>
<th>day 1</th>
<th>day 2</th>
<th>day 3</th>
<th>day 4</th>
</tr>
</thead>
</table>

Medical staff and dietitian to examine and carry out blood tests on consenting candidates

weighed food intake

fasting blood sample taken prior to 9.30 a.m.

Trial completed
Chapter 3

COMPARISON OF THE DIETARY INTAKES OF PATIENTS WITH SENILE DEMENTIA AND THE INTAKES OF THE HEALTHY ELDERLY AT HOME
Of the population over the age of 65 years, 10% suffer from dementia (Kay, 1964). Brothwood reported that, in 1971, 16% of the population were in this age bracket and this proportion will increase considerably by the year 2000. It is a personal, family and medicosocial problem of some magnitude.

The possible relationship between dementia and nutrition has been discussed previously (Chapter 1). Many workers (Vir and Love, 1979; Morgan and Hullin, 1982) have commented on the high prevalence of subclinical nutritional deficiency in the aged living in institutions, especially those having mental illness.

New nutritional studies have taken a specific interest in those patients with dementia. McLennan et al. reported in 1975 that long stay inpatients with dementia had low intakes of both vitamins and minerals.

The present study set out to investigate the nutritional status of a group of long stay inpatients with senile dementia and to compare their nutrition with a group of similarly aged individuals who were living in their own homes in the community.
3.1.a. Assessment of Nutritional Status

As explained in Chapter 2, dietary intake has been taken as the main indicator of nutritional status. Biochemical measurements of nutrients in the subjects were carried out by my colleagues, Dr. Keith Owng-a-on and Mr. Simon Tidmarsh. Their results are quoted in the text only for comparison with the dietary findings.

3.2 Selection

3.2.1. Patients

All were patients in the Royal Hamadryad and Whitchurch Hospitals, Cardiff. Those two establishments are under the same catering administration. Each patient was diagnosed as being severely demented on the basis of history, clinical characteristics, performance on the Higher Neurological Function Test and Mental Test Score (Appendix C).

It was not possible to find a sufficiently large number of patients who were not taking drugs, so all medicines taken were recorded. If any of the medicines taken were known to interfere with intestinal absorption, that patient was not accepted for the study (Appendix C). Principal drugs taken were: Thioridazine;
Promazine; Ibuprofen; Phenytoin; Temazepam; Diphenoxylate; and Isopaghula Husk BP.

Table 3.1 shows the mean age and range of ages for the patient and control samples. Unfortunately, it was not possible to obtain equal numbers of males and females, and the sample size reflects the sex distribution of patients suffering from dementia. In fact, in both the hospitals used, one ward was devoted to the care of male patients, whereas there were two wards for female patients. The age ranges were similar in both sexes, which shows that dementia affects the same age group, regardless of sex.

Each patient was given a physical examination. Blood samples were taken for routine haematological (full blood count, erythrocyte sedimentation rate) and biochemical (liver function test, urea and electrolytes, random blood sugar, thyroid function) tests. Any patient with physical pathology in addition to dementia was excluded.

3.2.b. Controls

To obtain a sample of healthy, ambulant, drug free, elderly individuals, advertisements were placed in the local press. The volunteers were all aged over 65 years. Several advertisements were placed in an
attempt to obtain a sample of volunteers aged 80 years and over.

All controls successfully completed the Mental Test Score and Higher Neurological Function Test, thus eliminating candidates with senile memory loss. The psychometry tests were conducted by the author, after training by the psychogeriatrician (Dr. Ian Wilson) (This enabled far more controls to be screened).

Appendix D shows the details of the volunteers accepted in the study. Only two of the twenty three subjects were taking medication. Each control had a blood sample for routine haematological and biochemical tests, described for the patient group. Their results are shown in Appendix D. Physical examination of the group was not possible but each subject was questioned as to their state of health at the time of the investigation.

Controls were selected to match the patient group for sex and, as closely as possible, for age (Table 3.1). All but three of the patients were matched within 5 years. There was no statistical difference between the mean ages. Initially, 29 patients with dementia and 35 healthy controls successfully completed the screening procedures and had dietary assessments made. However, 18 subjects were excluded, as they did not meet the 'matching' criteria.
Table 3.1

Ages of Patients with Senile Dementia (SD) and Healthy Controls (C)

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number</th>
<th>Age (years)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>M</td>
<td>9</td>
<td>75.0</td>
<td>66-83</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>14</td>
<td>78.6</td>
<td>68-85</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>9</td>
<td>75.1</td>
<td>69-82</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>14</td>
<td>76.8</td>
<td>67-85</td>
</tr>
</tbody>
</table>

SD - Patients with Senile Dementia
C - Healthy Elderly Controls
It must also be noted, that samples of patients and controls were mixed during the dietary investigation, to eliminate any bias in seasonal variation and assay technique. Both patients and controls were studied from January until December.

3.3. PROCEDURE

3.3.a. Patients

Dietary assessments were carried out as described in the methodology chapter (2.4.a.). All recipes were broken down so that the nutrient content of dishes could be calculated. Each item of food consumed was weighed for three days. Staff monitored and recorded the intake of fluids and any 'extras' taken in addition to the set meal pattern in both hospitals (Table 3.2). Patients were observed closely throughout the three days in order to construct a true impression of the patients and their eating habits. Notes were taken of whether the patients were smokers, as this is known to affect ascorbic acid status (Brook and Grimshaw, 1968). Observations were made of the way in which the patients ate, what they tended to prefer at meal times and whether they requested more to eat or drink.
3.3.b. Controls

The dietary assessments for control subjects were carried out as described earlier (2.4.b.). The controls were visited frequently, before and during the three days, to assess compliance and to observe any particular cooking methods that controls used.

3.4. RESULTS

3.4.a. Observations

3.4.a.i. Patient Group

The single outstanding observation of this group, was the way in which they ate their food. They tended to scoop food from their plates and swallow it with little, if any, chewing, usually bolting their meals. There were often difficulties in swallowing and the food provided had to be soft in texture. It was extremely rare for plates not to be cleared. On the few occasions when food was left, it was either inedible or the patient was 'in a mood' which was remarkably similar to the 'food strike' often adopted by toddlers.

Patients often stole food from the plates of their
neighbours or from the waste bucket. This behaviour was more common in male patients. Only one patient in this investigation was ever heard to ask for more food. In this case, it was a request for a cup of tea. Moreover, when patients were asked if they wanted more to eat, the answer was always, 'yes'. Half of the group were non-ambulant, but those who were able to walk around were extremely active. They wandered about the ward all day and were especially restless around 4.00 p.m. The nurses explained this as the time when most housewives would be busy preparing food for the homecoming families.

Ward routine was very rigid and Table 3.2 shows the times of meals at the two hospitals. Although design of the menus was different, on the whole the total intake was the same.

3.4.a.ii. Control Group

All of the control group were ambulant, although some were more active than others. One lady, aged 85, went on holiday to Russia after completing the dietary assessment, yet two ladies, aged 81 and 76 years, ventured little from their homes, with a trip to the local shops three times a week.

Obviously, there was no set menu for control subjects
Table 3.2

Times of Meals at the Two Hospitals

<table>
<thead>
<tr>
<th>Meal</th>
<th>Time</th>
<th>Details Whitchurch</th>
<th>Details Hamadryad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>9.00 - 9.30 am</td>
<td>Cereal and cooked breakfast i.e. egg, sausage or bacon plus tomatoes, baked beans or spaghetti</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9.30 am</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td>Noon - 12.30 pm</td>
<td>Meat, potato and vegetable plus pudding</td>
<td>Soup or snack e.g. ravioli, cauliflower cheese and pudding</td>
</tr>
<tr>
<td></td>
<td>12.30 pm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea</td>
<td>2.30 - 3.00 p.m.</td>
<td>Tea and biscuits</td>
<td>Tea, cake and sandwich</td>
</tr>
<tr>
<td>Supper</td>
<td>5.30 - 6.00 pm</td>
<td>Soup and snack</td>
<td>Cooked meal e.g. meat, potato and veg.</td>
</tr>
</tbody>
</table>

NB. Tea, coffee or squash was provided occasionally between breakfast and lunch.
but all ate three meals a day, taking their main meal at midday. None ate after 8.00 p.m., except for drinks. Plate waste was irregular and all meals were eaten immediately after preparation.

3.4.b. Intakes

3.4.b.i. Fluid

The mean fluid intakes, shown in Table 3.3, are the total fluid intakes, including fluid from drinks.

The fluid intake of the male patients was significantly lower (p<0.01) than that of their controls. The intakes of the female patients were similar to that of the controls, especially in the amount of fluid taken in drinks. Drinks were taken to mean tea, coffee, squash, lemonade, water, but not soup, gravy and sauces.

One third (7) of the patient group received no fluid from 6.00 p.m. until 9.00 a.m. the following day. For the remaining two thirds of the group, the latest drink was taken at 9.00 p.m. Half (11) of the control group had their latest drink at 10.00 p.m. or later.

The main drink for all subjects was tea, although half of the control group drank a minimum of two cups of
Table 3.3

Fluid Intakes of Patients with Senile Dementia in Comparison to Elderly Controls

<table>
<thead>
<tr>
<th>Group</th>
<th>Sex</th>
<th>No.</th>
<th>Mean</th>
<th>Range</th>
<th>Mean Fluid Intake in Drinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>M</td>
<td>9</td>
<td>1280</td>
<td>1070 - 1432</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>14</td>
<td>1502</td>
<td>1066 - 1756</td>
<td>559</td>
</tr>
<tr>
<td>Controls</td>
<td>M</td>
<td>9</td>
<td>1629</td>
<td>1218 - 2108</td>
<td>826</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>14</td>
<td>1383</td>
<td>885 - 1953</td>
<td>692</td>
</tr>
</tbody>
</table>
Table 3.4 gives the mean dietary intake of energy, protein, fat and carbohydrate.

The mean intake of energy was significantly lower ($p<0.01$) for patients, than for controls, when compared as a group. However, males had a significantly lower intake ($p<0.001$) whereas female patients had similar intakes to the controls. None of the male patients consumed the recommended daily amount (RDA) of energy, compared to two thirds of the control group. The mean intake of the female patients was similar to that of their controls, with no statistical difference over a similar range of values.

The foods contributing mostly to energy value of the patient's diet were milk and puddings in the form of pastry, sponge and/or milk puddings or custard; with potato, bread and cereal playing a minor part. Although the menus were dissimilar in the two hospitals, there was no difference between the amount of energy provided by them.

In comparison, the foods in the controls' diets gave a different energy distribution. Cereals provided the
Table 3.4
Intakes of Energy, Protein, Fat and Carbohydrate in Patients with Senile Dementia and Healthy Elderly Controls

<table>
<thead>
<tr>
<th></th>
<th>Patients</th>
<th>Controls</th>
<th>RDA*</th>
<th>Percentage of subjects below RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sex</td>
<td></td>
<td></td>
<td>Pts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean Intake</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>M</td>
<td>1600++</td>
<td>2100</td>
<td>2275</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1500</td>
<td>1800</td>
<td>1790</td>
</tr>
<tr>
<td>Protein</td>
<td>M</td>
<td>62+</td>
<td>73</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>57</td>
<td>64</td>
<td>44.5</td>
</tr>
<tr>
<td>Fat</td>
<td>M</td>
<td>68</td>
<td>88</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>65</td>
<td>78</td>
<td>-</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>M</td>
<td>173</td>
<td>259</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>187</td>
<td>210</td>
<td>-</td>
</tr>
</tbody>
</table>

Significant difference in student's two tailed t-test
++ p < 0.01
+ p < 0.05

*RDA - Mean recommended daily allowance for 65 and over age group for men, and 55 and over for women (DHSS, 1979a)

Table 3.5
Intakes of Fibre in Patients with Senile Dementia and Healthy Elderly Controls

<table>
<thead>
<tr>
<th>Group</th>
<th>Sex</th>
<th>Mean Intake</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>M</td>
<td>11.8*</td>
<td>9 - 16</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>12.1</td>
<td>7 - 17</td>
</tr>
<tr>
<td>Controls</td>
<td>M</td>
<td>22.0</td>
<td>11 - 37</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>14.7</td>
<td>7 - 26</td>
</tr>
</tbody>
</table>

*Significant difference in two tailed t-test p < 0.01
largest amount of energy in bread, cakes and pastries, sugar and potatoes, with milk, fats and meats being close behind. This elderly group contained a large proportion of cake eaters with over half of the group (12) taking tea and cake at some time during their day.

3.4.b.iii. Protein

The mean intake of protein received by both sexes of the patient group was above the RDA. Only two males ingested less than the recommended daily amount of protein for their age.

Once again, the bulk of the protein provided in the diet came from milk, which yielded an average of 3g per day. The main meal contained an average of 8g per day and the remaining protein of high biological value was in the form of bacon or egg, custard or milk pudding (provided every day) and in the sandwich filling or snack served later in the day. Of the sources, approximately 60% were of high biological value proteins. Protein provided 15% of the total energy intake in male and female diets.

For controls the mean intake in both sexes were above the RDA, however the ranges show that two of the female subjects had intakes below the RDA for their age group. The contribution of total energy from protein was 13%
and 15% for males and females respectively.

The bulk of the protein in the diets of controls subjects came from milk, meat or meat products. Proportions varied considerably between individuals. When milk was the main provider, it contributed 14%-25% of the total protein intake. Meat provided 30%-45% of the total protein intake. Other contributors were bread, cakes and biscuits. Significantly more male patients (p<0.05) had lower intakes of protein than their male controls.

3.4.b.iv. Fat

The amount of fat in the diet of the patients and controls varied considerably from day to day, but overall mean intakes were within normal range. Intakes were similar in males and females. Fat contributed 38% to the mean energy intake of both the patients' and controls' diets. For patients the majority of the fat came from cheese, fried potato or egg. Very little butter was eaten by the patient, whereas controls ate far more butter, margarine and fried foods. Eggs and meat provided a large amount of the remaining fat intake.
Mean intake of carbohydrate were similar between the two sexes in both groups. However, the mean total carbohydrate intake was greater in the controls than in the patients but the difference was not statistically significant.

Daily variations in the carbohydrate intake were wide in some of the controls with a difference, for example, of 100g of carbohydrate between two daily intakes.

When the intake of carbohydrate for patients was unusually low (111g) per day it was due to the absence of high carbohydrate foods in the diet, such as potato, sponge and pastry. All patients took sugar in beverages. A wide variation in intakes of control subjects was also due to the presence or absence of sugar, pastry or cake.

On average, 46% of the patients' total carbohydrate intake came from sugars and 53% came from polysaccharides. The controls consumed a similar proportion (45%) of their carbohydrate as sugar and a lower proportion (42%) of polysaccharide.

When comparing the carbohydrate to total energy intake for male and female patients, the values were 43% and 49% respectively. For controls carbohydrate
contributed 49% and 46% for male and female respectively to the mean energy intake.

3.4.b.vi. Fibre

Table 3.5 shows the mean daily intake of fibre for both groups and sexes. The mean amounts of fibre ingested by patients was similar between the two sexes. However for controls the males had a higher mean intake and the range was wider, with female controls taking remarkably less fibre than males. Male patients took significantly less fibre than their controls (p<0.01).

Sources of dietary fibre in the two groups were different. Two thirds of the fibre in the patient group was of vegetable origin (only a quarter coming from fruit), yet two thirds of the fibre intake of the control group was predominantly cereal fibre.

The poor cereal content of the patient diet was due to the fact that little bread was provided and it was only white bread. The only cereal eaten was porridge or cornflakes.

Of the control group, 5 subjects ate brown bread and 3 ate wholemeal bread. Those who ate brown bread, believed it to be the same as wholemeal. The controls were not fond of breakfast cereals. Muesli, of their
own making, or 'All Bran' was the only breakfast cereal regularly eaten. Many of them ate only toast at breakfast.

3.4.b.vii Tryptophan

Table 3.6 shows the mean daily intakes and ranges for the amino acid tryptophan. The mean intake of the patients was similar in the two sexes. Moreover, the female patients had a similar intake to that of their controls. Male patients had a lower mean intake than their controls, but the difference was not statistically significant due to the large range of individual values which reflected the range of protein intakes in the group.

3.4.c. Vitamin Intakes

Table 3.7 shows the mean intakes, standard errors and percentage of subjects with low intakes, compared to the recommended daily amount, of all the major vitamins.

3.4.c.i. Vitamin C

The mean intake for both patients and controls was
### Table 3.7

#### Vitamin Intakes of Patients with Senile Dementia and Controls

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Unit</th>
<th>Patients</th>
<th>Controls</th>
<th>RDA&lt;sup&gt;°&lt;/sup&gt;</th>
<th>% Low Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>35±2.1</td>
<td>47±4.2</td>
<td>30</td>
<td>39 17</td>
</tr>
<tr>
<td>Thiamin</td>
<td>mg</td>
<td>1.0±0.1</td>
<td>1.1±0.1</td>
<td>0.90</td>
<td>30 8</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>mg</td>
<td>1.7±0.1</td>
<td>1.7±0.1</td>
<td>1.60</td>
<td>27 39</td>
</tr>
<tr>
<td>Nicotinic Acid</td>
<td>mg</td>
<td>24++1.2</td>
<td>31±1.8</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Pyridoxin</td>
<td>mg</td>
<td>1.0±0.04</td>
<td>1.1±0.1</td>
<td>64</td>
<td>43</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>ug</td>
<td>8.6±1.9</td>
<td>5.9±1.9</td>
<td>39</td>
<td>57</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>ug</td>
<td>140±7.1</td>
<td>140±8.3</td>
<td>100</td>
<td>91</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>ug</td>
<td>2.3±0.3</td>
<td>2.2±0.4</td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>ug</td>
<td>1947±424</td>
<td>1477±356</td>
<td>750</td>
<td>61 43</td>
</tr>
</tbody>
</table>

* Values for patients which differ significantly from those of controls by students two tail t-test shown when + <i>p</i>0.05 and when ++ <i>p</i>0.01  
  a. RDA value for USA (U.S. Food and Nutrition Board)  
  b. RDA value from tables (DHSS, 1969)  
  c. RDA value from tables (DHSS, 1979).
### Table 3.6

**Intakes of Tryptophan in Patients with Senile Dementia and Healthy Elderly Controls**

<table>
<thead>
<tr>
<th>Group</th>
<th>Sex</th>
<th>Mean Intake</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>M</td>
<td>796</td>
<td>615 - 993</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>766</td>
<td>432 - 1194</td>
</tr>
<tr>
<td>Controls</td>
<td>M</td>
<td>919</td>
<td>727 - 1267</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>782</td>
<td>445 - 1092</td>
</tr>
</tbody>
</table>

### Table 3.8

**Destruction of Ascorbic Acid in Potato served at Whitchurch Hospital**

<table>
<thead>
<tr>
<th>State of Potato</th>
<th>Time</th>
<th>-mg of Ascorbic Acid per 100g Potato</th>
<th>% Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw</td>
<td>9.00 am</td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>Immediately after cooking</td>
<td>11.15 am</td>
<td>5.11</td>
<td>49</td>
</tr>
<tr>
<td>When served</td>
<td>12.30 pm</td>
<td>0.89</td>
<td>92</td>
</tr>
</tbody>
</table>
above the RDA of 30mg, although 39% of the patient group, compared to only 17% of the control group, did not achieve the RDA.

The main source of vitamin C in the hospital diet was potato. This provided on average 45% of the total mean intake. When the intakes of the patients were calculated without the inclusion in the calculation of all potato and vegetables, the mean intake of vitamin C was 12.7mg, a little over the minimum intake (10mg) required to prevent scurvy (Bartley et al. 1953).

Table 3.8 shows the results of vitamin C analysis of potato in one of the hospitals during its preparation and service to patients, as described in Chapter 2. Results show a loss of 92% of the original vitamin C content, 43% being lost after cooking whilst being kept hot for service.

Vegetables, including potatoes, provided 63% of the daily vitamin C for the control group; fruit providing 25% and other foods, including milk, providing the remainder. One of the control group had 8.3mg vitamin C. This gentleman ate no 'fresh' vegetables and took no fruit or fruit juice. Figure 3.1 shows the distribution of vitamin C intakes within the group.
Fig. 3.1. Comparison of Vitamin C Intakes in Patients and Controls

Intakes of vitamin C (mg)

- Patients
- Controls

Percentage of Subjects

- 75 -
- 50 -
- 25 -
- 12 -

0 - 20  21 - 40  41 - 60  61 - 80  81 - 100  101 - 120
There are two RDA values that apply to the age group investigated. For these males and females, the RDAs were 1.0mg and 0.8mg respectively. For those aged over 74 years, the figures quoted are 0.9mg for males and 0.7mg for females. When these figures are applied to the group, one third of the patient group had an intake below the RDA compared to only two members of the control group.

Meat or milk supplied most of the thiamin provided by the hospital diet. When fish replaced meat as the main meal, the amount of thiamin dropped, in some cases by 50%, and this resulted in a wide range of intakes (0.5-1.7). However, all values are mean intakes over the three day period and, in all cases, meat was included in the menu over that time. Sausages and beefburgers, though classed as meat, contributed little thiamin to the diet, compared to the larger amounts contributed by beef, lamb and pork.

Most of the thiamin in the diets of the controls came from bread which provided, on average, 36% of daily amount; milk and meat provided the majority of the remaining thiamin.

There was again a wide range (0.5-1.6) of intake and this was mainly due to the presence of meat in the
controls' diet. As with the patients controls ate meat over the three day period.

3.4.c.iii. Riboflavin

There are two RDA values for this age group, depending on sex. The figures are 1.6mg for males and 1.3mg for females.

The mean intake of both groups was the same. Six of the patient group and 9 of the control group had an intake just below the RDA figure.

Milk was the main source of riboflavin in both patient and control diet, with meat and eggs providing the majority of the remainder.

3.4.c.iv. Nicotinic Acid

Once more, the recommended allowance is split for males and females. There was a statistically significant difference in the mean intakes of this vitamin, with patients consuming significantly lower amounts, yet none of the group as a whole took less than the RDA.

Meat provided most of the nicotinic acid in the daily diet. However, 40% of the vitamin in the control
group came from cereals, compared to only 11% from this source in the patients.

3.4.c.v. Pyridoxin

There is no RDA, in the United Kingdom, for pyridoxin. As a gauge for the intakes of the group, the recommended value of the United States of America (Food and Nutrition board, 1980) was used, which is 1 mg per day. Two thirds of the patient group failed to have an intake above this figure, compared to half the control group; yet the mean intake was similar in the two groups.

The fluctuation in the daily intake for patients was reflected in the meat content of the diet and, also, in the presence or absence, of liver.

However, 5 of the 8 patients taking over 1 mg per day, did not have liver, but had bacon and/or fish during the three day period over which the intake was measured.

As for the patients, the controls' dietary intake fluctuated with the meat content. Only two of the 23 subjects took liver over the three days and a total of four controls took offal meat of some sort. Pyridoxin intakes were higher on the days when offal meat was
taken but the mean intake for these subjects did not represent the highest intakes for the group.

3.4.c.vi. Vitamin B12

There is no RDA set at present for this vitamin, although the DHSS, 1969 recommendation was set at 3-4 mgs per day. The lower limit is taken as the RDA for this investigation. There was no significant difference between the mean intakes of patients and controls.

The number of subjects with intakes below the RDA were 9 and 13 for patients and controls respectively.

The range of intakes was wide, due to the numbers taking liver and offal meats. Daily fluctuations of the vitamin were in part, paralleled by the amount of meat in the diet.

3.4.c.vii. Folic Acid

The mean intake of this vitamin in both groups was identical and only two of the control subjects, out of the whole group, achieved an intake above the RDA figure, used in this thesis, of 200 mgs per day. Three of the patients and five of the controls had intakes of folic acid below 100 mgs per day. Fig. 3.2 shows how
Fig. 3.2. Comparison of Folic Acid Intakes in Patients and Controls

<table>
<thead>
<tr>
<th>Intakes of Folic Acid (ug)</th>
<th>Percentage of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>71 - 100</td>
<td>10 - 15</td>
</tr>
<tr>
<td>101 - 130</td>
<td>15 - 20</td>
</tr>
<tr>
<td>131 - 160</td>
<td>20 - 25</td>
</tr>
<tr>
<td>161 - 190</td>
<td>25 - 30</td>
</tr>
<tr>
<td>191 - 220</td>
<td>30 - 35</td>
</tr>
<tr>
<td>221 - 250</td>
<td>35</td>
</tr>
</tbody>
</table>

Patients

Controls
the control subjects had a wider range of folate intake.

Milk was the main contributor of folic acid for both patients and controls. Vegetables and eggs provided the majority of the remaining folic acid.

3.4.c.viii. Vitamin D

The RDA (DHSS, 1979a) figure of 10 mg vitamin D was applied to the patients group only. All of the patients were considered as 'housebound', since they spent no time out of doors. The mean intake of the patients reached only one fifth of the RDA. Main sources of vitamin D in the patients' diet, were eggs, sponge, meat and malted milk drinks. The first two were items most frequently included on the menu.

One of the controls consumed, on average, 8 mg of vitamin D per day. This gentleman ate a large amount of sponge each day and also ate margarine. Six of the controls ate margarine in preference to butter, whereas only butter was used as spread by the patients.

3.4.c.ix. Vitamin A

The amount of this vitamin in the diet varied
considerably and was dependent on particular foods. Liver was present on the hospital menu for one week in a three week cycle. Ten of the 23 patients sampled took liver during the three-day weighed intake period and only two, of those not taking liver, had an intake of vitamin A above 750 mg.

The range of intakes for controls shows a very wide variation in intake of this vitamin. Once more, those who ate offal meat over the three days had intakes well over 1000 mg vitamin A per day. Nine, of the controls not taking offal meat, had an intake of vitamin A above 750 mg.

3.4.d. Intakes of Minerals

Table 3.9 shows the mean intakes, of calcium, magnesium, iron, zinc and copper, for the two groups of subjects.

3.4.d.i. Calcium

Milk contributed much of the calcium in the diet, 30% to the patients and 50% to the controls, the controls took nearly all their milk in tea, coffee and other
Table 3.9
Mineral Intakes of Patients with Senile Dementia and Controls

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Unit</th>
<th>Patients</th>
<th>Controls</th>
<th>RDA</th>
<th>% Low Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>788 ± 38.7</td>
<td>922 ± 65.7</td>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg</td>
<td>206+ ± 6.3</td>
<td>256 ± 17.0</td>
<td>N/A</td>
<td>78</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>9.2 ± 0.6</td>
<td>10 ± 0.6</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>8.4 ± 0.49</td>
<td>8.7 ± 0.57</td>
<td>15a</td>
<td>100</td>
</tr>
<tr>
<td>Copper</td>
<td>mg</td>
<td>1.1 ± 0.08</td>
<td>1.3 ± 0.09</td>
<td>2a</td>
<td>100</td>
</tr>
</tbody>
</table>

a. U.S.A. recommended value (Food and Nutrition Board)
+ Values for patients which differ significantly from those of controls by students two tailed t-test shown when $p<0.01$

N/A RDA for the mineral is not available.
beverages, whereas the patients, due to a poor beverage intake, took the bulk of their milk as puddings. Baked goods and cheese provided the bulk of the remainder. Half the patients had a mean intake just over the RDA of 500 mg. Only one of the controls had an intake below 500 mg per day.

3.4.d.ii. Magnesium

There is no RDA for this mineral. The intakes of the patients were significantly lower (p < 0.01) than the controls group, with a much greater range of intakes in the control group.

Forty per cent of the magnesium taken by patients came from vegetable sources, with the remainder coming mainly from porridge and milk. The majority of controls received most of their magnesium from bread, milk and vegetables.

3.4.d.iii. Iron

The DHSS (1979a) report, gives a RDA of 10 mg of iron per day for both males and females over 65 years. The intakes of the patients were similar to those of the controls. However, a greater proportion of patients than controls had a dietary intake below the
As in the case of vitamin B12, the high intakes of iron are due to the presence of liver in their diet. Again, if liver was not present in the three day's diet, intakes fell below the RDA.

The lowest intake in the controls was 4.6 mg, taken by a subject DW, whose meat consumption was limited to 95 g of pork chop and 50 g of ham over the three day period. The majority of protein in this lady's meals came from fish and cheese.

In the hospital diet, 70% of the iron came from a vegetable source and 30% from an animal source compared to 60% from vegetable and 25% from animal origin in the controls.

3.4.d.iv. Zinc

The American RDA for zinc (Food and Nutrition Board, 1980) has been used in the table, as a yardstick to assess the subjects' intakes.

Only one of the total group had an intake over the recommended level of 15mg per day.

The range and mean intake in both groups was remarkably
similar with animal sources contributing 50% or more of the total zinc intake.

3.4.d.v. Copper

The American recommendation for copper is 2mg per day. Once more, only one of the total group of 46 had an intake above this figure. The control with an intake over 2mg was not the same person whose intake of zinc exceeded 15mg per day. The amount of copper coming from animal sources was approximately 40% for both patients and controls.

3.5. DISCUSSION

3.5.a. Energy

It has been suggested that undernutrition is common and obesity rarely found in psychiatric wards. The results presented here agree with those of others (Asplund et al., 1981), in suggesting that dietary energy deficiency may be a contributing factor.

The mean dietary intake of energy for the male patients was significantly lower than that of their controls,
with none of them having a mean intake, from the three assessment days, over the recommended daily amount.

This finding must be seen against the background of activity seen in some patients with dementia. A proportion are restless and the ambulant ones spend much of their day walking around. It is likely, therefore, that their energy expenditure is greater than that of their healthy counterparts.

In the total patient group 87% of the patients had energy intakes below the RDA (DHSS, 1979a). Patients ate all the food presented to them. They appeared to have no strict preferences for food; if the food was not eaten, the patient either could not masticate it, or was in 'a mood' but these occasions were extremely rare.

The body weight of patients with dementia tends to be low, when compared to that of elderly patients with an affective disorder or schizophrenia (Morgan and Hullin, 1982). However, these patients are often treated with drugs that increase weight. Although the RDA for the healthy elderly is sometimes considered to be too high, this is not the case for patients with senile dementia who have been shown to have significantly lower intakes than healthy controls of similar age.

It is surprising to find a hospital diet low in energy,
especially when the proportion of fat and carbohydrate of the diet has been shown to be similar in both groups and similar to the percentages quoted for the population as a whole prior to the NACNE report. The NACNE report (James, 1983) cannot be applied to the group under discussion, as it is for the general population and not for specific age groups.

The lower energy intake by the patients was due to the size of the food portions. None of the patients could serve themselves and, as discussed earlier, could not request larger or second helpings. An example of differing portion sizes is illustrated by those of two males of 69 years of age. Patient WE received a helping of potato weighing 65g, compared to control JT whose serving of potato weighed 170g.

Intakes of protein, fat and carbohydrate were all higher in the controls, although the difference was not statistically significant due to the range of intakes. The lower intakes in the patients were due to poor portion size, and in the case of protein, poor menu content, beefburgers and sausages making up a large amount of the main meals and the meat content of these being particularly low.

The averages of the three days' intake of protein were surprising in view of an earlier unpublished report by Dickerson et al., 1974. They showed that protein
intakes in a psychiatric hospital greatly exceeded the RDA, yet in this work, 7 patients failed to take the RDA of protein. However, ten years separate these two studies and they were conducted in different parts of the country. Economic restraints upon the health service may be partly responsible for low protein intakes. A point to note was the large amount of milk that contributed to the daily protein intake of the patients. This particular food provides a large proportion of their nutrition, and it is hoped that catering departments in hospitals will continue to include it on the menu in custards, puddings and sauces.

3.5.b. Fluid

The patients had a low fluid intake. The common impression of the nursing staff is that a large fluid consumption results in increased incontinence and, therefore, in more nursing demands in changing soiled patients to relieve discomfort.

The total fluid intakes of the male patients was lower than that of their controls. In contrast the female controls drank less on average than the female patients.

For the majority of patients the total amount of fluid
taken in drinks was 4 cups of tea per day. One cup at breakfast, lunch, tea and the evening meal. The total volume of fluid consumed in this way amounted to an average of 500ml per patient which is much lower than the recommended for this age group.

It is therefore suggested that this low fluid intake on hot, dry wards, where patients were well clothed and often covered in blankets, could induce dehydration, which itself could affect the mental state. Confusion due to dehydration has been reported (Davidson et al., 1975a; Seymour et al., 1980). This could also be the cause of the weight loss seen in the demented elderly, if the practice of restricted fluids is seen in other areas of the country, apart from Cardiff.

In an attempt to prove to nursing staff that increased fluid did not mean an increase in incontinence, the patients on one of the wards in Whitchurch Hospital were put on fluid charts to increase the fluid intake. Their intake of fluid was increased to 7 cups per day, providing an average 840ml of fluid per day. Although not a quantitative result, the nursing staff did note that frantic activity of patients declined, with far more patients remaining seated and quiet, and being less distressed.
One of the biggest problems in any elderly person is constipation. Some elderly people even begin to expect to have difficulty in bowel habit with age and this was reflected in one third of the control group taking wholemeal, or what they believed to be 'wholemeal', bread each day, in an attempt to alleviate bowel problems.

There is no RDA for fibre. NACNE recommends 25g per day and although not accurately applied to this group, it shows how poor the hospital diet is.

The male controls had a high intake of fibre, with a wide range, although it would be unfair to suggest that they were a more dietary conscious group, as the majority were living with their spouse.

Until the fluid intake increases, it could be said to be more harmful to increase the fibre intake in the patient groups, as there would be a need to increase the cereal fibre intake, which was a very poor third of the total fibre intake in the patient group. Cereal fibre is known to take up far more fluid in the gut than vegetable fibre and it is a more beneficial dietary component than vegetable fibre.

Although only one of the patient group had a known
bowel problem and was taking Fybogel, it is tempting to suggest that induced constipation through poor fibre and fluid intakes, in more patients with dementia, could increase the degree of confusion due to the build up of nitrogenous and other waste products in the gut (Davidson et al., 1975b).

3.5.d. Vitamins and Minerals

As discussed in chapter 1, vitamins play a vital role in brain function, with deficiencies of many being suggested as a factor in senile dementia. The intakes of all vitamins give cause for concern in the group as a whole, but especially for those with dementia.

Although the mean calculated intake of ascorbic acid by both patients and controls exceeded the recommended daily allowance, evidence suggests that the values for the patients are spuriously high. In view of the fact that potatoes were the main source of vitamin C in the hospital diet and that this vegetable was found to lose 92% of its original content between preparation and service, there is some doubt about the accuracy of the mean calculated intake of the patients. The losses were so large that, effectively, all the potatoes and vegetables can be erased from the calculation of dietary vitamin C. This would have given a mean intake of 12mg per day. This figure is close to the lowest
intake of 10mg vitamin C known to protect against scurvy (Bartley et al., 1953). This destruction of the vitamin did not occur in the diet of the controls as foods were eaten immediately after cooking.

A low mean intake for the patients is supported by the finding that 50% of the patients had a plasma ascorbic acid level below the lower limit of normal, compared to only 9% of the controls.

The mean plasma concentrations were significantly different ($p<0.003$) with patients having a mean value of 0.40mg/100ml, compared to 0.77mg/100ml in the controls. These results are in agreement with those of other psychogeriatric patients (Morgan and Hullin, 1982) and of a healthy elderly South Wales population (Burr et al, 1974).

The leucocyte (buffy coat) concentration of ascorbic acid was similar in the patients and controls (35ug/10$^8$ cells and 42ug/10$^8$ cells respectively). However, according to Loh and Wilson (1971), plasma levels are a more reliable index of ascorbic acid status than tissue levels, as represented by the leucocyte concentrations.

The two patients and three controls who were smokers did not have low plasma levels of the vitamin.
Platt et al. (1963) documented the destruction of vitamin C in hospital food, yet hospital caterers continually ignore the problem of the poor vitamin C quality of their menus which so easily can be rectified with fortified fruit squash or the more expensive fruit juice. However, numerous conditions have been linked to the low status of ascorbic acid and it is interesting to consider whether many ailments taken as a normal consequence of ageing in this group, are in fact due to subclinical deficiency of the vitamin. Comparisons made between plasma ascorbic acid and age shows a significant correlation \((p<0.001)\) in the patient group only. Ascorbic acid has a cerebral function. Depression may be a symptom of avitaminosis C, due to a reduced activity of dopamine \(\beta\) hydroxylase, which is an ascorbic acid dependent enzyme. A lack of ascorbic acid could, theoretically, decrease endogenous carnitine which has been found to be low in concentration in patients with muscle weakness (Hughes, 1982). Also, vitamin C depletion has been linked to easy bruising of the skin, as seen in the Hess test (Davidson et al., 1975c). Many elderly patients bruise severely after venepuncture. The bruising is often contributed to poor technique on the part of the doctor, when it may be a sign of poor vitamin status.

It would therefore seem of great benefit to improve the menus or to embark on blanket vitamin supplementation for all elderly people admitted to hospital.
Certain vitamins of the B group are of particular relevance to brain function. A deficiency of thiamin may be a cause of confusion in the elderly (Older and Dickerson, 1982; Puxty, 1985).

The requirements for thiamin and riboflavin are related to the energy intake.

About a fifth of the total group (patients and controls) were receiving less than the RDA of thiamin and 36% of the controls and 38% of the patients had biochemical evidence of thiamin deficiency on the basis of elevated values for transketolase activation (Dreyfus, 1962). This gives cause for concern about the thiamin status of patients and controls. Older and Dickerson (1982) and Katakity et al. (1983) have also found elevated values for transketolase activation in geriatric patients, so it is not restricted to patients with senile dementia.

A number of factors may contribute to thiamin deficiency, including losses during cooking, losses in the stomach due to the use of antacids (Dickerson, 1978) and malabsorption. However, none of the group took antacids up to a week prior to the investigation and during the three day weighed intake. Losses during cooking cannot be calculated for the control group, one would assume negligible differences between the McCance and Widdowson (Paul and Southgate, 1979) calculated
figures and actual intakes. However, the losses during institutional cooking for patients have not been accounted for.

Approximately one third of the total group had low intakes of riboflavin, however, none of the subjects had biochemical evidence of riboflavin deficiency as judged by erythrocyte glutathione reductase activation.

The nicotinic acid intake of the patient group was significantly lower than the control group, but this is of no nutritional importance as none had an intake below the RDA for age.

Dietary intakes were reflected in the levels of N-methyl nicotinamine/creatinine ratio in urine which were used as an indicator of nicotinic acid status. They showed only one of the control subjects having a level indicative of deficiency.

As described earlier, the USA recommended allowance of 1mg was used as a yardstick for the dietary intake of pyridoxin. More patients (64%) than controls (43%) had a low intake, with the mean intake being remarkably similar. However, only 5% of the patients and none of the controls had biochemical evidence of deficiency of this vitamin, as judged by erythrocyte amino transferase activation.
The mean dietary intakes of vitamin B12 were similar between the two groups with far more controls having an intake below the 'withdrawn' RDA of 1979 of 3ug. None of the group had biochemical evidence of deficiency of vitamin B12 (Amersham International Ltd) yet levels were toward the lower limit of normal. The range of intakes were similar between the groups.

The intakes of folic acid as estimated from the values in the food tables were lower than the RDA of 200ug quoted in the first printing of the DHSS (1979a) tables, which have been used here as a yardstick.

Almost all of the subjects were receiving less than 200ug of folic acid per day and serum folate levels were normal (5.1ug/ml for patients and 6.7ug/ml for controls).

The mean dietary intakes of our subjects were in fact similar to the median value of 125ug/day reported by Bates et al. (1980) for elderly people living in their own homes. However, no calculation has been made of the destruction of folate in hospital catering practices, but due to the question of availability of certain forms and conjugates as discussed in chapter 1, the value of assessing destruction could be negligible.

The patients were found to have a lower mean erythrocyte folate concentration than controls
(patients 198μg/ml, controls 308μg/ml). This difference probably has no nutritional significance since the mean erythrocyte value was similar to the lower limit of normal (100μg/ml). It was also similar to that reported by Bates et al. (1980) in their study of elderly persons.

The lower erythrocyte concentration in the patients on a similar intake to the controls suggests a possible defect in absorption of folate or a decreased requirement. Serum folate values were similar between groups as was to be expected since serum levels reflect daily dietary fluctuations and the patients mean intakes were identical to the controls. However, the erythrocyte levels, reflecting tissue storage were significantly lower in patients and this suggests that body stores of the vitamin were depleted. It seems possible that this is one factor in the aetiology of dementia.

Cases of dementia associated with folic acid deficiency have been reported (Sneath et al. 1973). Folate deficiency may affect serotonin synthesis via its effects on the synthesis of the methyl donor S-adenosyl-1-methionine which has been shown to increase the turnover of serotonin in rat brain (Algeri et al. 1979).

The comment of many physicians is that folate deficiency cannot be present without macrocytosis,
however this work and that of Batata et al. (1967) has shown that red cell levels can be in the lower limit of normal, without any megaloblastic anaemia.

The patients relied totally on dietary sources of vitamin D due to the fact that they are technically 'housebound', never venturing out of doors. The reason for this is a technical one due to the risk to the patients if, and when, they wander off.

Sunlight may be considered a more important source of vitamin D in the elderly than the diet (Hodkinson et al. 1973; Lawson et al., 1979). The body is better adapted to handle vitamin D which is derived from sunlight than that from the diet (DHSS, 1980) as the skin transfers the vitamin to the blood stream at a controlled rate whereas dietary vitamin D gives wide fluctuations in plasma 25 hydroxycholecalciferol (Fraser, 1983).

None of the patients had a dietary intake of vitamin D above 10ug. In fact both patients and controls had similar intakes, but controls were all ambulant and went for walks out of doors daily, if only in their gardens.

Dietary intakes of calcium were adequate with only two control subjects failing to have an intake above the RDA.
The absence of inadequate vitamin D in the patients' diets casts doubt on whether adequate amounts of calcium would have been absorbed from the gut and suggests that the patients would be at risk of developing osteomalacia. The finding that calcium was within normal limits for both patients and controls is no guarantee that osteomalacia was not present for calcium could be reabsorbed from bones to maintain the blood calcium level. Osteomalacia is common in the elderly (Hodkinson et al., 1973) and Johnson et al. (1980) have suggested that a single dose or short course of vitamin D in the elderly may be sufficient to prevent deficiency.

The patients who had the lowest vitamin D intakes had an X-ray examination of their hips, but no Looser zones were detected. However, this does not conclusively mean that the patients are not in the early stages of the condition.

One of the patients who completed a three day weighed intake but did not complete the investigation, sustained a fractured femur on day 4. Her mean vitamin D intake was only 0.5ug and her mean calcium intake was 475mg.

The majority of patients with senile dementia die from pneumonia which tends to develop after they have sustained a fracture. Calcium and vitamin D nutriture
in this group requires more investigation and the need to supplement patients with vitamin D or to use ultraviolet light on long stay wards, seems on this evidence to be necessary.

Although patients had low intakes of iron, the haemoglobin levels measured as a routine investigation were within normal limits and none of the patients had evidence of anaemia.

Figure 3.3 shows iron intakes correlated against age in all the subjects. There was a significant correlation in the controls (p<0.05) the absence of correlation in the patients could be due to the 'standard' diet given to them as a whole, regardless of age, whereas diminishing portion size as with control DW (discussed earlier 3.4.d.iii) suggested a reduction in intake with age (DW age 82 years).

Zinc is the only mineral which has been suggested to be directly linked to dementia. Burnett (1981) suggested that dementia may represent the cascading effect of error-prone or ineffective DNA handling enzymes which have an age associated loss in ability to make zinc available for insertion into the newly synthesized enzyme.

The mean dietary intake of zinc by the patients and controls was similar (128umol, 8.4mg; and 133umol,
Fig. 3.3. Comparison of Iron Intakes Against Age.

+ Patients

○ Controls
8.7mg respectively). These values were similar to those (10.1mg for males and 7.6mg for females) reported by Lyon et al. (1979).

The mean plasma zinc concentration in the present study was also similar to the plasma concentration found by Bunker et al. (1982) in the elderly. A decline in plasma zinc with age was attributed by Vir and Love (1979b) to a fall in serum albumin as 60-70% of circulating zinc is bound to albumin. There was a similar correlation between plasma albumin and age in our controls (p < 0.01) but not in the patients.

There was an absence of any correlation in both groups between plasma zinc and serum albumin.

It should be noted that the use of a three day dietary assessment does not give a clear picture of zinc and copper intakes and that a longer period of investigation would be needed.
approximately one third, there seems little possibility that the low range of plasma zinc levels found in the patient group could be attributed to the cereal fibre ingested.

The range of intakes seen for copper in the total group, although below the American RDA, was adequate as plasma levels of the metal fell within the normal range. However, the patients had significantly higher mean plasma levels of copper (17.0 μmol/ml for patients and 13.27 μmol/ml for controls) and this was reflected in the absence of a significant correlation between intake and plasma copper in the patients in comparison to the controls (p<0.05). Copper, like zinc, is bound to albumin but there was no correlation between these two variables. Copper is stored mainly in the brain and liver, a release from this store in the patients could produce this high serum level. A possibility is that due to poor energy intakes in the patients, liver protein may be utilized for energy production, thus releasing stored copper. However, although this is known to occur in frank malnutrition, none of the patients were in this condition.

The dietary intakes of calcium could not explain the higher calcium levels seen in the patients (2.82 mmol/ml) compared with that in the controls (2.17 nmol/ml). Altered calcium metabolism, possibly through greater bone loss due to poor vitamin D status
(discussed earlier) may have played a part in the higher levels found in the patients. In view of the fact that hypercalcaemia may produce memory deficits and personality changes (Lindemann, 1982), this finding is of particular interest in the development of senile dementia.

3.5.e. Tryptophan

Plasma tryptophan levels were measured in the group of patients and controls. Previously, Shaw et al. (1981) had shown low fasting levels of the amino acid in patients with dementia in comparison to controls. Similarly, in this age matched sample the patients had significantly lower levels of plasma tryptophan. These low levels could not be attributed to dietary intakes since the female patients were receiving similar daily amounts to their controls. The other possible reason for low plasma levels was stimulation of the kynurenine pathway by which tryptophan is converted to nicotinamide. However, the excretion of N-methyl nicotinamide by the female patients was lower than that of the controls and would seem to provide no evidence for the stimulation of the kynurenine pathway.

The interrelationship between plasma concentrations of tryptophan and other relevant metabolic measurements (albumin, nonesterified fatty acids, insulin) measured
by my colleague, S.F. Tidmarsh, did not seem to provide a satisfactory explanation for the low concentration of tryptophan in patients with senile dementia.

One possibility is that the patients had some degree of malabsorption as suggested by Lehmann (1981). This theory is supported by the dietary findings, especially in the case of thiamin and folic acid where there also seems to be a valid argument for malabsorption. Certainly any degree of malabsorption will not be independent of the nutritional state, as poor nutrition results in the loss of integrity in the absorptive mucosa therefore increasing the degree of malabsorption. This produces a vicious circle that becomes ever diminishing (Fig. 3.4).

Many workers have commented on the poor nutritional status of the elderly in institutions. These results show that this is also true for patients with senile dementia resident in hospital and that considering the amount of research into nutritional status in hospital, there has been remarkably little done to overcome the defects continually highlighted in institutional catering. It is well known that nutritional sufficiency is of paramount importance in the maintenance of health and the healing process in an elderly person in an institution.

It would seem that in an elderly dementing person
Fig. 3.4.

Vicious Circle of Malabsorption
and Poor Nutritional State

Malabsorption → Loss of Absorptive Mucosa → Poor Nutritional State → Malabsorption
adequate nutrition is doubly important to maintain health and to prevent deterioration of mental state and/or production of secondary confusional state or affects developing. This will be further discussed in chapter 5.
Chapter 4

COMPARISON OF THE DIETARY INTAKES OF RESIDENTS IN PART III ACCOMMODATION AND THE INTAKES OF HEALTHY ELDERLY PERSONS AT HOME
4.1 INTRODUCTION

At present, in Britain, the care of the institutionalised elderly is divided between geriatric hospitals and residential homes (Pasker et al., 1976). Few studies have been done on the nutritional well-being of the elderly in part III accommodation, which is surprising in comparison to the number of nutritional studies carried out within geriatric and psychiatric hospitals.

At present, a third to half of all residents in part III accommodation show signs of dementia. The majority of all subjects who finally are resident on a longstay ward for demented elderly, pass at sometime through part III accommodation. With the current interest in community care and the abolition of large psychiatric institutions, the provision of more places in residential care for those with confusional states or dementias will increase (Margo et al., 1980). There is already evidence that the residential homes are caring for increased numbers of elderly people with higher levels of community problems (Wilken et al., 1978). With this knowledge and that of the poor nutritional state seen in longstay patients with senile dementia, it is necessary to investigate the nutritional state of those in Social Services residential care.
Vir and Love (1978) found an overall better nutrient intake amongst a group of 26 people living in Part III accommodation than amongst patients in a geriatric unit of a hospital or an elderly group living at home. A large proportion of the residents had biochemical evidence of ascorbic acid (46%) and vitamin B6 (62%) deficiency and only a small proportion had evidence of thiamin or riboflavin deficiency.

Read et al. (1965) and Andrews et al. (1969) found a high prevalence of low serum folate and plasma ascorbic acid, respectively, in residents with improvement on supplementation. A study of 50 elderly subjects in 5 welfare homes in the North of England revealed low energy consumption in comparison to quoted requirements for the age group (Hunt, 1980). In this same study, intakes of calcium, thiamin, riboflavin and nicotinic acid appeared adequate, yet intakes of fibre, magnesium, potassium, iron, zinc, copper, vitamin D, folic acid, pyridoxin and vitamin C were below the recommended amount. This was attributed to a general low food intake.

4.1.a. Assessment of nutritional State

As before, dietary intake has been taken as the main indicator of nutritional status. The biochemical
assessments are quoted in the text only as support to my dietary findings and were measured by my colleagues, Dr. Chung-a-on and Mr. Tidmarsh.

4.2. **SELECTION OF SUBJECTS**

4.2.a. **Residents**

Four local authority homes for the elderly, situated in North West Cardiff, gave permission for residents to be approached.

Ethical approval for the study was granted as specified in chapter 2. Untreated subjects were sought but this proved extremely difficult, therefore a list was compiled in each home of those taking relatively little medication. The drugs being taken were generally diuretics and anti-inflammatory. Those consenting to take part in the study were examined by a psycho-geriatrician (Dr. E.W. Sweeney) for their mental performance, using the Hare Scale (1978) (Fig. A.3).

A complete biochemical screen was undertaken of all consenting residents and medical notes were checked. Any resident having an abnormal biochemical or haematological test or having evidence of any major physical illness was excluded. Twelve residents, 9 female and 3 males, were accepted onto the study.
Table 4.1
Ages of Residents in Part III Accommodation (R) and Healthy Controls (C)

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Mean</th>
<th>Age (years) Range</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>12</td>
<td>83.6</td>
<td>78 - 89</td>
<td>±1.17</td>
</tr>
<tr>
<td>Controls</td>
<td>12</td>
<td>81.3</td>
<td>75 - 85</td>
<td>±0.88</td>
</tr>
</tbody>
</table>
Details of their medication, routine tests and Hare scale rating, are given in Appendix E.

4.2.b. Controls

Control subjects were selected from a group of controls previously obtained (Chapter 3.2.b.). The controls were age and sex matched as closely as possible to the 12 residents. Age matching within 5 years was achieved and the mean ages were not different statistically (Table 4.1).

All of the controls were screened for their physical well-being and all underwent tests for their mental performance, showing none of them to have any physical ailment or mental impairment (Appendix F).

Both controls and residents were investigated at various times of the year, therefore eliminating seasonal bias in the results.
4.3. **PROCEDURE**

4.3.a. **Residents**

Dietary assessments were carried out as described in Chapter 2. The four homes were all part of South Glamorgan Social Services Department but each had a completely free rein over menu design. Therefore, the pattern of daily intake could have been dissimilar yet, as shown in Table 4.2 the pattern of meals was comparable between the homes. Meal times were also similar due to the employment conditions of staff within the Social Services Department. Recipes used were often those of the Head Cook at each home and these were broken down as described before (Chapter 2). Pies etc., that were brought in ready cooked, were sectioned into constituent items as much as possible, e.g. pastry, meat, gravy, etc. to calculate nutritional intake.

Each resident had the procedure explained and monitored for themselves each item of food or drink eaten, which was not noted by the observer.

As with the patients, the residents were closely observed for any idiosyncracies in their eating habits.
4.3.b. Controls

The dietary assessments for control subjects were carried out as described earlier. Each control subject was visited frequently to ensure compliance to the agreed procedure.

4.4. RESULTS

4.4.a. Observations

4.4.a.i. Residents

It is often assumed that residents supplement their diet from their pocket money and gifts from visitors (Read et al. 1965). However, in the residents investigated this was not the case. The only items seen to have been eaten on a regular basis were biscuits and sweets and, in the case of one gentleman, 2-3 pints of beer in a week. In fact, 50% of the residents had some difficulty in walking and this certainly hindered any opportunity of going out to purchase items of food with pocket money. There was no opportunity of purchasing foods within the homes.

All residents had healthy appetites, there being little plate waste. All had been resident within each home for over one year and therefore staff knew their likes
and dislikes. Food was plated in the kitchen prior to service and staff portioned all items of food in accordance with what they thought to be the needs of the resident. None of the residents had eating difficulties.

During the period of investigation, none of the residents was heard to ask for more food and second helpings were seldom offered. Bread and butter was always placed on each table for the tea meal but, although every slice was eaten, extra was never offered. At one home, one gentleman, not involved in the study, took spare bread and butter from other tables. This gentleman was not overweight.

The majority stayed up for their evening drink and those that had retired often had a drink brought to them in their rooms, usually with night medication.

4.4.a.ii. Control Group

Observations for the control group have been previously noted (3.4.a.ii).
Table 4.2  Times of Meals at the Four Local Authority Homes

<table>
<thead>
<tr>
<th>Meal</th>
<th>Time</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>8.30-9.00</td>
<td>Cereal and cooked breakfast, bread and butter</td>
</tr>
<tr>
<td>Lunch</td>
<td>12.00-1.00</td>
<td>Cooked meal, eg meat, potato, vegetable and pudding</td>
</tr>
<tr>
<td>High Tea</td>
<td>5.00-6.00</td>
<td>Snack, eg beans on toast or cold meat and salad and cake</td>
</tr>
<tr>
<td>Before bed</td>
<td>8.00-9.30</td>
<td>Milky drink and biscuit</td>
</tr>
</tbody>
</table>

Table 4.3  Fluid intakes of Residents and Control Subjects

<table>
<thead>
<tr>
<th></th>
<th>Mean (ml)</th>
<th>Range (ml)</th>
<th>Fluid in drinks (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>1365.7</td>
<td>933-1954</td>
<td>984</td>
</tr>
<tr>
<td>Controls</td>
<td>1300.8</td>
<td>886-1953</td>
<td>857</td>
</tr>
</tbody>
</table>
4.4.b. **Intakes**

4.4.b.i. **Fluid**

The mean fluid intakes, shown in Table 4.3, are the total fluid intakes including drinks. Residents and controls had similar mean intakes, with the residents having a higher mean intake on drinks alone. All residents took a drink before going to bed. In some cases, this was as early as 8.00 p.m. Only 3 of them took a milky drink at this time. Six of the residents also received early morning tea, which they did not receive if they stayed in bed (there was no room service).

No coffee was taken by any of the residents during the three day investigation period. This was out of preference but coffee was only offered for a mid-morning drink.

In comparison, controls all drank tea during the three days yet 8 of them also drank coffee and 3 took alcohol at some time during the investigation.

4.4.b.ii. **Energy**

Table 4.4 gives the mean dietary intakes of energy, protein, fat and carbohydrate.
Mean intakes of energy did not show a significant difference, due to the narrower range of intakes in the resident group (951-2184 kcal) compared to the controls (801-2999 kcal). However, intakes were lower in the resident group and 92% of the group had intakes below the recommended daily amount. On chi analysis, the number having intakes below the RDA was significantly lower (p<0.01) than for the controls.

The foods contributing most to the energy value of the residents' diet were the pudding served at lunch and the cakes served with tea (92% of the group took the pudding and cake each day). Milk and sugar were the next in quantity to provide the bulk of the energy intake. 75% of the group took over 30g of sugar per day in tea. Bread and cereals provided the bulk of the remaining energy.

Mean intakes of energy were similar in each of the 4 homes, with a range of 1211-1823 kcal. However, the mean intake of 1823 was taken from a home where only 2 male subjects were studied and a higher mean value would have been expected.

In comparison the controls took most of their energy intake from bread and cereals, with 75% of the group taking over 50g a day in bread and 2 of the subjects taking over 100g per day. Over half (7) of the subjects took cake and/or dessert daily during the
Table 4.4  Dietary Intakes of Energy, Protein, Fat and Carbohydrate in Residents and Controls

<table>
<thead>
<tr>
<th></th>
<th>Residents</th>
<th>Controls</th>
<th>RDA</th>
<th>% below RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>1542</td>
<td>1857</td>
<td>♂ 2150</td>
<td>92++ 50</td>
</tr>
<tr>
<td>♀ 1680</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein (g)</td>
<td>48.2***</td>
<td>65.0</td>
<td>♀ 34</td>
<td>33++ 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>♀ 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat (g)</td>
<td>64.3</td>
<td>80.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>202.5</td>
<td>228.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

++ chi analysis p<0.01
*** students t-test p<0.001

Table 4.5  Dietary Intakes of Fibre (g)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>10.1</td>
<td>7.8 - 14.3</td>
</tr>
<tr>
<td>Controls</td>
<td>15.1</td>
<td>8.0 - 27.6</td>
</tr>
</tbody>
</table>
three day investigation and the remaining bulk of energy intake was provided from potatoes, milk, fats and meat. Only 2 of the controls took over 30g of sugar a day in tea and coffee.

4.4.b.iii. Protein

The residents consumed significantly less protein than the controls and more of them were receiving less than the RDA for protein. This was significantly different on chi² analysis.

The bulk of the protein provided in the diet came from milk, half of the residents taking over 12g protein a day from this source. The main meal provided an average of 8g protein, if milk pudding and custard are omitted from the calculation. The average serving of meat in the 4 homes was between 33g and 40g. Five subjects took less than 15g of meat per meal. In each home, sausages made one main meal out of the three measured and were a weekly feature on the cycle menu. Nine of the residents took cooked breakfast regularly. However, in half of these cases the main protein contributor to the breakfast was omitted, i.e. spaghetti in tomato sauce, black pudding, fried potatoes etc. being the main part of the meal. Protein provided 13% of the total energy intake of the residents' diets.
For controls the mean intake was above the RDA. The contribution to total energy from protein was 14%. Milk and meat provided the bulk of the protein in the diet; 10-16% of the daily intake of protein came from milk and 20-40% from meat. The average serving of meat taken by controls was between 70 and 80g. None of the controls took a cooked breakfast.

4.4.b.iv. Fat

Fat intake varied considerably, yet residents took less on average than their controls. All intakes were within normal ranges. The contribution to total energy intake by fat was 38% and 39% of residents and controls respectively. For residents, the majority of fat came from butter, fried potato (present on the menu at least once during the three days) and milk.

Controls ate more butter than the residents, due to the increased amount of bread taken. Meat was also one of the main providers of fat in the diet, due purely to the quantity taken in comparison to the residents.

4.4.b.v. Carbohydrate.

Mean intakes were very similar between the two groups, showing no statistical difference. Daily intakes of
carbohydrate for residents were very similar with no great fluctuations. However, controls had some wide differences in mean daily intakes of carbohydrate, due to the absence of cake/pastry, etc., on that day.

On average, 40% of the residents' total carbohydrate intake came from sugar and 50% from polysaccharides. The controls consumed 42% sugar but only 45% polysaccharides. The carbohydrate contribution to total energy intake for residents was 53% and for controls 49%.

4.4.b.vi.  Fibre

Table 4.5 shows the mean daily intake of fibre for both residents and controls. The mean value shows a lower intake by the residents with a much narrower range of intakes. However, there was no statistical difference between the two intakes.

None of the residents took wholemeal bread, and of the nine who took breakfast cereals only five took either porridge and/or All Bran, with the others taking cornflakes or Rice Krispies.

In the control group nine took white bread, with two taking brown and only one person taking wholemeal bread. Toast was by far the most popular breakfast
with only one person taking breakfast cereal (All Bran).

When comparing cereal against vegetable fibre, residents had similar intakes with two thirds of the fibre coming from cereal origin, similar to that of controls. However, of the vegetable fibre only one third of the residents took fruit on a regular basis compared to two-thirds of the vegetable fibre taken by controls coming from fruit. Half of the eight controls regularly taking fruit took more than one piece daily.

4.4.b.vii. Tryptophan

Table 4.6 shows the mean daily intake and ranges for the amino acid tryptophan.

Mean intakes show a difference between the two groups, but this was not statistically significant.

4.4.c. Vitamin Intakes

Table 4.7 shows the mean intakes and percentages of subjects with low intakes, compared to the recommended daily amount (DHSS, 1979a) of the major vitamins.
Table 4.6 Mean Daily Intakes of Tryptophan in Residents and Controls

<table>
<thead>
<tr>
<th></th>
<th>Mean Intake</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>612.7</td>
<td>378 - 888</td>
</tr>
<tr>
<td>Controls</td>
<td>807.1</td>
<td>446 - 1065</td>
</tr>
</tbody>
</table>

Table 4.7 Vitamin Intakes of Residents and Controls

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Unit</th>
<th>Group</th>
<th>Mean Intake</th>
<th>RDA</th>
<th>% Below RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C</td>
<td>mg</td>
<td>Res</td>
<td>19.9***</td>
<td>30</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>49.1</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Thiamin</td>
<td>mg</td>
<td>Res</td>
<td>0.86*</td>
<td>0.9</td>
<td>50++</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>1.08</td>
<td>0.7</td>
<td>8</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>mg</td>
<td>Res</td>
<td>1.54</td>
<td>1.6</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>1.59</td>
<td>1.3</td>
<td>42</td>
</tr>
<tr>
<td>Nicotinic Acid equiv.</td>
<td>mg</td>
<td>Res</td>
<td>22.2**</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>28.9</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Pyridoxin</td>
<td>mg</td>
<td>Res</td>
<td>0.53***</td>
<td>1</td>
<td>100++</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>1.05</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>ug</td>
<td>Res</td>
<td>3.85**</td>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>7.46</td>
<td></td>
<td>66</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>ug</td>
<td>Res</td>
<td>86.2**</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>139.9</td>
<td></td>
<td>92</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>ug</td>
<td>Res</td>
<td>1.85</td>
<td></td>
<td>750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>1.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A</td>
<td>ug</td>
<td>Res</td>
<td>872**</td>
<td></td>
<td>83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>1716</td>
<td></td>
<td>58</td>
</tr>
</tbody>
</table>

Students t-test p value shown
* p<0.05  ** p<0.01  *** p<0.001

chi² test p value shown ++ p<0.01
4.4.c.i. Vitamin C

The mean intake of vitamin C by the residents was significantly lower than that of controls. This was reflected in 92% of the residents failing to have an intake over the recommended allowance in comparison to 25% of the controls.

As noted earlier the quantity of vegetables and fruits in the diet of the residents was poor. Of all foods eaten, potato provided one third of the vitamin C content of the diet and another third was provided from other vegetables. The contribution of potatoes and vegetables in the controls diet was similar. Figure 4.1 shows the wide range of vitamin C intakes by the controls compared with the narrow range of the residents.

4.4.c.ii. Thiamin

The residents had a significantly lower mean intake of thiamin than the controls. Significantly more of the residents compared with controls failed to have an intake of the vitamin above the recommended daily amount. The range of intakes was wider in the controls (0.62-1.62).

Most of the thiamin consumed by the controls came from
Figure 4.1 Comparison of Vitamin C Intakes in Residents and Controls

Percentage of subjects

Intakes of vitamin C (mg)
meat and bread, with milk providing less than 20%. However, this was almost reversed in the diet of the residents with meat providing less than 25% of the thiamin and most of the vitamin coming from milk and cereal sources.

All of the controls ate meat in the form of pork, ham, beer or lamb on two out of the three day weighed intake. The third day was usually fish, chicken or sausage. Where mean intakes were below 0.8mg (in 5 subjects), sausages made one days main meal and on the other days although a red meat was included, the amount eaten was under 50g and in two cases, only 10 and 5g respectively of a lamb chop were eaten.

4.4.c.iii. Riboflavin

Mean intakes for this vitamin were remarkably similar between the two groups. The residents obtained more of their riboflavin from milk than did the controls. Five of the controls had intakes below the recommended amount for their age and sex compared to four of the residents.

4.4.c.iv. Nicotinic Acid

Only one of the residents had an intake below the
recommended amount of the vitamin. However, the mean intake of the group of residents was significantly lower than that of the controls. This once more reflected the amount of meat that contributed largely to the controls higher nicotinic acid intake. The majority of the vitamin in the diet of the residents was of cereal origin.

4.4.c.v. Pyridoxin

As stated earlier (3.4.c.v.) the recommendation of the United States Food and Nutrition Board (1980) of 1mg pyridoxin per day was used as a yardstick to assess the adequacy of the intake of this vitamin.

The residents consumed significantly (p< 0.001) less pyridoxin (mean 0.5mg) then did the controls (1.0mg). Fewer residents had an intake above the 1mg allowance (p<0.01).

Two residents and two controls ate liver once during the three days. However, the two residents who ate liver took only 25-30g of it in comparison with 100g and 70g sized portions for the controls. The poor pyridoxin intake of the residents can be attributed to the small quantity of meat and its products on the menu. Although meat featured regularly on the menu as mentioned before (4.4.b.iii.) the portions of meat
taken were smaller than of the controls.

4.4.c.vi. Vitamin B12

The mean vitamin B12 intake by the residents was just over the lower limit of the RDA quoted by the DHSS in 1969 (there is no current RDA) and was significantly (p<0.01) lower than that of the controls. However, practically the same number of controls (8) as residents (7) had an intake below the 3ug allowance. This was due to the large range of intakes by the controls. The mean intake of the controls having more than 3ug in the control group was 18ug. Two of the four controls having this large intake, took liver during the assessment period. The remaining two had intakes of meat weighing 335g and 215g on one of the days. This is in comparison to the residents where the mean intake of the five receiving more than 3ug was 8ug, again two of the five took liver, the remaining three having portion sizes of meat over 50g.

4.4.c.vii. Folic Acid

As with pyridoxin and vitamin B12 the mean intake of folic acid by the residents was significantly less than the controls. This as before is attributed to the poor quantity of meat in the residents' diet. None of the
Figure 4.2 Comparison of Folic Acid Intakes in Residents and Controls

Intakes of Folic Acid (µg)

Residents

Controls

Percentage of subjects
residents had an intake above the 200ug used as a yardstick and similarly eleven of the controls had a mean intake below that value. Fig. 4.2. shows the wide range of intakes in the controls in comparison to the residents.

Although residents received more folic acid from milk than controls, the quantity of folic acid from vegetables taken in the diets of the controls was greater than that of the residents.

4.4.c.viii. Vitamin D

The RDA figure of 10ug suggested by the DHSS (1979a) for the housebound elderly was not used for this group although as commented earlier (4.4.a.i.) few of the residents ventured out of doors.

The mean intakes of the two groups were very similar. The range of intakes for residents was narrower (0.6-3.4ug) compared to controls (0.4-4.6ug). All residents took butter, whereas 25% of the controls used margarine instead of butter. However, the residents ate more sponge and this was made using the creaming method of fat and sugar rather than cake mix.
4.4.c.ix. Vitamin A

The residents' diet provided significantly ($p < 0.01$) less vitamin A.

As explained earlier (4.4.c.v.) two residents and two controls ate offal meat in the form of liver over the three day weighed intake. It was these two residents that had a mean intake above 750ug whereas of the five of the control group having an intake at or above the current RDA, two had liver over the three days, and of the remaining three one had 100g of margarine and the other took large amounts of carotene in fruits and vegetables (130g apricots, 115g carrots).

4.4.d. Intakes of Minerals

Table 4.8 shows the mean intakes and percentages of subjects having intakes below the RDA for calcium, magnesium, iron, zinc and copper for residents and controls.

4.4.d.i. Calcium

Milk was the main provider of calcium in the diets of both residents and controls. However, residents had more milk than controls and this contributed over 40%
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Unit</th>
<th>Group</th>
<th>Mean</th>
<th>RDA</th>
<th>% below RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>mg</td>
<td>Res</td>
<td>760</td>
<td>500</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>801</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg</td>
<td>Res</td>
<td>153.9</td>
<td>n/a</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>219.7</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Iron</td>
<td>mg</td>
<td>Res</td>
<td>6.8**</td>
<td>10</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>9.8</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg</td>
<td>Res</td>
<td>5.9**</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>8.2</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Copper</td>
<td>mg</td>
<td>Res</td>
<td>0.9*</td>
<td>2</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con</td>
<td>1.4</td>
<td></td>
<td>92</td>
</tr>
</tbody>
</table>

Student t-test p value shown as *p<0.05  **p<0.01
USA RDA (Food and Nutrition Board, 1980)
of the calcium intake compared with 35% for the controls.

The higher intake of milk by the residents was partly due to the higher intake of beverages.

Mean intakes of the mineral were similar, only one subject from each group failed to have an intake above the RDA.

4.4.d.ii. Magnesium

No RDA for this mineral has been used against this data. The residents had a lower mean intake than controls, but the difference was not statistically significant. The range of intakes was similarly wide for both groups (119-225 for residents and 134-293 for controls).

Milk and vegetables contributed most of the magnesium in the residents' diets whereas more came from cereals and vegetables in the control group.

4.4.d.iii. Iron

The mean intake of iron by the residents was significantly lower than that by controls. Only one of
the residents had an intake over the RDA. This gentleman took a large amount of red meat in his diet in comparison to most other residents. On day two he ate 145g mince at one meal.

Half of the controls had intakes below the RDA. Of these six, two ate meat in two out of the three days, and the remainder took meat and/or bacon or ham on one of the other days. All six took fish on one of the days.

Two thirds of the iron in the residents' diet came from vegetables and cereals, one third from animal origin compared to a quarter of iron in the controls' diets coming from animal origin.

4.4.d.iv. Zinc

Both groups failed to have intakes above the American RDA (Food and Nutrition Board, 1980). However, residents had significantly lower intakes than controls and the range of intakes was much narrower (residents 4.1-7.2mg, controls 4.3-12.1mg). Animal sources made up over half of the total zinc intake in both groups.
4.4.d.v. Copper

One subject out of each group had an intake above the RDA. Both of these subjects took liver during the three days of the investigation (intakes of 35g and over of liver).

The residents had a significantly lower intake of the mineral than controls which was attributed to the lower quantity of red meat eaten by the residents.

4.5. DISCUSSION

4.5.a. Energy

It has been mentioned earlier (3.5.a) that undernutrition is common in long stay elderly patients and that dietary energy deficiency is a possible contributing factor. Hunt (1980) studied elderly subjects in five welfare homes for the elderly. This work showed that the consumption of energy was generally low in relation to recommended daily amounts.

In both sexes our residents and community controls had energy intakes below the RDA. Although the RDA of energy for the elderly may be too high, the significant difference between community controls and residents is cause for concern.
The residents ate all the food presented to them. The infrequency of waste was due to staff knowing individual preferences. Males tended to have larger helpings than females, and often the ladies would allow the gentleman the 'lions share' of bread and butter left on the tables.

The low energy intake of the residents was not due to poor menu design but to small portion size. Although never asking for more food or commenting on feeling hungry, portion sizes were very small. For example, the mean portion size for bread and potatoes was 68g and 75g respectively for males and 55g and 63g respectively for females. Whereas for controls the mean portion size for the same foods was 180g and 147g for males and 71g and 168g for females.

The energy intake must be judged against energy expenditure. One of the main reasons for people to become resident in part III accommodation is the loss of mobility and inability to care for themselves. Certainly few subjects ventured very little distance from the home, therefore energy expenditure may be judged to be low in comparison to the control group, who were active going out of doors at least once per day, if only into the garden. However, the homes that were studied were very large buildings and far larger than any domestic residence. Therefore it is important not to underestimate energy expenditure in moving
around from bedroom to sitting and dining rooms. None of the residents investigated were overweight unlike those studied by Hunt (1980), one third of whom were overweight.

The mean portion size of the protein component of the main meal for the residents was 40g in comparison to the 110g for the controls. In all four homes investigated, sausages made up one main meal during the three days. They featured weekly on the menu along with meat pies and beefburgers. The contribution of these items to total protein intakes is low.

4.5.b. Fibre

Intakes of fibre by residents were much lower than by controls. This was due to the absence of wholemeal bread and only five of the total group taking a high fibre cereal. None of the residents expressed problems with constipation and consequently none received laxative medication. It is possible that the adequate fluid intake, helped to alleviate any potential bowel problem. Certainly their main fibre intake of 12.5g per day was less than half that recommended by the James (1983) report for the population as a whole. However, the recommendation can be applied only with reservation to elderly persons.
Dietary surveys have revealed that the elderly often have low intakes of vitamins (Exton-Smith and Stanton, 1965; DHSS, 1972; Macleod et al., 1974b; Vir and Love, 1979a).

Vir and Love (1978) found an overall better nutrient intake in a group of elderly residents in part III accommodation in comparison to the elderly patients in a geriatric ward of a hospital. However a large proportion of the residents had biochemical evidence of ascorbic acid and pyridoxin deficiency and a small proportion had thiamin and riboflavin deficiency.

The mean calculated intake of ascorbic acid for the residents presented here was significantly lower than for controls. Vitamin C is easily destroyed during cooking as shown in Table 3.8. One of the main sources of vitamin C in the diets studied here was potato; no estimate was made of the destruction of this vitamin in the residential homes, but as food was kept warm for 30 minutes to 1 hour before service, it must be assumed that at least 50% of the dietary vitamin C was lost. The high percentage of low intakes of vitamin C for the residents was reflected in the low plasma levels of vitamin C thought to be a reliable indicator of ascorbic acid status (Loh and Wilson, 1971). A large proportion of the residents were on medication and the
majority were on diuretics and anti-inflammatories. Neither class of drug is known to interfere with ascorbic acid metabolism. The fact that few elderly subjects show evidence of scurvy cannot be used as an argument for not improving the intake of vitamin C through the diet. Supplementation of the vitamin has been reported to increase well-being in this age group (Andrews et al., 1969).

As many residents in part III accommodation are there due to lack of mobility, depression and an inability to care for themselves, vitamin C nutrition becomes of interest.

There is a need to improve the vitamin C content of the residents diets. Provision of more fresh fruit, fresh fruit juice, fortified fruit squash and larger portions of freshly cooked vegetables would be of benefit.

Half of the residents were receiving less than the RDA of thiamin, their intakes being significantly lower than those of the community controls. Yet a similar number of controls had biochemical evidence of thiamin deficiency as judged by the transketolase percentage activation. Elevated values are common amongst the geriatric population (Older and Dickerson, 1982; Katakity et al., 1983). Poor dietary intake or malabsorption may be the possible cause of such poor status. None of the residents or controls took
antacids during the investigation, so the poor thiamin status was not a result of destruction of the vitamin by antacids in the stomach.

Half of the group of residents had evidence of memory impairment. Thiamin deficiency is associated with confusional states among the elderly (Older and Dickerson, 1982; Puxty, 1985). The low thiamin status of the residents may contribute or even be the sole cause of memory loss or confusion.

More residents than controls had low intakes of pyridoxin compared to the American Allowance of 1mg per day (Food and Nutrition Board, 1980). None of the subjects had biochemical evidence of deficiency. It may therefore be assumed that the American Allowance is too generous.

The mean intakes of vitamin B12 was also significantly lower in the residents than controls. This was due to the low red meat content in their diet. Almost the same number of controls and residents had an intake below the lower limit of the range of the RDA set by the DHSS (1969) and subsequently withdrawn. No biochemical measurements of B12 status were made in this group, but none had evidence of any haematological disturbance.

The RDA of folate of 200ug quoted by the DHSS (1979a)
was withdrawn in subsequent editions of the tables due to the uncertainty surrounding folate requirements and the estimation of the folate content of foods (Bates et al., 1982). However, for the purposes of this study the old RDA figure has been adopted as a yardstick for comparison with the group. Almost all the subjects studied had folic acid intakes below 200ug per day. A third of residents had low serum concentrations, a proportion similar to that seen by Read et al. (1965). These workers suggested that serum folate levels were normally lower in old age due to a decrease in intake and reduced demands as a consequence of lower cellular activity.

In this study dietary intakes may be a contributory factor to the low serum levels, but due to the similarity of red cell levels, the theory of reduced cellular demand is of interest and this could be the cause of memory impairment in half of the resident group.

Intakes of vitamin D in both groups was below the RDA of 10ug per day for the housebound elderly. All controls and residents were ambulant, but the latter group had increased mobility (one of the reasons for entering the homes) therefore the RDA could be applied to the group. Lawson et al. (1979) recommended an intake in excess of 5ug per day to maintain plasma concentrations above those seen in osteomalacia, which
is common in this group (Hodkinson et al., 1973). Intakes of the residents were well below this recommendation. The majority of the investigation took place during the warmer months and many of the residents went to sit outside in the gardens. It is therefore assumed that dietary vitamin D was supplemented from sunlight sources.

A higher proportion of residents (5) than controls (1) had serum levels of calcium above the higher limit of normal. This could not be explained by the mean intakes of calcium and vitamin D, which were similar in the two groups. Hypercalcaemia produces a range of disorders including neuromuscular and psychiatric disturbances (Lindemann, 1982).

Vir and Love reported low intakes of magnesium in residents in part III accommodation. This was also seen in the residents studied in Cardiff. However, the mean serum level of magnesium was similar between the two groups (0.81nmol/ml residents and 0.88nmol/ml for controls), yet significantly (p<0.05) more residents than controls had plasma levels below the lower limit of normal.

Muscle weakness and mental disturbance can occur as a result of slight changes of electrolyte concentration (Lindemann, 1982). This is of interest to the resident group where half had signs of memory impairment and two were taking anti-inflammatory drugs for arthritic
symptoms. Along with ascorbic acid, magnesium should also be investigated for its link with muscle weakness in the elderly.

The mean daily intake of iron was significantly lower in the control group with eleven of the residents having an intake below the RDA, compared to only six of the controls. This, once more, is directly linked to the quantity and quality of meat in the diet.

4.5.d. Tryptophan

As mentioned earlier half of the group of residents had evidence of memory impairment on the Hare Scale rating (Hare, 1978) (Fig. A.3).

Tryptophan and related variables were measured in these subjects because of its role as the precursor of the neurotransmitter, serotonin, which is known to be reduced in dementia and confusional states.

Female residents had significantly lower plasma concentrations of total and bound tryptophan (residents, bound 38.8nmol/ml, total 50.5nmol/ml; controls, bound 46.6nmol/ml, total 57.6nmol/ml). The concentrations were in fact similar to those seen in patients with senile dementia (3.5.e.). These levels could not be explained by the dietary intakes, as they
were similar between the groups, or by other tryptophan related variables. When the total and bound tryptophan levels in the six residents who had lower Hare Scale ratings, indicative of memory deficit, were compared to the others in the group, they were found to be lower. This suggests an association between these measurements and memory impairment.

4.5.e. Social Services Accommodation

The demand for part III accommodation will increase with the growing proportion of the population reaching old age. Subsequently, as discussed earlier (chapter 1), the proportion of these elderly people suffering from organic brain disorder will also increase. The current trend to treat people with confusion and early dementia in the community and to maintain them outside long stay psychiatric institutions will put an ever increasing strain on part III accommodation. Especially those homes willing to take the confused elderly.

It is evident that nutrition plays a part in brain function and that several vitamins and minerals are directly linked to confusional states. It could have been assumed that small homes would provide a higher standard of nutrition than large hospitals, due to unrestricted purchasing and smaller scale catering,
however our study has shown that the elderly in part III accommodation are at risk from nutritional deficiency especially for vitamins A, C, B1, B2, B6, B12 and folate.

Protein and energy intakes were also lower than those of their counterparts in the community.

Of the residents known to eat food in their rooms, the majority took biscuits, sweets etc. rather than fruit; thus their supplements were a contribution to energy rather than nutrient intake.

Half of the residents studied had evidence of senile memory loss and some of the vitamin and mineral levels give cause for concern about their possible effects on mental state. Certainly results of ascorbic acid, thiamin, folate and magnesium status in this group, along with the tryptophan findings, give rise to the need for further investigation.

The reason for entry of an elderly person into a home of this type is usually inability to care for themselves, due to immobility, depression (especially after bereavement over the loss of a spouse) and memory impairment. Therefore the nutrition of persons of this sort may be poor at the time of entry into the home.

Although three cooked meals were provided per day for
the residents, the dietary intakes fell below the RDA and below the mean intake of the control group, resulting in subsequent poor nutrition. It may well be that low intakes of iron, folate, thiamin and pyridoxin were the result of small amounts of meat served for residents.

Unlike the findings of Vir and Love (1978) the residents in the part III accommodation had intakes of many nutrients that were lower than intakes of patients with dementia (chapter 3).

These findings suggest an immediate need for the reappraisal of the nourishment provided for residents in homes for the elderly.
Chapter 5

GENERAL DISCUSSION
The basis for the studies presented in this thesis, is the knowledge of poor nutritional state in many elderly persons. The fact that a growing proportion of elderly people develop some form of organic brain disease, and that a large number of these elderly confused people become resident in long stay institutions, raises questions about the possible effect of malnutrition on the progression of senile dementia and the possible aetiology of the condition.

Research into senile dementia has focused on three areas. The possibility that senile dementia is hereditary has been explored. However, the other two main areas of research have a more definite link with nutrition.

The possibility that senile dementia occurs as a result of a viral infection, suggests that the poor nutritional state seen in elderly persons produces a vulnerable condition on which the virus can act and that the course of the infection will be rapid and irreversible in a malnourished person.

However, it is well documented that there are neurochemical abnormalities in senile dementia and this seems to be the current forerunner in the research developments. Malnutrition will produce a decrease in the nutrient precursors of these neurochemicals and therefore, could exacerbate the mental condition or
Animal studies have suggested that the blood brain barrier is affected in senile dementia (Wisniewski and Kozlawski, 1982). This affects the supply of vitamins and amino acids to the brain. The poor nutritional state of patients with dementia shown in the studies presented in this thesis may therefore be expected to affect neurotransmitter synthesis, through having diminishing levels of nutrients available and this in turn producing a lower level in the brain due to a defect in the blood brain barrier.

Impaired brain neurotransmitter metabolism has been produced by experimental vitamin deficiencies (Blass and Gibson, 1980; Plaitakis et al., 1978). The low ascorbic acid, thiamin and folic acid status seen in the patients with senile dementia may therefore put the supply of these nutrients at risk in susceptible individuals and contribute to the low levels of neurotransmitters found in demented brains (Gottfries et al., 1968; Carlsson, 1970; Perry et al., 1977).

The poor vitamin C status seen in patients with senile dementia could be attributed to the poor dietary intake. The destruction of the vitamin confirmed in institutional catering reduces the amount of vitamin C in the hospital diet to a level well below the mean intake of the control group. The problem of the
destruction of this nutrient has been previously documented (Black et al., 1983) yet little has been done in many large institutions to alleviate it.

Provisions of fruit juices, or the less expensive fortified fruit squashes and fortified potato powder, would provide enough of the vitamin in the daily diet.

At present dietetic personnel advise on menu content in National Health Service establishments. However, the meagre financial allocation to all hospitals (£9.10 a head per week for psychiatric hospitals) does not always allow for these fortified items to be included regularly as they are often more expensive than their alternatives.

It is of interest that the vitamin C status of the residents in part III accommodation was as poor as that of the hospital patients and similarly the diet was the major factor responsible for their poor status.

There was no dietetic advisor for the Social Services in Cardiff. Each home menu is written by the warden or matron. Although having good intentions and a healthier financial allocation than the National Health Service, there is still an omission of the items that would provide adequate dietary amounts of vitamin C.

It would seem of benefit to consider the combination of
all long term residential accommodation, and produce district or regional menus that would produce greater purchasing power through bulk food orders, enabling more economy. Such a combination would increase the bargaining power with regional or even national administration for financial allocation. In this way, menus would become more varied and nutritional status would therefore improve.

A catering establishment of this type would also ensure more sensible menu planning. For instance, at one old persons' home lamb chops were served. This is a difficult item for any able-bodied person to extract meat from. In this particular case, 5g and 10g of meat were taken by the residents. The portion sizes of both patients and residents, of all foods was small. The assumption that elderly persons take less food with age was shown not to be the case in the control subjects investigated.

Of the two meal service systems available for large scale catering, the bulk trolley method would most suit the needs of elderly persons. The plated system allows no second helpings except where meals are plated in a central kitchen parallel to the dining area (as in the homes for the elderly). The bulk service method does allow for flexible portion sizes, but staff must receive instruction on patients' individual requirements and must be reminded that 'action speaks
louder than words' even when applied to second helpings. It would seem, from personal observation, that the demented and confused elderly are able to recognise their needs more by sight than by request. It is also possible in this way to overcome the problem of subjects receiving foods which they do not like and refusing to eat one or two of the main meals in a day.

If meals are plated and offered to demented subjects, they are able to choose the one that they would prefer to eat. However, the need to eliminate waste in hospital catering departments means that halfway through the serving of a ward of patients, only one choice will remain.

Some health authorities now photograph selected menu items to enable patients to select meals prior to service.

The feeding problems experienced by many demented persons also produce nutritional problems. Many patients require feeding and if they are restless, the procedure takes some time and nurses are tempted to give up leaving the patient hungry. Fluids may therefore be a better way of providing nourishment for these patients.

Poor fluid intake in patients was a very distressing finding. Fluids were withheld to decrease bladder
function. This lack of knowledge of physiology must be rectified in nurse training. A small pilot investigation showed that increasing fluid intake in these patients reduced the mental confusion. The relationship between fluid balance and physiological performance needs to be investigated more thoroughly. This possible remedy for confusion in the elderly is a simple and cheap one.

The fluids provided to these patients must be nourishing ones. Fluids providing only energy have the disadvantage of diluting nutritional intake, since fluids tend to dull the appetite.

An increased fluid intake may also alleviate problems with constipation. As discussed for both patients and controls, there is a need to increase the fibre content in the diet provided. There is, however, one major disadvantage in the move to the 'new' eating ideas suggested by the NACNE (James, 1983) and COMA (DHSS, 1984) reports. By increasing the unrefined carbohydrate content of the diet of elderly persons the energy density is reduced. For patients this could have serious repercussions as their energy intake is low on a low bulk diet. Therefore the increase in the fibre content of the diet should be made cautiously and under strict dietetic supervision. The full NACNE recommendations of decreasing fat and refined carbohydrate should be questioned in the light of the
rapid weight loss seen in patients with senile dementia. They have a high activity rate in contrast to the energy expenditure commonly attributed to the hospitalised elderly.

Patients with dementia who are treated with drugs should take care to maintain normal body weight to allow correct functioning of the drug. Drug function is altered in underweight people.

However, a more realistic assessment of the energy requirements of the elderly needs to be established, especially for the difficult group investigated here.

In this thesis, the recommended daily amounts of energy and other nutrients have been used as a yardstick against which to assess the adequacy of all dietary intakes.

The recommendation of energy is defined as the average intake of individuals in a group (DHSS, 1979a) and it is stated that not every person should receive the exact amount recommended. Therefore, the RDA should be used for guidance only and the true assessment of adequate intake should be judged against healthy, similarly aged subjects.

In the case of nutrients, the recommended amount represents a judgement of the average requirement, plus
The application of such a figure to a group of elderly persons needs to be done with care. The only adequate assessment must be to apply the results obtained from a control group. The selection of a suitable control group is therefore vitally important. In the case of assessment of patients with senile dementia it would be unwise to judge their intakes against patients on a geriatric ward. These subjects may be physically ill and this will affect their food intake. Patients with dementia have only a mental illness and should be physically fit and treated as such. Their requirements would then be expected to be similar to those of healthy free-living elderly persons.

Similarly for residents in part III accommodation, who are in this accommodation because they are not able to care for themselves. Their food intake should be equivalent to that of any healthy free-living person of similar age, who then constitute their control group.

The recommended daily amount for folate has been withdrawn, therefore the most accurate evaluation of the adequacy of the diet is to use the intakes in the control group as the standard. Both patients and controls had similar intakes, thus low intakes do not explain the low level of red cell folate in the patient group. This low level suggests some degree of
malabsorption. However, the destruction of folic acid by heat in the preparation and prolonged heating of hospital food, must be first assessed. It is possible that folate intakes were overestimated presenting a problem similar to that with the vitamin C intakes. Also, as discussed in chapter 1, the determination of the folate content of foods is difficult and the values given in the food tables are suspect. The malabsorption hypothesis is also suggested by the low plasma levels of tryptophan seen in patients with dementia. Furthermore any degree of malabsorption will decrease the integrity of the absorptive mucosa and further exacerbate the nutritional deficiencies. This produces a vicious circle between poor intake, malabsorption and decreased brain function as shown in Fig. 5.1.

This serves to show how the recommended figure of the United States Food and Nutrition Board (1980) is too generous to be applied to the diets of the elderly.
Figure 5.1.
The Vicious Circle of Poor Nutritional State and Impaired Mental Function

- Poor Nutritional State
- Malabsorption
- Decreased Production of Neurotransmitters
- Poor Dietary Intake
- Memory Impairment and Mental Function
Valuable information regarding the role of vitamin status can be obtained by investigating the effects of supplementation.

A group of patients with early (phase 1) senile dementia was selected for a supplementation study. Twenty physically fit elderly persons, showing early signs of memory loss with little loss of higher neurological function, who presented to the psychogeriatric unit in Cardiff were randomly allocated on active or placebo vitamin preparation. The active supplement was one tablet of Orovite and one tablet of Pregnavite Forte F (Messrs. Bencard) details of their composition is given in Appendix G.

Prior to the start of the supplementation period, a three day weighed intake was completed to assess normal vitamin intake. Psychometric testing was completed by a psychiatrist (Dr. M. Briscoe). Supplements were taken for 56 days. On days 54-56 inclusive, a three day weighed intake was repeated to check on any increase in dietary intake and during this time, the psychometric testing was once more repeated. Blood samples for the determination of vitamin levels were taken before and after supplementation.

Dietary intakes were similar before and during supplementation.
The blood results showed an improved status with respect to all vitamin measurements in patients on the active preparation as was expected from previous work with geriatrics (Hoorn et al., 1975).

There was also an improvement in mental performance of patients on the active preparation. Of this group, 75% improved on three out of four psychometry tests, whereas only 30% of the placebo group had higher scores on three tests after the two month period.

This, therefore, suggests that the mental condition was improved with an improvement in vitamin status. The mental improvement observed did not reach statistical significance due to the small number of subjects.

Patients with early dementia were required to enable the mental assessment to be carried out with some degree of accuracy. However, few patients with early dementia present to a psychogeriatric unit. Many elderly patients discovering loss of memory, become embarrassed and try to hide the problem and even recognise it as a progression of normal ageing. Therefore, the patients fail to present, until there is a loss of cognitive function.

It may be naive to think that vitamin supplementation could benefit something as physical as a senile plaque or neurofibrillary tangle. However, the degree of
improvement shown, when compared to pharmacological treatments, shows that the results obtained by vitamin supplementation are indeed favourable compared to drug treatments. In addition drug treatments in their exploratory stages risk the disadvantages of side effects, whereas vitamin supplementation works within the normal physiological range.

These results are in need of replication in a larger group, with a longer supplementation period. There is a need to ensure accurate psychometric testing and in addition, the optimum combination and dose of vitamins must be found. It seems from the work presented here that vitamin C, thiamin, nicotinic acid and folate are the vitamins that might provide the best results in these patients. Shaw et al. (1971) supplemented patients with senile dementia with folic acid alone. No measurable changes occurred in mental function. However, the authors suggested a longer period of supplementation. With the knowledge of the abnormal folate status in patients with dementia, a larger and longer study with adequate psychometric testing, using folate as the supplement, may provide valuable information to the vitamin's true link with dementia.

The increasing numbers of elderly persons suffering from senile dementia is of major social importance. To date there is no accurate method of assessing those at risk from developing this debilitating and emotionally
distressing condition and there is no effective treatment for it.

It would therefore seem that assessment of nutritional status may aid the identification of those at risk, and vitamin supplementation in the early stages of the condition, if these individuals can be identified, may improve mental function.
Appendix A

PSYCHOMETRY

Mental Test Score (Blessed et al., 1968). See figure A.1.
This test is known as an information-memory-concentration test. Blessed et al. (1978) found that the score on this scale was highly correlating with the mean plaques in the brain.

This is a test designed to investigate aphasia, agnosia and apraxia. This test takes longer than the others, due to the amount of time required for the subjects to complete drawings, etc.

Hare Scale (Hare, 1978). See figure A.3.
This test was designed to test memory and verbal ability, and takes very little time for its completion.

Psychometry was carried out on all participants in the project, although not all completed the same tests.

The patients suffering from senile dementia completed the mental test score and higher neurological function tests, that were given to the patient by a consultant psychiatrist (Dr. Sweeney).
### MENTAL TEST SCORE

<table>
<thead>
<tr>
<th>NAME</th>
<th>DATE</th>
<th>DATE</th>
</tr>
</thead>
</table>

**NAME**

- **Name**: [Name]
- **Age**: [Age]
- **Time (hour)**: [Time]
- **Time of Day**: [Day]
- **Day of Week**: [Week]
- **Date**: [Date]
- **Month**: [Month]
- **Season**: [Season]
- **Year**: [Year]
- **Place - Name**
  - **Street**: [Street]
  - **Town**: [Town]
  - **Type of place (e.g. home, hospital, etc.)**: [Place]
- **Recognition of person (cleaner, doctor, nurse, patient, relative - any two available)**: [Recognition]

**MEMORY**

1. **Personal**
   - **Date of Birth**: [Birth]
   - **Place of Birth**: [Birth]
   - **School attended**: [School]
   - **Occupation**: [Occupation]
   - **Name of sibs or name of spouse**: [Sibs]
   - **Town where occupation carried out**: [Town]
   - **Name of employers**: [Employers]

2. **Non-Personal**
   - *Date of World War 1*: [War 1]
   - **Date of World War 2**: [War 2]
   - **Monarch**: [Monarch]
   - **Prime Minister**: [Prime Minister]

3. **Name and address (5 minute recall)**
   - Mr. David Jones, 42 West Street, Swansea [5]

**CONCENTRATION**

- **Months of year backwards**: [Months]
- **Counting 1 - 20 forwards**: [Count 1-20]
- **Counting 20 - 1 backwards**: [Count 20-1]

*½ for approximation within 3 years*
Fig. A.2.  HIGHER NEUROLOGICAL FUNCTION

NAME ______________________ DATE ___________ TOTAL SCORE _____

1. Left/right orientation:   
(a) Show me your left hand 
(b) Touch your left ear with your right hand 
(c) Touch your right ear with your left little finger

2. Calculation:  
Subtract (a) 2 from 3  
(b) 3 from 7  
(c) 7 from 10  
(d) 13 from 24  
(e) 81 from 100

2. Calculation:  
Score

3. Nominal aphasia:  
Name the following objects:  
(a) Watch  
(b) Pen  
(c) Watch-strap  
(d) Pencil  
(e) Buckle  
(f) Nib  
(g) Winder

3. Nominal aphasia:  
Score

TOTAL: _____

4. Tactile agnosia:  
Name each letter traced on the forehead:  
(Patient's eyes closed)  
(a) T  
(b) U  
(c) X  
(d) H  
(e) M

4. Tactile agnosia:  
Score

TOTAL: _____

5. Constructural apraxia:  
Copy with following patterns made with matches:  
(2 attempts each, the results to be drawn in the space provided)

No of matches 1st attempt 2nd attempt Score

(a) [ ] 3

(b) [ ] 4

(c) [ ] 5

(d) [ ] 6

Cont....
5. Copy the following designs:

(a) 

(b) 

(c) 

(d) 

(e) 

Cont...
<table>
<thead>
<tr>
<th><strong>Memory</strong></th>
<th><strong>Score</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What year are we in?</td>
<td></td>
</tr>
<tr>
<td>What month is it?</td>
<td></td>
</tr>
<tr>
<td>Can you tell me two countries we fought in the second world war?</td>
<td></td>
</tr>
<tr>
<td>What year were you born?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Aphasia</strong></th>
<th><strong>Score</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you call this (a watch)?</td>
<td></td>
</tr>
<tr>
<td>What do you call this (a wrist strap or band)?</td>
<td></td>
</tr>
<tr>
<td>What do you call this (a buckle or clasp)?</td>
<td></td>
</tr>
<tr>
<td>What is a clock for?</td>
<td></td>
</tr>
<tr>
<td>What is a television for?</td>
<td></td>
</tr>
<tr>
<td>What is a refrigerator for?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Parietal signs</strong></th>
<th><strong>Score</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Show me your left hand</td>
<td></td>
</tr>
<tr>
<td>Touch your left ear with your right hand</td>
<td></td>
</tr>
<tr>
<td>Name the coin in hand named (as 10p or two shillings)</td>
<td></td>
</tr>
<tr>
<td>No tactile inattention present</td>
<td></td>
</tr>
<tr>
<td>Normal two point discrimination</td>
<td></td>
</tr>
<tr>
<td>Draw a square</td>
<td></td>
</tr>
</tbody>
</table>
The dietitian gave the controls the higher neurological function and mental tests. If individuals had a poor score and the test was suspect, the dietitian asked the consultant to make a fuller examination. Fortunately, all the controls completed both the higher neurological function test and the mental test scores successfully.

For the residents of the Old Peoples Homes, the Hare scale psychometry test was used given by Drs. Sweeney and Briscoe.
Appendix B

BIOCHEMISTRY

Before starting each stage of the study, each individual had a physical examination and biochemical screening. The latter included analysis of thyroid function, random blood sugar, blood urea and electrolytes, red and white blood counts, liver function tests, urine analysis, and chest X-ray. By completing this screen it was possible to detect any unknown ailments. The routine biochemical results are listed in the tables relating to each section of the study.

Samples

On the third day of monitoring the diet, an attempt was made to obtain a urine sample over a four-hour period, for the determination of n-methyl nicotinamide (Goldsmith and Millar, 1967) and creatinine (Bonsnes and Toussky, 1945). A fasting blood sample was taken by venesection on the fourth day and was suitably partitioned for subsequent biochemical analysis.

Analysis

Both plasma and leucocyte ascorbic acid levels were assayed by the method of Denson and Bowers (1961) which estimates total ascorbate, i.e. ascorbic, dehydroascorbic and diketogulonic acids. In order to assess the reliability of the ascorbic acid value for
vegetables given in the McCance and Widdowson Food Tables, the ascorbic acid content of raw, cooked and served potato was estimated by 2,6-dichlorophenolindophenol titration method as described by the Association of Vitamin Chemists (Mapson, 1942).

Thiamin, riboflavin and pyridoxine were measured in plasma by the enzyme activation methods described by Bayoumi and Rosalki (1976). Folate levels in red blood cells and whole blood was determined by radio-assay using the kit supplied by Amersham International.

Calcium, magnesium, zinc and copper were measured in plasma by atomic absorption.

Vitamin A levels were measured in serum by the method described by Hanser and Warwick (1969) with a slight modification suggested by Van Stevenick and DeGoeij (1973). Total plasma tryptophan was measured by the method of Denckla and Dewey (1967). Free tryptophan was measured by ultrafiltration at 37°C by the method described by Riley and Shaw (1981). The concentration of albumin in plasma was estimated by immuno electrophoresis (Laurell, 1966) and that of non-esterified fatty acids by the method described by Duncombe (1964). Serum insulin was estimated by radioimmuno assay (Amersham International). The insulin method was changed for the latter part of the
study to that of the method used by the Clinical Biochemistry Department, University of Surrey.

Biochemical determination of vitamins, metals and insulin was carried out at the Department of Biochemistry in the University of Surrey, by Dr. K. Chung-a-on. Free and total tryptophan, creatinine, albumin and non-esterified fatty acids were analysed at the Biochemical Psychiatry Laboratory in Whitchurch Hospital, Cardiff by Mr. S.F. Tidmarsh. Preliminary preparation of the samples was carried out in the hospital and the samples were stored at -70 C. Samples for the University of Surrey were transported packed in solid CO₂, no later than seven days after collection. They were then analysed within ten days of the original blood collection.

To overcome any delay between collection of the blood and the subsequent partitioning for analysis, all homes and hospitals were within a 30 minute drive to the laboratory. The controls were brought into the laboratory for the blood taking, making a much wider catchment area possible.
## Appendix C

### Details of Patients suffering with Senile Dementia

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* - smokers
### Appendix C

#### Results of Psychometry Rating on Patients

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*Maximum score on HNF and MTS is 85 (combined)*

Scores under 28 on MTS are indicative of memory impairment.

Scores under 38 on HNF are indicative of higher neurological involvement.

---

* MTS - Mental Test Score (Blessed et al. 1968)

HNF - Higher Neurological Function (Wilde, 1971)
| MP | MS | WE | CS | JP | MC | BF | MJ | ND | HW | WT | RB | RL | RG | AH | IS | AD | AW | BH | TL | WW | KM | BD |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ca | 2.3 | 2.17 | 2.31 | 2.37 | 2.05 | 2.21 | 2.23 | 2.49 | 2.31 | 2.25 | 2.25 | 2.31 | 2.23 | 2.31 | 2.21 | 2.17 | 2.17 | 2.3 | 2.07 | 2.3 | 2.17 | 2.19 |
| Albumin | 45 | 41 | 42 | 44 | 42 | 40 | 45 | 48 | 45 | 42 | 42 | 41 | 38 | 110 | 44 | 44 | 42 | 38 | 38 | 34 | 45 | 38 | 39 |
| Bilirubin | 6 | 7 | 5 | 9 | 6 | 8 | 6 | 11 | 7 | 11 | 10 | 8 | 6 | 44 | 18 | 10 | 11 | 3 | 5 | 7 | 11 | 6 | 6 |
| Alk Phos | 77 | 64 | 143 | 105 | 129 | 222 | 110 | 70 | 103 | 106 | 103 | 105 | 78 | 20 | 71 | 98 | 87 | 127 | 115 | 175 | 110 | 131 | 122 |
| Na | 141 | 143 | 140 | 138 | 139 | 138 | 143 | 140 | 137 | 140 | 139 | 139 | 138 | 140 | 141 | 141 | 140 | 137 | 140 | 137 | 140 | 140 |
| K | 3.4 | 3.4 | 4.0 | 3.7 | 3.9 | 3.9 | 3.9 | 3.9 | 3.6 | 3.9 | 3.5 | 3.9 | 3.7 | 3.9 | 3.7 | 3.5 | 3.5 | 3.9 | 4.2 | 4.2 | 3.6 | 4.3 | 4.1 |
| CL | 105 | 102 | 103 | 109 | 106 | 106 | 107 | 97 | 102 | 104 | 104 | 106 | 103 | 101 | 102 | 103 | 101 | 105 | 101 | 105 | 101 | 103 | 104 | 106 |
| Bicarb | 31 | 35 | 30 | 27 | 28 | 23 | 30 | 27 | 27 | 29 | 28 | 25 | 27 | 21 | 29 | 27 | 26 | 28 | 26 | 26 | 26 | 24 | 26 | 26 |
| Urea | 6.4 | 7.5 | 5.7 | 4.8 | 7.4 | 9.2 | 7.2 | 6.9 | 5.7 | 9.4 | 4.9 | 5.7 | 7.9 | 7.2 | 6.2 | 9.2 | 8.9 | 5.7 | 6.7 | 9.9 | 5.7 | 6.2 | 6.9 |
| Creatinine | 60 | 70 | 106 | 55 | 115 | 100 | 90 | 75 | 100 | 140 | 90 | 65 | 90 | 120 | 95 | 100 | 95 | 90 | 90 | 75 | 90 | 95 | 110 |
| WBC | 8.1 | 7.5 | 8.6 | 6.9 | 6.1 | 5.9 | 4.1 | 7.9 | 8.8 | 6.3 | 8.7 | 7.5 | 5.6 | 7.9 | 7.5 | 6.2 | 8.1 | 7.5 | 6.6 | 6.7 | 5.9 | 6.6 | 4.5 |
| RBC | 4.9 | 4.7 | 4.4 | 4.86 | 4.02 | 4.6 | 4.18 | 4.45 | 4.23 | 4.6 | 4.85 | 4.7 | 4.45 | 4.8 | 4.6 | 4.8 | 5.31 | 5.3 | 5.1 | 4.8 | 5.1 | 4.69 | 4.07 |
| Hb | 14.1 | 12.9 | 10.7 | 14.3 | 12.9 | 12.9 | 9.7 | 13.1 | 13.5 | 12.8 | 14.2 | 12.3 | 12.9 | 12.8 | 13.9 | 12.6 | 13.1 | 10.7 | 12.0 | 14.7 | 13.7 | 12.7 |
| Thyroxine | 90 | 108 | 79 | 89 | 70 | 93 | 84 | 83 | 76 | 80 | 112 | 90 | 93 | 108 | 89 | 112 | 80 | 83 | 128 | 100 | 83 | 70 | 86 |
| Glucose | 5.6 | 4.0 | 5.6 | 5.0 | 5.3 | 6.8 | 4.4 | 6.2 | 7.4 | 2.8 | 5.9 | 6.1 | 6.1 | 5.8 | 7.9 | 4.9 | 4.0 | 4.1 | 5.9 | 7.7 | 5.6 | 4.1 | 6.0 |

**Appendix C**

**Results of Patients' Routine Tests**
### Appendix D

#### Details of Healthy Community Controls

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* Patients who were smokers
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### Results of Controls' Tests
## Appendix E Details of Residents in Part III Accommodation

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Results of Residents Routine Tests
Appendix G

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(Pregnavite Forte F and Orrovite)

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Department of Health and Social Security (1984). Chief Medical Officer Committee on Medical Aspects of Food Policy.


Mapson (1942). Association of Vitamin Chemists.


