https://theses.gla.ac.uk/

Theses Digitisation:

https://www.gla.ac.uk/myglasgow/research/enlighten/theses/digitisation/

This is a digitised version of the original print thesis.

Copyright and moral rights for this work are retained by the author

A copy can be downloaded for personal non-commercial research or study, without prior permission or charge

This work cannot be reproduced or quoted extensively from without first obtaining permission in writing from the author

The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author

When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given

Enlighten: Theses
https://theses.gla.ac.uk/
research-enlighten@glasgow.ac.uk

An Investigation into Nutritional Aspects of Care in Long Stay Establishments for Elderly People

By

Jacqueline Mary Flett, BSc, SRD

A thesis submitted for the degree of MSc

Faculty of Medicine

University of Glasgow

Scotland

November, 1998

©

ProQuest Number: 10390956

All rights reserved

INFORMATION TO ALL USERS
The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript
and there are missing pages, these will be noted. Also, if material had to be removed,
a note will indicate the deletion.

ProQuest 10390956

Published by ProQuest LLC (2017). Copyright of the Dissertation is held by the Author.

All rights reserved.
This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

GLASGOW
UNIVERSITY
LIBRARY
11478 (copy 2)

Abstract

Introduction

Demographic projections indicate that there will be an increase in the number of elderly people over the next century. This has major implications for the caring sector as requirements for care increase with age. Nutrition has a vital role in the maintenance of health and quality of life. However, nutritional care may have a low priority in some long-term care settings. A higher than expected prevalence of low body weight and inadequate dietary intake in long-term care has raised concern due to the morbidity and mortality associated with it. This study aimed to examine the nutritional status of elderly NHS continuing care residents, assess the nutritional adequacy of the diet offered and consumed and examine the environment where they ate.

Methods

Four establishments providing care for elderly NHS continuing care residents were randomly selected. All NHS long-term care residents, providing consent, aged 60 years and over, in care for 3 months or more, not terminally ill or having a malabsorptive disorder, having all limbs, not on tube feed, liquidised or fluid restricted diets were included. Nutritional status was assessed by one trained observer using standardised anthropometric techniques to calculate: estimated height (from knee height); arm muscle area (AMA); arm muscle circumference (AMC); corrected arm muscle area (cAMA); body mass index (BMI). Results were compared to published UK elderly anthropometric reference data-sets and commonly used criteria to define undernutrition. The nutritional content of the diet offered and consumed was assessed using three day weighed dietary record in a randomly selected 66% of the subject group. Data were analysed using a computerised dietary assessment programme and assessed for adequacy by comparing mean results to age and gender specific UK dietary reference values and estimated energy expenditure (ETEE) as calculated using BMR x PAL 1.3 and PAL 1.5. Functional ability was assessed using an activity of daily living scale (ADL) and cognitive ability assessed using a mini mental test (MMT). The physical and social environment where subjects ate was observed and described. One and two tailed t-tests were used to identify differences, p-values less than 0.05 were considered significant.

Results

From 196 subjects identified (49 males, 147 females; mean age 82.5 years; mean length of stay 28.8 months), 132 participated in the dietary survey. Subjects had multiple medical problems: most were dependent (mean ADL score 33/100; *SD* 33) and the majority (76%) had some cognitive impairment (mean MMT score 4/10; *SD* 3.3). Men were significantly heavier (mean weight 63.4Kg; *SD*10.5Kg) than women (mean 53.3Kg: *SD* 11.5Kg); taller (mean estimated height 165.3cm; *SD* 5.9cm) than women (mean 151.3cm; *SD* 5.6cm); had larger AMC (mean 227.1mm; *SD* 25.9mm) and AMA (mean 4154.4mm^2; *SD* 931.9mm^2) and cAMA (mean 31.6cm^2; *SD* 9.3cm^2) compared to women (AMC mean 202.7mm; *SD* 28.0mm; AMA mean 3333.5mm^2; *SD* 952.2mm^2; cAMA mean 26.9cm^2; *SD* 9.5cm^2). Women had significantly larger triceps skinfold thickness (TSK mean 12.3mm) than men (mean 9.8mm) and no significant differences in BMI were detected (men mean 23.2, women mean 23.3). Compared to the reference percentiles of Burr and Phillips (1984) and Lehmann et al (1991), the study group was leaner: for BMI 8% were below 5th percentile and 15% below the 10th percentile; for TSK 7% were below the 5th percentile and 11% below the 10th; body weight was significantly lower than reference ($p<0.001$). However, females aged 80 years and over appeared to be more muscular than the reference as AMA at the 50th percentile was significantly higher ($p<0.001$) than reference. Anthropometric trends such as decreasing weight, fat and fat free mass with increasing age were identifiable within the study group. The prevalence of undernutrition varied depending on the criteria used (11% using cAMA; 14% using BMI and/or cAMA; 24% using BMI alone). Energy content of diet offered (males mean 8.1MJ/d; *SD* 1.7MJ/d; females mean 6.9MJ/d; *SD* 1.2MJ/d) was significantly below the estimated average requirement (EAR) for energy and as a group was below estimated total energy expenditure PAL x 1.5 but not PAL 1.3. Energy intake (males mean 6.7MJ/d; *SD* 0.72MJ/d; females mean 5.3MJ/d; *SD* 1.3MJ/d) was significantly below the EAR and ETEE but not basal metabolic rate (BMR). Fluid, non-starch polysaccharide, vitamin D and potassium were inadequate in the diet offered and folate and iron also in the diet consumed. Failures in providing appropriate choice in meal, snack and drink provision, poor physical environment and lack of nutritional screening were identified.

Discussion

The information collected suggests that similar anthropometric trends appear to exist between elderly groups in different geographical areas such as decreasing weight and body mass with age but, absolute values differ. This suggests that the reference data available may be inappropriate. The study group appeared leaner and more muscular than the reference. The prevalence of nutritional status varied from 11-24% depending on the criteria used. This prevalence appears high compared to free living elderly and either similar or lower than other elderly long-term care groups. The lack of a gold standard definition for undernutrition and appropriate reference percentiles has important implications for screening and identifying undernutrition. Energy consumed was inadequate compared to the EAR and ETEE, this may explain the prevalence of undernutrition and the inadequate nutrient content of the diet. Intakes may have been influenced by various social and environmental factors, which may have placed the group at nutritional risk.

Conclusion

The group seem at risk of undernutrition from lack of nutritional screening, inadequate diet and various environmental factors. The group was leaner but more muscular than community reference groups and the prevalence of undernutrition was higher than community free-living elderly. Further research is required on appropriate reference percentiles, criteria for identifying undernutrition and environmental risk factors.

Recommendations

Various recommendations were made to the Health Board and Trust Management Teams which required multi-disciplinary input and change in aspects of nutritional care. Recommendations included: redesigning menus making them more appropriate for the elderly (both nutritionally and culinary); implementation of nutritional screening; nutritional education of ward staff; vitamin D supplementation; environmental improvements; identifying, recording and taking account of residents' meal, snack and drink preferences.

Contents

Appendices

List of tables

List of figures

Acknowledgements

I wish to thank the following:

All subjects and staff who assisted in the study

Dr JJ Reilly, my supervisor, for all his support, guidance and encouragement

Ms L Sinclair for her statistical assistance

Dr D Walker for his assistance and encouragement to complete this piece of work

My Mum, Dad and sisters for their support throughout the undertaking of this work

My colleagues in the Dietetic Department at Crosshouse Hospital for their support

North Ayrshire and Arran NHS Trust for allowing me study time and references

Ayrshire and Arran Health Board for their financial support

Declaration

I certify that all the work presented and the writing of this thesis is specifically my own and any assistance received is specified in the text. This thesis does not include work forming part of a thesis for a degree in this or any other University.

Signature: **Date:** November 1998

Jacqueline Mary Flett, BSc, SRD

Abbreviations

ADL	Activities of Daily Living
AMA	Arm Muscle Area
BMI	Body Mass Index
BMR	Basal Metabolic Rate
cAMA	Corrected Arm Muscle Area
DoH	Department of Health
DRV	Dietary Reference Value
EAR	Estimated Average Requirement
ETEE	Estimated Total Energy Expenditure
LRNI	Lower Reference Nutrient Intake
MAC	Mid Arm Circumference
MAMC	Mid Arm Muscle Circumference
MMT	Mini mental Test
No.	Numbers
NSP -	Non-starch Polysaccharide
PAL	Physical Activity Level
RNI	Reference Nutrient Intake
SD	Standard Deviation
SRD	State Registered Dietitian
TEE	Total Energy Expenditure
TSK	Triceps Skinfold Thickness
WHO	World Health Organisation

1. Introduction - Ageing, nutrition and long term care

1.1 Population trends

It is well known that the numbers of elderly people are increasing. Demographic projections show that the number of people aged over 65 years will change relatively little, however there will be a 7% increase in those aged 75-84 years, and a 34% increase in over 85 year olds (Laing and Buisson, 1994). This trend has been maintained throughout this century. In 1900, within the UK, there were 58 000 people aged 85 years and over, this increased to 876 000 in 1991 and is expected to increase to 1.2 million by 2001, with a peak of over 3 million expected in 2056 (Laing and Buisson, 1994). This increase in life expectancy has been primarily due to the cure and prevention of diseases through better living conditions and improved medical care. This upward trend in the population has left society with a large and growing challenge in providing both social and health care for this older adult population (Evans et al, 1984).

It is well known that elderly people's need for care increases with age (Katz et al, 1983; Laing and Buisson, 1994). Therefore, the numbers requiring short and long-term care are set to rise in the future. One local study by Womersley (1987) in Glasgow indicates this (see Table 1).

Table 1: Accommodation trends in Glasgow (Womersley, 1987)

Age Group (Years)	% Individuals in Institutional Care
65-74	2.4
75-84	6.5
85+	20.4

In recent years, some changes have occurred in the type of provision of care for the elderly. In a 5 year period from 1981 to 1986 there was a 21% increase in the number of registered private nursing homes within the UK (Registered Nursing Homes Association, 1980, 1985). Also, due to the publication of the 1993 Community Care Act, there has been a transfer of responsibility from the NHS to Local Authority for ensuring the provision of care. One of the main aims of the act was to ensure that people did not remain in hospital care unless there was a specific continuing medical need. Therefore, the Act placed a greater emphasis on the provision of care in the community. What has been seen as a result is a higher dependency level of residents in receipt of hospital continuing care. This was demonstrated in a comparative study of institutionalised elderly in Fife (Carter et al, 1992). The study assessed the dependency levels of 441 elderly people in NHS long term care, 488 people living in private nursing home care and 637 in local authority residential care. Results indicated that the most dependent were in hospital care, the most able in residential homes, with private nursing homes accommodating elderly people with intermediate dependency levels (Carter et al, 1992).

Unfortunately the history of NHS long-term care has been punctuated by a series of public revelations of major inadequacies. Recurrent deficiencies have been described in a recent report, such as unsuitable buildings, batch treatments, lack of privacy, fixed routines, inactivity and boredom (British Geriatric Society, 1992). It is important to note that this report did not make any reference to mealtimes or nutritional care which have been indicated as being inadequate in long term institutional care (Department of Health (DoH), 1992).

Lengthening life may seem laudable if quality of life is maintained but if the later years are spent in institutional care where quality of life, health and intellect can decline then the reasons why this is the case require to be addressed. Therefore, the priority in the future should not only be to increase the length of life but also to maintain an adequate quality of life and health status so that the later years can be enjoyed. Nutrition plays one part in leading us to this goal. Quality of life, as far as food and nutrition are concerned, means improving health and functional ability with good nutrition and enjoyable meals.

1.2 Nutrition and health in old age

Nutrition has been recognised as an important factor in influencing the functional outcome of ageing (Munro, 1992) as has the effect ageing has on nutrition. Cross-sectional data have indicated that height, body weight, lean and fat mass decrease with increasing age (Bannerman et al, 1997; Delarue et al, 1994; Lehmann et al, 1991; Burr and Phillips, 1984). However, there is a lack of basic information on anatomical and anthropometric data in the elderly (DoH, 1992; Durnin, 1983).

1.2.1 Anthropometry

The density of the skeleton has been found to decrease with age which has been mainly attributed to a fall in mineral content within the skeleton (Durnin, 1983). Various factors have been implicated in this decrease, such as reduced activity and calcium intake (Durnin, 1983). The change in height is a result of pathological abnormalities such as kyphosis, vertebral collapse and loss of disc height which are common in elderly groups (DoH, 1992). Assessing height accurately in the elderly is therefore difficult and sometimes impossible using normal methods (standing height measurements). Estimates of height are frequently used.

Arm span or knee height can be used to estimate the stature of individuals. Arm span has been found to alter less with age than height (Bassey, 1986) and is highly correlated with stature (Haboubi et al, 1990). However, it can be difficult to measure in individuals with chest deformities, upper limb arthritis and the bed bound. Alternatively, knee height is relatively easy to obtain in those who cannot stand and does not alter with age. Knee height has been shown to have acceptable accuracy, reliability and produces unbiased estimates of stature for groups (Bannerman et al 1997; Chumlea et al, 1985).

Due to the lack of a gold standard for assessing height, different methods are employed by researchers. For example, in three cross-sectional studies of elderly people living within the community, standing height was used to assess 1500 elderly Welsh individuals (Burr and Phillips, 1984), knee height was used in assessing 188 elderly people residing in Edinburgh (Bannerman et al, 1997) and demispan (half armspan) was used in a study of 890 subjects from the Nottingham area (Lehmann et al, 1991).

Within the UK, body mass tends to increase throughout middle age due to an accumulation of fat, and thereafter it declines along with lean body mass (DoH, 1992). Decreasing body mass (fat and fat-free mass) in the elderly has been measured by decreasing weight, body mass index (BMI), triceps skinfold thickness (TSK) and mid-arm circumference (MAC) (Bannerman et al, 1997; Delarue et al, 1994; Lehmann et al, 1991; Burr and Phillips, 1984). Although similar anthropometric trends are recognised in each cross-sectional study, absolute values differ which may be as a result of geographical differences or secular trends (Bannerman et al, 1997; Delarue et al, 1994). More research is required to assess why these differences are apparent between different geographical areas. As large differences are apparent there is a definite need for more representative elderly body composition data to be developed and clinically defined criteria for those undernourished or at nutritional risk established.

1.2.2 Undernutrition in the elderly

Undernutrition and not overnutrition has been agreed to be the main cause for concern in the elderly, particularly for those with acute or chronic illness and those who are hospitalised or institutionalised (DoH, 1992). This is primarily due to the increase in morbidity and mortality associated with undernutrition compared to moderate obesity (Potter et al, 1988; Mattila et al, 1986). Muhlethaler et al (1995) indicated from analysing deaths over a 4.5 year period of 219 geriatric patients that protein-calorie malnutrition indicators were independent risk factors predicting decreased length of overall survival. Kemm et al (1984), in a series of 304 admissions to a geriatric unit, found weight, MAC, TSK, albumin, retinol binding protein and plasma retinol were all significantly lower in patients who died.

It is now well established that undernutrition impacts on both physiological and biochemical systems leading to impaired immune response and respiratory function, delayed wound healing and overall increased complications, longer rehabilitation and greater length of hospital stay (Windsor et al, 1988; Kelly et al, 1984; Bistrian, 1977; Sullivan et al, 1990; Heatley et al, 1979; Hanson et al, 1992; Dionigi et al, 1979; Potter et al, 1995; Robinson et al, 1987).

In view of the importance of the adverse clinical effects of undernutrition, it is concerning to find a higher prevalence of undernutrition in elderly long term care compared with the free-living elderly. In the elderly population, the DHSS survey of 1972/73 indicated that 18.3% of elderly men and 11.5% of elderly women were 'thin', defined as a body mass index of less than 20. In a study by Fevre (1993) in a group of 18 long stay elderly people in Glasgow, 39% were identified as undernourished using the same criteria. Larsson et al (1990) found a 29% undernutrition in a study of 501 elderly long stay residents. In a report from the DoH (1992) it was suggested that energy intakes may be inadequate and low body weights were common within institutional elderly and there was a need for more research into addressing the possibility of "institutional starvation" amongst this group.

1.2.3 Defining undernutrition

There is a requirement for more accurate elderly body composition data and well defined criteria for undernutrition or where nutritional risk is great (Bannerman, 1997, Pennington, 1997), due to the poor clinical outcome associated with undernutrition. In the study by Friedman et al (1985), the cut-off levels of corrected arm muscle area (cAMA) to define severe wasting undernutrition were determined after consideration of UK, New Zealand and USA data on the elderly. Of 201 subjects aged 65 years and over, 10 subjects were identified as undernourished using the criteria developed and this group were found to have a much higher 90-day mortality than the 191 normally nourished subjects (50% versus 16.2%). Potter et al (1995) indicated in a random sample of 69 acutely ill geriatric assessment patients that episodes of sepsis occurred significantly more often in the severely undernourished group ($p < 0.04$) than the normally nourished group. Larsson et al (1990) found in a study of 501 long-stay elderly that the mortality rate among the undernourished group was higher than the well nourished group ($p < 0.01$).

At present researchers use different criteria for defining undernutrition, as there is no gold standard or satisfactory tool for measuring undernutrition (Pennington, 1997, Gibson, 1990). For example, Potter et al (1995) used both BMI cAMA in the study involving acutely ill geriatric assessment patients and found that 22% were undernourished (BMI < 5^{th} percentile) and that 31% of men and 27% of women were severely undernourished (cAMA < $16cm^2$ for men and <$16.9cm^2$ for women). Fevre (1993) in a the study of long stay elderly in Glasgow, used a BMI < 20 and Larsson et al (1990) defined undernutrition as residents having three or more of the following: found a rate of 29% undernutrition in elderly long stay residents:

Weight index (proportion of ideal body weight)	<80%
TSK (women)	<=12mm
TSK (men)	<=6mm
AMC (women 79 years or under) (women over 79 years)	<–19cm <=18cm
AMC (men 79 years or under) (men over 79 years)	<=23cm <=21cm
prealbumin (women)	< 0.20g/l
prealbumin (men)	<0.26g/l
serum albumin	<36g/l

Gibson (1990) details how the use of one or more classification system for identifying malnutrition within one population can produce some contradictions, depending on the measurement, the reference limits or the cut-off points selected. Standardising methods of evaluating anthropometric indices are essential for assessing the nutritional status of population groups and identifying malnourished individuals (Gibson, 1990).

1.2.4 Assessment of undernutrition

The result of using different criteria to define undernutrition is likely to be spurious variations in the prevalence rate of undernutrition between studies, and this is addressed in this thesis. The question of how to define undernutrition is important for individual patients (eg screening of patients for undernutrition), for audit, and for research (Bannerman, 1997). Nutritional assessment systems use a variety of methods to characterise each stage in the development of a nutritional deficiency state (Table 2). Several different methods to assess nutritional deficiency such as dietary, anthropometric, functional, clinical, biochemical/haematological are employed either alone or in combination (Gibson, 1990).

Table 2: Generalised scheme for the development of a nutritional deficiency (Sahn et al, 1984)

Stage	Depletion Stage	Method(s) Used
1	Dietary inadequacy	Dietary
2	Decreased level in reserve tissue store	Biochemical
3	Decreased level in body fluids	Biochemical
4	Decreased functional level in tissues	Anthropometric/biochemical
5	Decreased activity in nutrient dependent enzyme	Biochemical
6	Functional change	Behavioural/ physiological
7	Clinical symptoms	Clinical
8	Anatomical sign	Clinical

1.2.4.1 Dietary assessment of nutritional status

Dietary assessment identifies the first stage of a nutritional deficiency. The dietary intake of one or more nutrients will be inadequate at this stage through either a primary deficiency (low levels in the diet) or a secondary deficiency. In a secondary deficiency, the diet appears to meet the individuals nutritional needs but factors such as drugs or disease state interferes with digestion, absorption, utilisation or excretion of nutrients (Gibson, 1990). Methods of assessing dietary intake vary depending on whether individual, group or populations are being assessed. Table 3 indicates a selection of dietary assessment methodologies to estimate either usual nutrient intake or the pattern of food use of free-living subjects (Beaton, 1982).

Table 3: Methodology to estimate usual nutrient intake (Beaton, 1982)

Desired information	Preferred approach
Actual nutrient intake over finite time period (eg in a balance study)	Chemical analysis of duplicate meals or calculated intake from weighed food records
Estimate of usual nutrient intake in free living subjects	One day intake with large number of subjects and adequate representation of days of week
Group average	Replicate observations of intake or diet history
Proportion of the population 'at risk' based on individual intake, for correlation or regression analysis	Multiple replicate observations on each individual
Group or individual pattern of food use indicating proportion of population with particular pattern	Food frequency questionnaire
Average use of a particular food or food group for a population	Food frequency questionnaire or a one-day intake with large number of subjects and adequate representation of days of the week

Each method of gathering usual food or nutrient intake has its limitations and none is devoid of systematic errors, or prevent alterations in the usual food habits of subjects. As with nutritional assessment in general there is no ideal dietary assessment method, the choice depending primarily on the objectives of the study (Gibson, 1990).

A recent study in long stay elderly patients, using a three day weighed dietary survey, found energy intakes were in good agreement with measured total energy expenditure indicating both that the dietary technique was accurate, and that patients were in energy balance, as confirmed by body weight and composition not altering markedly during the experimental period (Reilly et al, 1995). Basiotis et al (1987), found that intakes of micronutrients such as vitamin C varied considerably between individuals and between days. The number of days required to estimate the true average consumption of micronutrients for a group or individual has been found to vary between 4 and about 44 days depending on the nutrient but, in general, fewer for energy and macronutrients than for micronutrients. However, the Basiotis (1987) study was conducted in young adults with a lifestyle (and therefore diet) which varied considerably more than institutionalised elderly. In Barnes and Hodkinson's study (1988), of 15 clinically stable long stay elderly patients, no significant differences were found in the mean intakes of the group for any of the micronutrients (potassium, calcium and vitamins C and D) and macronutrients (energy, protein, carbohydrate and NSP) studied using 2-3 day weighed dietary record and a 7 day weighed dietary record. With the exception of NSP no differences were found between weekdays and weekend days, nor between the days of the highest and lowest intake, nor between the first part and the second part of the week. Day to day differences in the group's NSP intake were observed only on the highest and lowest days intakes. All observations for 3 days or more gave results within 5 per cent of the 7 day average indicating that 3 or 4 day observation periods provide a very good approximation to 7 day values for a group. There were significant between-individual variations although estimates for energy over a 3 or 4 day period appeared acceptable (Barnes and Hodkinson, 1988).

Systematic and random errors occur in food composition tables and nutrient databases which are used to calculate the nutrient content of the weighed dietary surveys. Systematic bias occurs due to the wide variation in all foods, but particularly certain fortified and manufactured foods. Random and systematic errors can arise in food as nutrients vary with the season or the stage of ripeness. Such errors must be recognised when reporting on the findings of any dietary survey which has calculated nutrient intakes based on food composition tables (Gibson, 1990). Also, nutrients losses from cooking and storage are not taken into account. Vitamin C and folate losses have been found to be high in long-stay establishments (Lowik et al, 1993) with losses as high as 75% for some green vegetables (Jones et al, 1988).

1.2.4.2 Laboratory assessment of nutritional status

Several of the stages in the development of a nutritional deficiency state can be identified by laboratory methods. Depletion of nutrients in body tissue stores may lead to a reduction in nutrients or in the level of metabolic products in body fluids and tissues, and/or in the activity of nutrient-dependent enzymes. This type of depletion can be assessed by biochemical tests, and/or by tests that measure physiological or behavioural functions dependent on specific nutrients (Solomons, 1985). These tests are usually invasive, require special equipment and are not always easily interpreted (Gibson, 1990).

1.2.4.3 Anthropometric assessment of nutritional status

Anthropometric methods measure the physical dimensions and gross composition of the body (Jelliffe, 1966). They can be used to detect, in some cases, moderate as well as severe degrees of malnutrition and have the advantage of providing information on past nutritional history, which cannot be obtained with equal confidence using other assessment methods (Gibson, 1990). Anthropometric measurements are relatively fast, non-invasive, and require the minimum of equipment compared to laboratory techniques. Anthropometric measurements are of two types: growth and body composition (Gibson, 1990). Body composition measurements can be further divided into measurements of body fat and fat-free mass which make up total body mass. Anthropometric indices can be can be derived from either single measurements or a combination of measurements.

Selection of anthropometric indices for nutritional assessment will depend on the study objectives. For example, to identify undernourished individuals, a screening system which monitors past and previous nutritional state would be more desirable than a nutritional surveillance system which monitors short term changes in nutritional status (Gibson, 1990). The latter assessment system may be more useful if the impact of nutrition intervention on a specific high-risk group was being assessed. The sensitivity and specificity of anthropometric indices are important to ensure the correct identification of both healthy nutritional states and depleted states. There are limitations to anthropometric assessment, for example it is a relatively insensitive method that cannot detect disturbances in nutritional status over short periods of time or identify specific nutrient deficiencies (Gibson, 1990).

Assessing nutritional status using body measurements in frail elderly populations is not entirely satisfactory because:-

1. Collecting accurate and reliable measurements from this group can be difficult and on occasions impossible due to the fact that a high percentage of subjects are bed bound (Munro, 1989)
2. There is a lack of appropriate reference data for comparison.(Bannerman, 1997).
3. Inter- and intra-observer errors for body measurements in the elderly have been found to be high, especially for circumferences and skinfolds of the trunk (Chumlea et al 1984).

To improve the assessment of nutritional status, anthropometric measurements along with assessments of dietary intake, medical history, laboratory measurements and immune testing should be employed (Munro, 1989). Unfortunately assessing all these parameters is often, as in this study, not practical due to time and financial constraints. In addition, there is no agreed method for integrating all of this information, even if it were possible to obtain (Gibson, 1990).

An alternative and relatively common way of determining undernutrition is to monitor changes in anthropometry with time. One such criteria which is indicative of undernutrition is a 10% change in usual body weight within 6 months (Gibson, 1990). However, assessing change in anthropometry of the elderly is problematic. With weight, alterations may be due not to changes in nutritional state but may be related to alterations in total body water (eg oedema, ascites). Body circumferences and skinfold thickness are useful for initial classification but might not be sufficiently precise for short-term follow up and monitoring. The interpretation of a small change in TSK or AMC is difficult while a change from 25th to 50th percentile is too insensitive for general use (WHO, 1985).

1.2.4.4 Clinical assessment of nutritional status

A medical history and physical examination are clinical methods used to detect signs and symptoms associated with nutritional deficiency. However, many of the critical physical signs are non-specific and therefore must be interpreted in conjunction with other anthropometric, dietary or laboratory data before specific nutritional deficiencies can be described (Gibson, 1990). The medical history assessment would generally include descriptions of patients' relevant environmental, social, and medical family history. Questions on weight loss or gain, oedema, anorexia, vomiting, nutrient intake, anaemia, chronic illness, surgery, medications and dietary supplements may be asked. This information is used to establish whether a nutrient deficiency is primary, arising from inadequate dietary intake, or secondary in origin due to such factors as drugs, disease state or dietary component. Respondent bias may occur during the conduct of the medical history (Gibson, 1990). The physical examination examines physical changes believed to be related to inadequate nutrition. However, the physical examination has several limitations, the most major of which is the non-specificity of the physical signs. This is especially the case in mild to moderate deficiency states, eg nasolabial seborrhea can arise from deficiency of pyridoxine, riboflavin, or niacin. Other physical signs such as eczema may be caused by non-nutritional factors. Other limitations include subjects with co-existing nutrient deficiencies who may exhibit multiple physical signs which confuse the diagnosis. Also, examiner inconsistencies have been found where examiners may record lesions in subjects with mild to borderline evidence of lesions while other examiners only record more severe forms (Gibson, 1990). This problem can be reduced with appropriate examiner training and standardisation of criteria for defining the signs. There is no universal set of signs and symptoms suitable for all ages and all countries. All these limitations of the physical examination confound the diagnosis, making it essential to included laboratory tests to confirm whether a specific nutrient deficiency is present or not (Gibson, 1990). Clinical symptoms only develop during the advanced stage of a deficiency and signs and symptoms can be non-specific. Therefore, clinical diagnosis of nutritional deficiency should not be relied on exclusively (Gibson, 1990).

In summary, there is no ideal method for assessing nutritional status and identifying undernutrition (Bannerman, 1997; Gibson, 1990). Undernutrition is common in hospital and institutional care (Potter et al, 1995; Fevre, 1993; Bistrian et al, 1974; Bastow et al, 1983; McWhirter and Pennington, 1994). The increase in poor nutritional status as dependency and illness increase and as individuals move into hospital or institutional care is now well described (Morgan et al, 1986; DoH, 1992).

The development of disease may be accompanied by decreasing appetite, biochemical and physiological changes leading to tissue wasting, and intestinal malfunction associated with impaired absorption of nutrients which lead to undernutrition (Pennington, 1997). However, there are many other factors which lead to undernutrition in hospital and institutional care which are not related to disease state, and these are briefly considered below.

1.3 Social and environmental aspects of undernutrition

A lack of awareness of undernutrition is common in hospital care. McWhirter and Pennington (1994) assessed, by anthropometry, the nutritional status of 500 patients on their admission to a Dundee Teaching Hospital, 100 of whom were to an acute elderly ward. They assessed case notes to determine the attitudes and practices of medical staff. Of the 500 patients assessed on admission to hospital, 40% were defined as undernourished (BMI < 20; 43% for the acute elderly group) and nutritional status was found to decrease throughout the hospital stay. A limited amount of documentation on nutrition at outpatient visits and on admission to hospital highlighted the problem of lack of awareness of nutrition by staff. This had been indicated in a previous study of 319 junior doctors in seventy hospitals. This study found that only 34% of doctors knew if their patients had been weighed and 60% of the remainder thought weight was unimportant (Lennard-Jones et al, 1995). Of course, recognition is made more difficult by the lack of suitable and agreed clinical indices of undernutrition.

Factors related to meal provision are also important but the literature is scarce in this area. Patients missing meals through being absent from the ward at mealtimes or the poor quality of the food presented to them gives rise to concern. This is believed to be a particular problem now because centralised kitchens can mean that no additional food for alternative meal choice is now available on the majority of wards. One study in Glasgow examined the number and cause of missed meals in a random sample of patients in five clinical units over a two week period. The percentage of missed meals ranged from 11% to 27% with breakfast being the most frequently missed and evening meal the least frequently missed and reasons for missed meals were because of clinical investigations, pre- and post-operative fasting, illness, the quality or the taste of the food and the lack of variety in the meals available (Eastwood, 1997). A study by Fenton (1989) found that patients consume more at breakfast than at lunchtime due to the 14 hour fast from supper to breakfast. It was indicated that the large amounts of food waste at lunch and evening meal was due to poor staffing ratios, incompatibility of portering, staffing and catering rosters, inadequate equipment and lack of guidance on appropriate menu choices and the importance of ward practices safeguarding the nutritional status of patients. In effect, it was seen that management had failed to give sufficient priority to good food, well served, in pleasant surroundings, to improve the quality of patient lives and their nutrition (Fenton, 1989). Some of these problems have been identified as risk factors for undernutrition in long-term institutional care. Henderson (1988) found the following to be risk factors for undernutrition in the institutionalised elderly: previously housebound; poverty; cultural dietary restrictions; loss of control over food choices; depression; unattractive surroundings; distractions at mealtimes; inappropriate food timing or food temperature; need for assisted feeding; victims of abuse. Keller (1993) concluded after a study involving 200 elderly long stay patients that factors determining overall malnutrition in the elderly included environmental conditions and disease processes which affect the ability of patients to consume food. Slow feeding/eating was highly associated with undernutrition in this sample.

Some researchers have investigated causes of poor food intake/food provision by undertaking intervention studies. Although useful, in many of these studies quantitative assessments of dietary intake have not been undertaken. For example, four risk factors were found to be influential in optimising the dietary intake in elderly patients with Alzheimer's disease. These were skilled feeding techniques, selecting appropriate food consistency, providing adequate time to feed, and capitalising on the midday meal when cognitive abilities were at their peak (Suski and Nielson, 1989). In an earlier study by Melin and Gotestam (1981), several aspects of ward routines were changed to study the effects of the environment on the behaviour of 21 elderly mentally ill patients. This study indicated that communication and eating behaviour improved when patients were allowed more time to eat, provided with more freedom in their meal choice, furniture was rearranged and the surroundings were improved. The actual quantities of food consumed by the group was not assessed and this requires further investigation. Overall, it would appear that ensuring an adequate food intake for people in institutional care has implications for both clinical services and administration.

1.4 Energy expenditure

The reduction in body mass and fat-free mass with advancing age has the effect of reducing energy expenditure which impacts on dietary intake (Prentice, 1992; Durnin, 1983). Total energy expenditure in the elderly may be affected in several ways but the most important are via reduction in basal metabolic rate (BMR), and reductions in the energy expended on physical activity. The cause of the decrease in basal metabolic rate with age has been found to be a fall in active cell mass and not a decrease in the metabolic activity of each cell (Prentice, 1992). In most cases total energy expenditure will reduce by about 10% between the age of young adulthood and about 60 years, and between 60 - 70 years another 10% decline has been noted (Durnin, 1983). However, there is some evidence to indicate that if elderly people avoid the marked changes in body composition which occur with age then BMR will not necessarily become lower (Murray et al, 1996; Keys et al, 1973; Tzankoff and Norris, 1977). Reduction in physical activity, either through stopping work or reduced social activity will impact greatly on energy expenditure. For some people stopping a manual job may lead to a large decrease in activity and for others stopping work may increase sporting activity which may well increase energy expenditure (Prentice, 1992; Patrick et al, 1986; Durnin, 1983). A study by Dallosso et al (1988), designed to indicate the normal activity profiles of elderly people from a community sample of 507 elderly people aged 65-74 years and 535 people aged 75 years and over found customary engagement in many activities was low, age (old versus very old) and sex being among the most important determinants of participation. While this indicates a variable picture, overall, as age increases activity will decline and this may be as a result of discomfort or pain when moving around due to the increasing number of degenerative diseases which arise with age (Durnin, 1983).

Until the recent development of the doubly-labelled water technique to measure total energy expenditure (TEE), it had been difficult to make fully quantitative estimates of the amount of physical activity undertaken by elderly people. Therefore, studies such as those by McGandy et al (1966) from the United States indirectly estimated the amount of energy devoted to activity from energy intake data. This large study measured energy intake and BMR in order to calculate the energy used for activity in 10 year cohorts of subjects living in Baltimore. The study found a steady decrease in estimated total energy expenditure (ETEE), BMR, and physical activity with increasing age. In the eighth decade only 70% as much energy was used for physical activity as in the third decade of life. A relative index of physical activity, known as the physical activity level (PAL) and calculated as ETEE/BMR, decreased with age from 1.74 to 1.55.

Although the amount of activity has been reported to decline with age the amount of energy expended during activity may increase due to a reduction in mechanical efficiency (Hellon et al, 1956; Durnin and Mikulicic, 1956). Elderly men in a small study by Durnin and Mikulicic (1956) seemed to have similar degrees of mechanical efficiency to younger men if the exercise did not involve much gross body movement. However, if large muscle groups and control of balance was required, as with walking, this resulted in a marked decrease in efficiency and an increase in energy expenditure. Women with overt problems like amputation, arthritis or overweight have been found to experience even greater increases in the energy cost of standard activity (Bassey and Terry, 1986 and 1988).

Therefore, energy expenditure in the elderly is complex and seems to be affected by three main factors: BMR; amount and type of physical activity; mechanical efficiency of activity. These factors will vary by individual but in some settings, for example long term institutional care, certain factors, such as activity, may be relatively constant within a group. The DoH (1992) calculations for predicting energy expenditure take account of this by recommending a 1.5 PAL for free living elderly (community based) and a 1.3 PAL for institutional elderly. This indicates that in long term institutional care physical activity is relatively low. Reilly et al (1995) measured total energy expenditure of 8 long stay elderly residents and 5 other patients with hip fracture using the doubly-labelled water technique. The measured energy expenditure for long stay elderly was 6.2 MJ per day (*SD* 1.2MJ/d) (1MJ=239kcal) and 9.0MJ per day (*SD* 2.3MJ/d) for the hip fracture group with mean PAL of 1.3 and 1.5 respectively. No evidence was found that the current standard predictive calculations for ETEE using a PAL of 1.3 for long stay elderly would lead to large systematic errors, although the numbers in this study were small. Further research in this area is required (DoH, 1992). However, this study did find that in a few patients PALs were even lower than 1.3, indicating extreme inactivity in some long stay elderly individuals. In an earlier study by Reilly et al (1993) of 11 apparently healthy community dwelling elderly women (mean age 73 years; *SD* 3 years), they were found to have higher than expected TEE (mean 9.2MJ per day; *SD* 1.5) and high PAL (mean 1.8; *SD* 0.2). The subjects involved were a self-selected, highly motivated group of individuals who cannot be regarded as a representative sample of the elderly community population. However, they do indicate that age-related reductions in energy requirements are not inevitable and that the effects of ageing on physical activity, body composition, and therefore energy requirements are variable. These studies suggest that within segments of the elderly population activity levels can vary considerably (DoH, 1992) and this must be taken into account when estimating energy expenditure and energy requirements.

1.4.1 Energy balance

Until energy balance could be measured, calculation of energy requirement was based on estimates of energy expenditure or observed energy intakes of people assumed to be in energy balance over a measured period of time (DoH, 1979). However, when these two methods are applied, estimates of energy expenditure often exceed energy intake. This has been thought to be as a result of subjects concealing their true intake or as a result of inadequate methodology (James and Shetty, 1982). The study of eleven free living apparently health elderly females (Reilly et al, 1993) found that TEE, as measured by the doubly-labelled water method, exceeded apparent energy intake in all subjects although subjects were in energy balance as indicated by serial weighing and skinfold thickness measurement. This raised the question of the validity of the methodology for measurement of energy intake and expenditure. The design of the study did not allow the identification of factors which could have led to the mismatch between TEE and energy intake. However, underestimation of habitual energy intake was indicated as the possible source of error rather than the doubly-labelled water technique (Reilly et al, 1993). Other studies have identified discrepancies between apparent energy intake and expenditure in community subjects who are in energy balance (eg Livingstone et al, 1990; Schoeller, 1989). Underestimation of energy intake is the usual finding due to either under-reporting of consumption, under-eating during the measurement period, or imprecision in the estimate of energy intake from the weighing record. This led Black et al (1996) to examine published dietary surveys and compare energy intakes with energy requirements. Out of the 68 groups involved in the 37 studies they reviewed, two thirds of the reported intakes were found to reflect invalid measures of energy intake, even for sedentary lifestyles. Ten of the 68 groups reported energy intakes below the 1.27 PAL x BMR, which is the World Health Organisation (WHO, 1985) estimate of the minimum energy requirement for survival. It is now generally accepted that underreporting is a problem of dietary studies and that further research is required to determine the patterns of under- and over-reporting (Black, 1996). The issues regarding under-reporting in community populations may not be as apparent in hospitalised or institutionalised groups. This may be for a number of reasons, including the normally cyclic nature of institutional menus, standard portion sizes and set meal and snack times which allow the researcher to conduct weighed food records instead of the subject weighing their own food. Further research in this area is required (Black et al, 1996).

1.4.1.1 Energy Balance in different elderly groups

In relation to energy balance, the TEE, BMR, energy intake and nutritional status of 8 long stay elderly patients and 5 elderly hip fracture patients were also assessed in the study by Reilly et al (1995). Results indicated that the energy intake and TEE were identical in the long stay patients and these subjects were in energy balance, as no change in anthropometric measurements over the study period were seen. The hip fracture group was in negative energy balance (TEE exceeded energy intake), and a moderate weight loss was found in the group. Although the long stay group was in energy balance the low activity level and low energy intake found gave rise to concern to energy intakes being so low as not to support an adequate intake of all other essential nutrients. The estimated energy requirement (EAR) avoids the incremental approach for groups of elderly people with very low activity levels because achieving an adequate diet from such a low energy intake would be nearly impossible (DoH, 1992). In summary, even if energy balance can be achieved on an energy intake which is less than 1.3 PAL x BMR this is undesirable from the point of view of micronutrient intake.

1.4.1.2 Energy intakes in free living elderly

The results of cross-sectional surveys of energy intakes of free living elderly people have indicated that men consistently consume more energy than women, even after standardising for body mass (DoH, 1992) and that energy intake declines with increasing age (DoH, 1979; Lundgren et al, 1987). A longitudinal study assessing the dietary intakes of 365 elderly people in the UK began in 1967/8 and then reassessed intakes 5 years later (DHSS, 1972). The mean energy intake in 1967/8 was 9.4 MJ per day for men and 7.2 MJ per day for women, and this decreased to 9.0 MJ per day and 6.8 MJ per day five years later. However, decreases were less marked when expressed per kilogram body weight because of the declining weight found in the sample. Dietary intakes of elderly people from other countries also vary greatly as indicated by Table 4, but the same basic trends are apparent.

Table 4: Dietary intakes of community elderly people in the UK and abroad

	Sweden. Borgstrom et al (1979)		**Britain. DHSS (1979)**		**USA. Uauy et al (1978)**		**Britain. Bunker et al (1989)**		**Holland. Loenen et al (1990)**	
Sex	M	F	M	F	M	F	M	F	M	F
No. Subjects	17	20	169	196	50	37	11	13	237	223
Age (yrs)	67-97		68-90		67-99		69-85		65-69	
Mean energy intake (MJ/d)	8.6	6.7	8.9	6.8	9.7	8.0	8.7	6.6	10.2	8.0
Mean energy (KJ/d)intake by weight(kg)	113	96	138	117	130	117	126	105	134	117

In a 5 year longitudinal study of 269 elderly people from Gothenberg, Sweden, a similar trend of decreasing energy intake with age was observed (Lundgren et al, 1987). In a more recent UK survey, the average energy intake of different age groups was compared and a trend towards decreasing energy intake with age was observed (Gregory et al, 1990). Some reduction in energy intakes for elderly people may be appropriate due to their, previously discussed, reduced activity, body mass and energy expenditure (Schorah and Morgan, 1985). However, as noted above, concerns have arisen that energy intakes in some age groups may be so low as not to support an adequate intake of all essential nutrients, with subgroups of the population, like those suffering chronic disability who have very low energy intakes, particularly at risk of nutritional inadequacy (DoH, 1992).

1.4.2 Energy intakes of elderly people in different clinical settings

Energy intakes of elderly people have also been found to vary across different settings and clinical groups and might vary between different methods of assessment. Vir and Love (1979) found in a study of 196 elderly subjects from non-institutionalised and institutionalised settings, low energy intakes and nutrient inadequacies with a high rate of sub-clinical deficiency, particularly in the hospital institutionalised groups. The lower energy intake of the hospitalised group was attributed to lack of interest in food and surroundings, poor appetite with limited energy expenditure, lack of attention and encouragement during meals. Morgan et al (1986) found that dietary intakes and nutritional indices such as weight, TSK, arm muscle circumference (AMC), plasma albumin, plasma prealbumin and plasma vitamin C concentration varied with degree of disease and dependency in samples of elderly women from the free living community, day centre clients, day hospital patients, long stay hospital patients and acute or chronic long stay patients (Table 5).

Table 5: Nutritional status of elderly women in different clinical groups (Morgan et al, 1986)

Group	No. subjects	Mean age (range) (years)	Mean weight (Kg)	Mean energy intake (MJ/d)
Active free living	57	73 (69-78)	64	7.8
Day centre clients	75	81 (65-94)	60	6.5
Day hospital patients	46	81 (63-93)	55	-
Long stay patients	71	84 (61-101)	48	6.4
Acute or chronic long stay patients	20	82 (69-92)	48	5.4

However, comparing the dietary intake values of these groups must be viewed with caution as different dietary methodologies were used to gather information. In the active free living group, 17 subjects kept a 7 day weighed food and fluid record, in the day centres, 17 subjects kept 7 day descriptive food and fluid records and in the long stay and acute groups the weight of food wasted was deducted from food offered. The results from the study showed only small differences in nutritional indices measured between the young and the active elderly but indicated large differences between the various elderly groups and that each group was reasonably homogeneous. Relationships between energy intake and body weight, protein intake and plasma protein levels and vitamin C intake and plasma vitamin C concentration were found. The major finding of the study was that the nutritional indices indicated progressive deterioration in nutritional state as the degree of illness and dependency increased.

Klipstein et al (1995) in a study involving twenty patients from an acute geriatric unit in Glasgow found a mean energy intake of 4.8MJ/d (*SD 1.5)*. This is lower than the 5.4 MJ/d found in the acute elderly unit by Morgan et al (1986). ETEE exceeded measured energy intake in fifteen out of nineteen subjects in the Glasgow study. The evidence from this small study indicated that negative energy balance was common in elderly patients during hospitalisation. Weight change in fourteen out of the nineteen subjects was accurately predicted by estimated energy balance. In the other five subjects weight gain was apparent although they were found to be in negative energy balance (mean -1.3MJ/d). This may have been as a result of imprecision of the energy balance assessments. Alternatively, subjects' energy intakes may have been higher than actually measured during the recording period or outside the recording period. Overall, there was a significant decline in mid arm muscle circumference and body weight and the magnitude of the changes was consistent with the moderate negative energy balance found. The low energy intake found in this study again gave rise to concern regarding not only the expected weight loss but the inadequate vitamin and mineral intake found. Food actually offered to the subjects by the acute geriatric unit did meet the energy requirements of the sample but subjects did not eat all that was provided. This may be for a variety of social and environmental factors which will be discussed later in this chapter.

1.4.2.1 Energy intake of elderly people in long term care

Studies in long-term care have indicated that the energy content of food offered may not always meet energy requirements. In a study in Southampton by Thomas et al (1987), 19 out of 21 elderly long term care resident's dietary intakes were below 1.27 x BMR. The low intake found could not have met the group's energy needs, and they consistently lost weight over a one year period.

A sample of 10 weight-losing and 10 weight-stable elderly patients with senile dementia of Alzheimer's type and multi-infarct dementia in Southampton were involved in a study assessing dietary intake and energy expenditure (Sutherland and Wooton, 1992). The dietary intake of the group was monitored by 7 days weighed observation and BMR was measured by indirect calorimetry using a ventilated hood and predicted from age, sex and body weight. The BMR of the weight-losing group was found to be significantly higher than the weight-stable group. When energy intake was expressed as a ratio of BMR, the weight-losing group were being served and were consuming approximately 29% less than the weight-stable group. The authors concluded that food provision seemed insufficient to meet the greater metabolic demands for energy of the weight-losing group.

The energy requirements of a sample of 18 patients, from a long stay hospital in Glasgow, were estimated and compared to the energy intake estimated from a five day weighed food record (Fevre,1993). Only three of the group were consuming sufficient energy to meet their estimated energy needs.

In summary, it appears that energy intake and the energy content of food offered may not always meet the energy requirement of elderly people and energy intakes decrease as illness and dependency increase. Elderly people in long term care appear to be at risk of inadequate energy intake more so than free living elderly. Where energy requirements are not met low nutritional indices such as body weight, serum albumin levels and upper arm anthropometry are found. This will impact on the health and well-being of individuals.

1.5 Protein

As discussed in Section 1.2, lean body mass and therefore total body protein decreases with age. Studies have indicated that protein synthesis (Uauy et al, 1978), turnover (Golden et al, 1977) and breakdown (Lehmann et al, 1989) all decrease with age. With increasing age protein utilisation and the homeostatic mechanisms which control albumin synthesis may be less efficient (WHO, 1985) and common health problems in this group can further upset the balance between protein synthesis and degradation (Lehmann et al, 1989; Reeds and James, 1983; Beaumont et al , 1989). To minimise protein loss, it is vital that an adequate intake of energy is maintained as adequate energy exerts a protein sparing effect (DoH, 1992). The DoH (1992) indicated that the current UK Reference Nutrient Intakes for protein for the population aged 50 years and over (46.5g/d for women and 53.3g/d for men) were in good accord with the WHO (1985) recommendation of not less than 0.75g protein/ kg body weight/d. A study by Campbell et al (1994) on 12 healthy older men and women aged 56-80 years indicated, from short term nitrogen balance studies, that a safe recommended protein intake for the elderly is 1.0-1.25g protein/kg body weight/d. Evans (1995) suggests, using this revised recommendation for protein intake, that a large percentage of housebound elderly people consuming 0.67g protein/kg body weight/d (Bunker et al, 1987) must have been shown to be in negative nitrogen balance. Bunker & Clayton (1988) indicated that the housebound subjects, 7 men (mean age 78 years; range 69-85 years) and 13 women (mean age 78.8 years; range 70-82 years) with various chronic disorders, were in negative balance for nitrogen. However, whether their intake of protein was inadequate to maintain nitrogen balance or whether they had an increase need for nitrogen was not distinguishable. In the same study healthy free living elderly, 11 men (mean age 78.2 years; range 70-85 years) and 13 women (mean age 75.8 years; range 69-85 years), were found to be in nitrogen balance with a mean protein intake equivalent to 0.97g protein/kg body weight/d. It was stated that this was not a minimum requirement and lower intakes may also be adequate. In a study involving institutionalised elderly, 17 women and 4 men (mean age 81.7 years; range 63-89 years), mean protein intakes of 44.6g/d equivalent to 0.79g /kg body weight/d were found to be probably adequate compared to the WHO (1985) recommendation (Thomas et al, 1988). A study in 18 long term care elderly patients in Glasgow (Fever 1993) found the group were consuming adequate protein when compared UK Dietary Reference Values (DRVs) (DoH, 1991).

The compensatory response to a long-term decrease in dietary protein is a loss in lean body mass (Evans, 1995). The average intake of protein recorded in 1986/7 in adults aged 16-64 years were well in excess of the RNI value and the trend was for intakes to increase with age (Gregory et al, 1990). In the presence of disease, the coincidence of low intake, inefficient homeostasis and possible attendant anabolic demands, may mean that a higher intake of protein is necessary in the elderly (DoH, 1992) Further research into protein requirements of the elderly has been requested (DoH, 1992). However, until the evidence is available it would seem sensible to continue to use the RNI (DoH, 1991) and WHO (1985) protein recommendations when deciding protein adequacy for food offered and consumed in long term care elderly care.

1.6 Other nutritional issues

The study presented here was prompted after a 1992 North Ayrshire NHS Trust medical audit found that 66% of elderly NHS continuing care patients were on various laxative regimens. The laxatives were being used to aid problems of constipation in this patient group. Both fluid and non-starch polysaccharide (NSP) have been indicated in the development of constipation and as a result will be discussed in this thesis.

1.6.1 Fluid

Water is essential to all biological functions in the body (Steen and MacLannen, 1991). The loss of water may have profound consequences because of its essential role in the regulation of cell volume, nutrient transport, waste removal and temperature regulation (Schoeller, 1989). At birth the total body water accounts for approximately 80% of total body mass, but this slowly decreases to 60-70% in old age (Reiff, 1987). In a series of cross-sectional studies, it has been demonstrated that the changes in total body water with age are mainly due to the decline in body cell mass (Lesser and Markofsky, 1979; Shock et al, 1963). Water homeostasis depends on maintaining the balance between water intake and output. However, in the elderly, delayed and reduced diuresis and diminished thirst have been found which may lead to water imbalances (Lindeman et al, 1985; Pfeil et al, 1990; Phillips et al, 1984). Although thirst may well be diminished, fluid intake may be reduced deliberately through fear of incontinence or may be reduced due to inability to obtain adequate fluid. This has been found to be a common problem in the institutionalised elderly who are dependent on others to meet their needs (Pfeil, 1990). Hypernatraemic dehydration can occur when water losses via the skin, kidney, gastrointestinal tract and mucous membranes exceed the intake of water (Ross and Christie, 1969). Inadequate fluid intakes have been found to be a major factor in hypernatraemic dehydration which has a 60% mortality rate (Arieff et al, 1984). Individuals whose thirst mechanism is blunted or whose access to fluids is limited are particularly at risk of hypernatraemic dehydration, this including the elderly (Himmeistein et al, 1983). Dehydration in the elderly can also lead to depression, mental confusion, seizures, stupor and damage to the central nervous system (Chernoff, 1994). Hypernatraemic dehydration, sub-clinical dehydration and undernutrition were found to be common in a large Glasgow hospital for the mentally and physically disabled. However, they dealt with the problem successfully by introducing a 2.5-3.0 litre of fluid per patient per day policy, increasing the ratio of staff to patients and discontinuing the use of hypertonic enemas (Macdonald et al, 1989). Although this study was not conducted in the elderly, the authors indicated that similar problems could be found in elderly units.

1.6.2 Non-starch polysaccharide

The term NSP is a description of what is conventionally described as 'dietary NSP'. NSP includes all the carbohydrates of the plant cell wall which are not digested and absorbed in the small intestine. Unfortunately it has been difficult to assess claims for the therapeutic or preventive benefits of NSP because it cannot be defined or measured precisely and because of other nutrients consumed with NSP (DoH, 1992). The interest in NSP has mainly grown due to the link between NSP and constipation. Constipation is a recognised problem in the elderly, however its pathology is poorly understood (Varma et al, 1988). Depending on the definition, constipation is a condition which has been found to affect around 20% of the elderly population (Cummings et al, 1992), although other authors have indicated the rate to be higher at 34% for elderly women (Stewart et al, 1992; Hale et al, 1986) and 30% for elderly men (Whitehead et al, 1989). In Ayrshire's NHS continuing care elderly wards, 66% of elderly patients were on various laxative regimens to relieve problems with constipation at the time of this study (Unpublished North Ayrshire and Arran Trust, 1992.) Constipation is known to be more prevalent amongst institutionalised elderly (Kallman, 1983; Burkitt et al, 1979; Witchita, 1977; Zimring, 1978). It is the most common digestive complaint in the United States, with the greatest number of physician visits relating to this complaint in adults aged 65 years and over (Sonnenberg and Koch, 1989).

Constipation is of multi-factorial origin and factors associated with constipation include multiple medication, chronic illness, low energy intake, inadequate fluid and NSP intake and decreased activity (Stewart et al, 1992; Sandler et al, 1990; Everheart et al, 1989). Whitehead et al (1989) indicated a poor correlation between NSP and bowel function and Kinnuen (1991) and Donald et al (1985) found a poor correlation between constipation and both NSP and fluid. A cohort study by Towers et al (1994) on 36 free living elderly subjects, 18 constipated and 18 controls, found that the constipated subjects reported consuming fewer meals ($p=0.01$) and less energy ($p=0.07$) per day compared with controls. No differences were found in dietary NSP or fluid intakes. However, slow colonic transit time was significantly related to low energy intake ($p<0.0001$), higher protein diet ($p<0.05$), low fluid intake ($p<0.05$) and depression and anxiety ($p< 0.05$). The study concluded that constipation in the elderly is related to energy intake rather than NSP or any other dietary factor. Psychological symptoms were also highlighted as a possible etiologic factor in constipation.

Johnston et al (1988) found by comparing the NSP intakes, bowel function, lifestyle and medication of elderly nursing home residents and community dwelling elderly, that dietary NSP was only one part of the basis for inadequate large bowel function. In a long stay elderly population in Glasgow, energy, non-starch polysaccharide (NSP) and fluid intakes were found to be low (Fevre, 1993) which may increase the risk of developing constipation.

2. Aims and specific background to the studies undertaken

As noted earlier, this study was prompted as a result of an audit which found 66% of elderly NHS continuing care patients were suffering from constipation. Constipation has been found to be more prevalent in the older adult (Kallman, 1983; Burkett et al , 1979), with Cummings et al in 1992 suggesting that around 20% of the elderly population are affected. The number of patients suffering from constipation and on laxatives in the 1992 audit was therefore higher than expected. As inadequate intakes of energy, NSP and fluid have been indicated as one cause of constipation (Hope and Down, 1986; Fischer et al, 1985; Towers et al, 1994), the study was designed to estimate the dietary intakes of these nutrients and assess their adequacy.

As discussed above, the prevalence of low body weight and undernutrition in the institutionalised elderly population is high (Lipiski et al, 1993; DoH, 1992). The consequences of undernutrition are well documented, with low body weight being linked with higher mortality and morbidity rates (Sullivan et al, 1990; Robinson et al, 1987; Kings Fund Report, 1992). Therefore, the study primarily set out to assess the nutritional status of elderly NHS continuing care patients in Ayrshire and determine if they were undernourished. Secondly, food and fluid offered and consumed was assessed to determine if it was adequate to meet energy, protein, NSP and fluid requirements. These nutrients were concentrated upon as they are mainly linked with undernutrition and constipation.

As indicated above, social and environmental factors have been identified as possible causes for decreasing dietary intakes and undernutrition (Exon - Smith, 1980; Davies, 1990). Fenton (1989) related undernutrition found in one hospital to poor food provision, bad environment and lack of priority to nutrition by staff. This led to the present study observing environmental issues surrounding food and fluid provision.

2.1 Hypotheses

Hypotheses for the study were:

1. The nutritional status of NHS continuing care elderly people within four establishments in Ayrshire is poorer than free living elderly people of similar age and sex.
2. The nutritional content of food offered to and consumed by NHS continuing care elderly population in four establishments in Ayrshire is adequate in protein but inadequate in the following nutrients:

    → Energy

    → Fluid

    → NSP.

2.2 Aims

The aims of the study were:

1. To examine the nutritional status of a representative sample of NHS continuing care elderly patients in Ayrshire against community reference standards and published criterion for undernutrition.
2. To assess the nutritional content and adequacy of energy, protein, NSP and fluid in food and fluid offered and consumed by the elderly sample by comparison to current UK Dietary reference values and estimated energy expenditure (BMR x PAL 1.3 and 1.5).
3. To observe the eating environment of the majority of the sample.
4. To test the hypotheses.

3. Methods

3.1 Study design and overview

A cross sectional study was conducted in NHS continuing care patients within the Ayrshire and Arran Health Board area. Four establishments were randomly selected to participate, one of which was a private establishment with NHS contracted beds. All patients aged 60 years and over, in NHS long term care for three months or more were asked at the start of each site investigation for participation in the nutritional status, mental function and mental ability surveys. A proportion (66%) of this group was randomly sampled for inclusion in the dietary survey. Throughout the investigation of each site, an environmental survey of patients' eating environments, using qualitative methods, was conducted.

3.1.1 Nutritional status survey

The following anthropometric measurements were made on all subjects:-

1. weight (kg)
2. knee height (cm)
3. mid-arm-circumference (MAC) (mm)
4. triceps skinfold thickness (TSK) (mm)

3.1.2 Functional and mental ability survey

Functional and cognitive abilities were assessed by obtaining activities of daily living (ADL) scores (Mahoney, 1962) and abbreviated mental test (AMT) scores (Hodkinson, 1972) on each subject.

3.1.3 Dietary survey

A three day weighed dietary record was conducted on the randomly selected sub-sample of subjects and the nutrient content of food offered and consumed was assessed against published reference values (DoH, 1991). This proportion of the total number of subjects was chosen for purely pragmatic reasons, related to financial and time constraints.

3.1.4 Environmental survey

Using observational techniques, the eating environment and staff practice in relation to dietary provision were assessed.

3.2 Subjects

Subjects were recruited from the following four establishments within the Ayrshire and Arran Health Board area:-

1. Arranview Nursing Home, Saltcoats - Private nursing home with elderly contracted NHS beds (Investigated December 1993)
2. Ayrshire Central Hospital, Irvine - Mixed site hospital with continuing care beds for the elderly (Investigated January 1994)
3. Biggart Hospital, Prestwick - Continuing care hospital for the elderly (Investigated February 1994)
4. Kirklandside Hospital, Kilmarnock - Continuing care hospital for the elderly (Investigated April 1994)

At the beginning of each site investigation, details of patients' age, sex, medical history, duration of stay and eating ability were collected. Using this information potential subjects were recruited.

3.2.1 Inclusion criteria

To be included in the study subjects had to:

1. Have given verbal consent or assent on their behalf had to be provided by a relative or professional staff
2. Be aged 60 years or over
3. Have been in continuing care for 3 months or more
4. Be in a condition where they were well enough to withstand the investigations

3.2.2 Exclusion criteria

Exclusions were those patients who were:

1. Terminally ill and therefore unfit to participate
2. Suffering from a known malabsorptive disorder which would alter their nutritional status
3. Amputees whose anthropometric measurements would be misleading or difficult to interpret
4. On fluid restriction, as this might bias fluid results
5. Taking a liquidised diet, as assessing dietary intake would be difficult
6. Being enterally or parenterally fed and therefore not consuming a normal diet

A discussion on the excluded group can be found in Section 4.1.

No sample was taken as all patients who gave consent and did not fall under the exclusion criteria participated. After excluding patients on the criteria above, the remaining patients were asked verbally by their nurse to participate, if they agreed then the author explained the study in more depth and sought their verbal consent. It was explained to each patient that participating in the study did not affect their care in any way and they may withdraw from the study at any point. If patients were cognitively impaired then either the Consultant or nurse in charge of their care assented on their behalf. At the time the study was conducted, clinical audit did not require signed consent or ethical approval. Therefore, as the study was considered and funded as clinical audit these two items were not sought.

3.3 Nutritional status survey - anthropometric assessments

Anthropometric measurements were used to assess nutritional status by comparing the subject group results to the most appropriate age and gender specific reference values available.

Chumlea et al (1984) noted that inter-observer errors in elderly anthropometry were high. For this reason, one trained observer (the author) collected anthropometric data on each subject. Anthropometric measurements were made three times in each subject and mean values used.

3.3.1 Anthropometric reference data for the elderly

Reference data from two published sources were used for comparisons in this study to determine if the study group's nutritional state were normal: Burr and Phillips (1984) and Lehmann et al (1991). The Burr and Phillips reference data set was compiled from three community surveys conducted in South Wales in the 1970's. Over 1500 subjects were included from five elderly age groups which included people aged 85 years and over. The majority of subjects resided at home but a proportion (4% and 3% respectively) were residents of nursing/residential establishments and NHS continuing care wards. BMI, TSK, MAC, AMC and arm muscle area (AMA) were collected and compiled into percentile charts. BMI was calculated using standing height rather than estimates of height. This is the only set of published anthropometric percentile charts of its kind in the UK and is therefore commonly used (for example Reilly et al, 1995; Delarue et al, 1994). For these reasons it was used as the basis of comparisons for BMI and upper arm measurements in this study.

Lehmann et al (1991) compiled percentile charts from anthropometric information obtained during a demographically representative survey of 890 people age 65 years and over in the Nottingham area in the mid 1980's. All participants were well enough to live at home, unlike the Burr and Phillips (1984) study which included institutionalised elderly in the sample. In the Nottingham study, stature was estimated using demispan (half armspan) and not knee height. This made comparisons between the heights of subjects in this present study and the Nottingham reference data inappropriate due to the possible differences in each of the two calculations for estimated stature. Therefore, percentiles for body weight only were used for comparisons with the Nottingham data and percentiles for demiquet (body weight (Kg) / demispan(m^2)) and mindex (body weight (Kg) / demispan (m)) were not used.

3.3.2 Height

Obtaining height measurements is essential for determining body mass but obtaining standing height measurements in the group under study was impossible, therefore height was estimated using knee height as it has been found to correlate well with stature, especially when estimating mean heights of a population or group (Chumlea et al, 1985). It was therefore appropriate to compare the BMI of the study group with Burr and Phillips reference data, even though the height measurement used to calculate BMI was standing height for the reference data and estimated height in this present study.

Knee height was therefore used to estimate stature in this study. Knee height was assessed in each subject unless a deformity of the legs prevented collection. Measurements were taken as described in Gibson (1990). Measurements were made on the left leg while the subject sat upright or lay recumbent, with both knee and ankle joints bent at 90 degrees. A sliding broad blade calliper (SECA 209, SECA Weighing Limited, Weighing and Measuring Systems, 40 Barn Street, Birmingham) was used to measure the distance from the head of the fibula to the sole of the foot, and measurements were recorded in centimetres. Three measurements were collected and the mean value used in the calculations of Chumlea et al (1985) to estimate height:-

men: height (cm) = 64.19 + [knee height (cm) x 2.02] - [0.04 x age (y)]

women: height (cm) = 84.88 + [knee height (cm) x 1.83] - [0.24 x age (y)]

These equations were recently found to accurately predict stature (without bias) in a representative 118 non-institutionalised sample of free living elderly people aged 75 years and over in Edinburgh (Bannerman et al, 1997).

3.3.3 Body weight

All subjects were weighed in light clothing, wearing light shoes or slippers and after emptying the bladder. Subjects were weighed to within 0.1 kilograms on SECA chair scales (SECA 942, SECA Weighing Limited, Weighing and Measuring Systems, 40 Barn Street, Birmingham) by the author. Scales were calibrated at the beginning of the study period and once during the study. Weight measurements were used to calculate BMI, to estimate TEE, and estimate fluid and protein requirements. The mean body weight of the subjects aged 65 - 74 years and 75 years and over were compared with mean age and gender specific body weights given by Lehmann et al (1991) (see Table 6).

Table 6: Mean body weight of reference group (Lehmann et al, 1991)

Subject age and Sex	Number of subjects	Weight (Kg)
65-74 years		
males	205	72.5
females	257	64.5
75+ years		
males	153	68.6
females	275	59.7

3.3.4 Body mass index (BMI)

Weight / height ratios, like BMI, are commonly used indices of fatness in adult populations because of their simplicity. Several ratios have been used and all correct body weight for height in some way. Quetelet's index (weight (kg) / height $(m)^2$) is now a standard nutritional assessment index and has been suggested as the best choice but possibly only for those aged twenty to sixty-five years (Gibson, 1990). Using the definitions from the Scottish Health Survey 1995 (Scottish Office Department of Health, 1997) and EURONUT-SENECA (De Groot, 1991), the following BMI values were used to categorise nutritional status as underweight (BMI <20), desirable (BMI 20 - 24.9) , overweight (BMI 25 - 29.9) and obese (BMI >30).

Due to the lack of adequate body measurements which exist in elderly subjects, the exact relationship between BMI and percentage body fat has not been substantiated (Garrow 1983). As BMI cannot determine whether excess BMI is the cause of large adipose tissue stores, oedema, or large muscle mass, other measures of fatness such as skinfold thickness should also be employed (Frisancho and Flegel, 1982).

BMI has not been validated as a measure of fatness in elderly populations, partially due to the difficulty in obtaining accurate height measurements (DoH 1992). It has also been suggested that with the centralisation and internalisation of fat mass with advancing age, BMI distribution should be modified for use in the elderly (Deurenberg 1989). Nevertheless, BMI is still the most widely used measure of obesity (overnutrition and undernutrition). Although, the Scottish Health Survey (1997) did not include people aged over 65 years, EURONUT-SENECA (De Groot, 1991) (a major European study) involved only those aged over 65 years. The above factors were taken into account in this study and BMI was used with caution. BMI was determined using estimated height (from knee height), and compared to UK age and gender specific community reference values (Burr and Phillips, 1984) (see Table 7).

Table 7: Percentiles for BMI (Kg/m^2) (Burr and Phillips, 1984)

Age Group (years)	No. subjects	Percentiles						
		5th	10th	25th	50th	75th	90th	95th
men								
65-69	46	18.1	19.4	21.8	24.3	26.9	29.2	30.5
70-74	171	18.9	20.2	22.6	25.1	27.7	30.0	31.3
75-79	188	17.5	18.9	21.3	23.9	26.5	28.9	30.3
80-84	87	18.1	19.4	21.4	23.7	26.0	28.1	29.3
85+	41	17.9	19.0	21.0	23.1	25.2	27.2	28.4
women								
65-69	53	17.2	19.2	22.7	26.5	30.3	33.8	35.9
70-74	250	18.4	20.2	23.1	26.3	29.5	32.4	34.2
75-79	329	18.1	19.8	22.8	26.1	29.4	32.4	34.1
80-84	200	17.1	19.0	22.1	25.5	28.9	32.0	33.9
85+	88	16.7	18.2	20.8	23.6	26.4	29.0	30.5

3.3.5 Upper arm anthropometry

Anthropometric measurements are used to assess both fat and fat-free mass. Two of the body compartments (adipose tissue and muscle) become depleted in undernutrition. By assessing these two body compartments, nutritional status can be determined. Picking up any skinfold in elderly subjects and distinguishing between subcutaneous adipose tissue and muscle is said to be more difficult than in younger subjects. Bowman and Rosenberg (1982) found that in the elderly, the greater compressibility and/or poor tissue separation of skinfolds significantly influenced reliability. Taking these elements of error into consideration, one trained observer (the author) conducted upper arm anthropometry. Measurements were taken three times on each subject and mean values used.

3.3.6 Mid arm circumference (MAC)

MAC is an index of subcutaneous fat and muscle. A decrease in MAC indicates a reduction in fat and/or muscle mass. MAC is generally used as an indicator of protein/energy status, due to its correlation with muscle mass (Gibson 1990). Using a standard technique (Munro 1989, Gibson 1990), the circumference of the upper arm was measured at its mid point while subjects were seated. The mid point was located on the left arm of subjects, with the arm bent to a 90^0 angle at the elbow and the forearm placed palm down across the trunk. With the upper arm approximately parallel to the trunk the author measured and marked the mid point between the tip of the acromial process and the tip of the olecranon process. The arm was then repositioned to hang loosely by the side with the palm facing inward. Using a steel measuring tape (Holtain Limited, Croswell, Crymych, Dyfed), the circumference of the arm was taken at the marked mid point and recorded in millimetres. Care was taken not to squeeze the arm. As an index of body fat and muscle mass, MAC was compared to Burr and Phillips (1984) reference data (see Table 8).

Table 8: Percentiles for MAC (mm), (Burr and Philips 1984)

Age Group (years)	No. Subjects	Percentiles						
		5th	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**
men								
65-69	47	206	218	238	260	282	302	314
70-74	45	209	219	236	255	274	291	301
75-79	119	197	208	226	245	264	282	293
80-84	56	193	202	219	237	255	272	281
85+	31	189	198	213	230	247	262	271
women								
65-69	54	212	223	243	264	285	305	317
70-74	47	201	213	233	255	277	297	309
75-79	219	193	206	226	249	272	293	305
80-84	131	179	192	212	235	258	279	291
85+	75	164	176	198	221	245	266	278

3.3.7 Triceps skinfold thickness (TSK)

Durnin and Rahaman (1967) found TSK to provide an accurate estimate of the size of subcutaneous fat mass and an accurate estimate of total body fat. Obtaining skinfold thickness measurements is a standard practice in nutritional anthropometry. In the present study, since a large number of subjects were disabled, skinfold thickness was taken at the triceps only. This single site measurement seems suitable for an assessment of percentage body fat in women and children only and may be of limited value in the elderly (Gibson 1990). For this reason, percentage body fat of subjects was not calculated. Instead TSK was compared to Burr and Phillips (1984) reference values (see Table 9) as an index of body fatness.

Table 9: Percentiles for triceps skinfold thickness (mm), (Burr and Philips 1984)

Age Group (years)	No. Subjects	Percentiles						
		5th	10th	25th	50th	75th	90th	95th
men								
65-69	47	3.6	4.3	5.9	8.1	11.3	15.2	18.2
70-74	45	3.7	4.3	5.8	8.0	10.9	14.6	17.3
75-79	119	3.6	4.2	5.3	7.0	9.2	11.7	13.6
80-84	56	3.5	4.1	5.1	6.6	8.5	10.7	12.3
85+	31	3.4	3.9	5.0	6.5	8.4	10.6	12.2
women								
65-69	54	9.9	11.3	14.1	18.0	22.9	28.5	32.5
70-74	47	8.2	9.5	12.1	15.9	20.9	26.8	31.1
75-79	219	7.5	8.6	11.1	14.6	19.1	24.5	28.4
80-84	131	6.2	7.2	9.5	12.7	17.1	22.4	26.2
85+	75	6.0	7.0	8.8	11.5	14.9	19.0	21.8

TSK measurements were taken using a standard method (Gibson 1990). Measurements were taken at the mid point on the left arm using calibrated Holtain precision callipers (Holtain Limited, Croswell, Crymych, Dyfed) while subjects were seated. With the arm hanging loosely by the side and palm facing inward, a vertical fold of skin plus underlying fat, 1cm above the marked mid point, was grasped using the thumb and forefinger. The skinfold was then gently pulled away from underlying muscle, and then calliper jaws were applied at right angles at the mid point. While the measurements were being taken the skinfold was held between the fingers. Readings were read 2 -3 seconds after the calliper jaws were closed. Measurements were recorded to 0.2mm.

3.3.8 Arm muscle circumference and area

As an assessment of muscle mass and nutritional status, AMC, AMA and corrected arm muscle area (cAMA) were calculated using MAC and TSK results:

$$\text{AMC (mm)} = \text{MAC (mm)} - (\pi \times \text{TSK (mm)}) \qquad \text{(Gibson, 1990)}$$

$$\text{AMA (mm}^2) = \frac{(\text{MAC (mm)} - (\pi \times \text{TSK (mm)}))^2}{4\pi} \qquad \text{(Gibson, 1990)}$$

$$\text{cAMA} = \frac{(\text{c1} - (\pi \times \text{TSK}))^2}{4\pi} - 6.5 \text{ for women}$$

$$\text{cAMA} = \frac{(\text{c1} - (\pi \times \text{TSK}))^2}{4\pi} - 10.0 \text{ for men}$$

Where cAMA = corrected mid upper arm muscle area (cm^2), c1 = MAC (cm) and TSK (cm) (Heymsfield et al, 1982).

AMC and AMA were compared to Burr and Phillips (1984) reference data (see Tables 10 and 11). The above cAMA calculations have not been validated as indices of whole body muscle mass for use in elderly subjects but unlike other calculations of arm muscle area, these measure absolute bone-free arm muscle area which reduces the average error. The cAMA is widely used in nutritional assessment of elderly patients (Lipiski et al, 1993; Friedman et al, 1985; Potter et al, 1995). Corrected arm muscle values of below 16cm^2 for men and 16.9cm^2 for women are indicative of severe muscle wasting (Lipiski et al, 1993; Friedman et al, 1985; Potter et al, 1995). These values were therefore adopted to define undernutrition in the present study and the number and percentage of subjects falling below these values was recorded.

Table 10: Percentiles for AMC (mm), (Burr and Philips 1984)

Age Group (years)	No. Subjects	Percentiles						
		5th	10th	25th	50th	75th	90th	95th
men								
65-69	47	187	196	213	231	249	266	275
70-74	45	184	194	209	227	245	260	270
75-79	119	182	190	205	221	237	252	260
80-84	56	176	184	199	215	231	246	254
85+	31	172	180	193	208	223	236	244
women								
65-69	54	163	172	187	204	221	236	245
70-74	47	158	168	184	201	218	234	244
75-79	219	161	169	184	200	216	231	239
80-84	131	151	160	175	192	209	224	233
85+	75	141	150	165	182	199	214	223

Table 11: Percentiles for AMA (mm^2), (Burr and Philips 1984)

Age Group (years)	No. Subjects	Percentiles						
		5th	10th	25th	50th	75th	90th	95th
men								
65-69	47	2680	3040	3650	4320	4990	5420	5960
70-74	45	2710	3030	3560	4140	4720	5250	5570
75-79	119	2530	2840	3360	3940	4520	5040	5350
80-84	56	2370	2660	3160	3710	4260	4760	5060
85+	31	2270	2540	2980	3470	3960	4400	4670
women								
65-69	54	2020	2310	2810	3350	3890	4390	4680
70-74	47	1840	2160	2690	3270	3850	4380	4700
75-79	219	1970	2240	2710	3230	3750	4220	4490
80-84	131	1720	2000	2460	2970	3480	3940	4220
85+	75	1430	1700	2170	2690	3210	3680	3950

3.3.9 Classification of undernutrition

As noted earlier, there is no single universally accepted criterion for determining undernutrition in the older adult (Bannerman et al, 1997; Kerstetter et al, 1992) and this may have a large part to play in the varying percentages of undernutrition reported in different institutionalised elderly populations. To try to determine the prevalence of undernutrition in the study sample and show the variations which can occur with the use of different criteria, various definitions for undernutrition were applied to the data. These were those most commonly used in the literature, as follows:-

1. BMI < Burr and Phillips (1984) 5th percentile and/or cAMA of <16cm^2 for men and 16.9 cm^2 for women (eg used by Potter et al , 1995)
2. BMI < 20 (eg used by the Scottish Office Department of Health, 1997; EURONUT-SENECA (De Groot, 1991))
3. cAMA <16cm^2 for men and 16.9cm^2 for women (recommended by Friedman et al, 1985; Lipski et al, 1993)

Each of the above criteria identifies undernutrition using one or more anthropometric index and 'cut off' points.

3.4 Dietary survey

At the beginning of each site investigation 66% of the subject group were randomly selected to participate in the dietary survey. The weighed food and fluid record is the most precise and accurate method of determining the usual nutrient content in food offered and consumed (Gibson, 1990).

A three day dietary survey is not as accurate or precise as measuring food and fluid over a longer period, but in institutionalised elderly populations day to day dietary variation is reduced compared to free living people (Barnes and Hodkinson 1988). Due to this small variation in dietary habits of elderly continuing care patients, probably due to the cyclic nature of hospital menus, food and fluid was recorded over three consecutive weekdays rather than seven consecutive days (Barnes and Hodkinson, 1988).

Random and/or systematic errors may occur during the measurement of food, fluid and/or nutrients (Gibson 1990). To decrease such errors within the present study the following measures were undertaken:

1. One observer (the author) measured and recorded all formal meals
2. Trained observers (nursing and domestic staff) recorded offered and wasted food and fluid in household measures (eg 1 slice of white toast, butter and jam , a cup of tea with milk and 1 sugar) on a standardised form (see appendix 1) during the periods the author was unavailable eg during the late evening and night.
3. Household measures were used between formal meals with dietary items that were frequently used eg biscuits, cups of tea, squash. These items were weighed three times at the start of each ward investigation and the mean values used thereafter.
4. The same observer (the author) who conducted the weighed survey coded and inputted data into the computerised nutritional analysis programme
5. Computerised data were checked twice before calculating the nutritional content of food offered and consumed
6. Recipes for meals were gathered at each site and used in calculating nutrient intake.

Over the three day period, one observer (the author) accurately weighed , using Tanita-TLD - 612 electronic digital scales (Marsden Weighing Machine Group Limited, Head Office, 388 Harrow Road, Paddington, London), all formal meals from Tuesday to Thursday. Weekend days were not included as staff felt there was no change in the eating habits of residents at the weekends, and this was supported by inspection of weekend day choices and by Barnes and Hodkinson (1988). All food items at breakfast, lunch and evening meal were weighed independently to the nearest 0.5g, using the tare facility on the scales. The meal was weighed onto clean warm plates to avoid a change in temperature or disrupted presentation of the meal. Wasted food was weighed in the same fashion. Food offered and wasted was recorded separately on standard recording sheets. Subjects' intakes were calculated by deducting plate waste from food offered.

Snacks and fluids offered and consumed between meal times were recorded using household measures. During the day the author recorded such items on a standard form. During the times the author was not present on the ward, nursing staff recorded any items offered to or consumed by subjects. The nursing staff were trained to carry out this duty prior to commencement of the study. The next day, the author would check recorded data for accuracy and completeness with staff and subjects.

The computerised nutritional analysis programme Comp-Eat Version 4.0 (Nutrition Systems, 1993), which is a computerised version of McCance and Widdowson's, "The Composition of Foods"(RCC and MAFF, 1992), was used to analyse the collected data on food and fluid offered and consumed. Recipes of dishes from each site were created and used in the analysis as many of the dishes consumed by subjects were not available on the Comp-Eat 4 database. This should have increased the accuracy of the nutrient results except for nutrients which are affected by heat and light (notably vitamin C and folate). The mean value of the three day nutrient content in food offered and consumed was used and compared to appropriate age and gender specific reference values (DoH, 1991 and 1992). Comp-Eat 4 analyses 31 nutrients automatically but only those nutrients significantly below reference values and of interest are presented and discussed in this thesis. Nutrients found to be of interest and their reference values were as follows:

1. Energy was compared to estimated average requirements and to BMR and ETEE (DoH, 1991, 1992). Calculations for estimating TEE were based on Schofield et al (1985) from 50 men and 38 women over 60 years of age. Data from this group were then collated with data on 101 men aged 60-70 years studied by Durnin, and with unpublished data on 170 men and 180 women supplied by Ferro-Luzzi. Calculations used for predicting estimated BMR (MJ/d) were as follows:-

Male	60-74 years	0.0499 weight (kg) + 2.930
	75+ years	0.0350 weight (kg) + 3.434
Female	60-74 years	0.0386 weight (kg) + 2.875
	75+ years	0.0410 weight (kg) + 2.610

It is accepted that energy expenditure in the elderly declines due to decreased body weight and reduced activity, as discussed in Sections 1.4 and 5.4 However, to prevent an incremental approach to energy requirements, a 1.5 x BMR has been recommended (DoH, 1992). A 1.3 x BMR may be adequate for those elderly spending approximately 1 hour per day on their feet (DoH, 1992) but, as the subject group in the present study were very inactive, a 1.2 x BMR calculation could also have been used as Shetty et al (1996) and Black et al (1996) found a PAL of 1.2 to be more suitable for the bed or chair bound. However, a PAL of 1.2 is lower than the 1.27 PAL indicated by the WHO (1985) as the minimum survival requirement and therefore, was not considered appropriate. It is beyond the scope of this study to determine the PAL of the group as measured TEE would be required. Therefore, energy requirements of the subjects were calculated as BMR x 1.5 and 1.3. Energy content of food offered and consumed was compared against these calculated energy requirements and the estimated average energy requirement (DoH 1992, 1991).

2 **Protein** was compared to dietary reference values and individual protein requirements using WHO (1985) and DoH (1992) recommendation of 0.75g protein/ kg body weight/day.

3. **NSP** was compared with dietary reference values (DoH, 1991)

4. **Fluid** was compared to the reference value 30ml/kg body weight/day (Lipschitz, 1992)

It was felt inappropriate to discuss the vitamin and mineral adequacy of the diet in detail without having conducted any laboratory assessments to objectively assess subjects' vitamin and mineral status. Therefore, nutrients found to be significantly below the RNI are presented briefly in Section 4.5 only as an indicator of the general adequacy of the diet. All nutrients analysed were presented in a separate report for Ayrshire and Arran Health Board and the detailed results of food offered and consumed compared to lowest reference nutrient intake (LRNI), estimated average requirement (EAR) and reference nutrient intake (RNI) (DoH, 1991, 1992) by age, sex and site are outlined in Appendix 2.

3.5 Cognitive and functional ability survey

There are many different types of assessment tool for functional and mental ability. Within the North Ayrshire and Arran NHS Trust's Geriatric Medical Directorate the Barthel Activity of Daily Living Scale (Appendix 3) and Hodkinson's Abbreviated Mental Test (Appendix 4) are the preferred measures of function and mental ability (Mahoney ,1962, Hodkinson, 1972). Both assessment tools are recommended by the British Geriatric Society, are widely used by medical and nursing staff and are seen as reliable and valid (Collin et al, 1988; Wade et al, 1988; Hodkinson, 1972). It was for this reason that these two assessment tools were used in the present study.

3.5.1 Mental tests

The abbreviated mental tests (detailed in Appendix 4) were conducted by the author while subjects were sitting comfortably. Ten questions were asked (Hodkinson, 1972) . Scores between 8 - 10 were indicative of normal mental ability while scores below 8 were indicative of mental impairment (Royal College of Physicians, 1992). Those subjects who were unable to communicate or were dysphasic did not receive a score. The number and percentage of subjects scoring below 8 was calculated to characterise the level of mental ability in the study group.

3.5.2 Functional tests

The nurse in charge of each ward scored subjects' functional ability using the Barthel Scoring system (Mahoney and Barthel, 1962). Scores of below 40 are used by North Ayrshire and Arran Medical Geriatric Team as indicative of high dependency. The number and percentage of subjects scoring below 40 was assessed to determine the dependency level of the study population.

3.6 Environmental survey

As environmental and social factors have been indicated as altering the dietary intakes of elderly people (Davies, 1990, Fenton 1989), the study groups' eating environment was assessed by direct observation. Observations were conducted by one observer (the author) during the three day weighed dietary survey and staff were not informed of this aspect of the study. In this way, staff were unaware that observations of their ward and their practice were in progress. By conducting observations in this manner it was hoped that a reasonable reflection of the ward environment would be gained. Observations were unstructured so that a free descriptive account of the ward could be taken. From this information, a check list was developed for future audits. There were several areas which the author did seek to assess within each establishment. These areas of specific interest observed were: menus (eg were they designed for the elderly); room and seating arrangements (was the room homely and were residents seated in small social settings); crockery and cutlery used (was crockery institutional or homely); drink and snack provision (was choice provided); meal provision (were residents given choice of meals, were they provided with the meal they ordered); meal system used (was the meal system bulk or plated); nutritional screening practices (were residents nutritionally screened); social and physical activities (were residents encouraged to undertake social and physical activities); staffing numbers at mealtimes; residents choice (were residents give they choice of where to eat their meals). Any differences between sites were noted. It was realised that the information gathered was subjective and therefore open to bias.

3.7 Statistical analysis

All data were checked for normal distribution either using stem and leaf plots and/or using the Cochrane C test together with the Levene Statistic (Caswell, 1995; SPSS,1994). Once normality was established, one and two sample t-tests and one way analysis of variance F-tests were performed to determine if there was any difference between:

1. Anthropometric data between sites
2. Anthropometric data between the study group and reference groups
3. Nutrient content of food offered and consumed and dietary reference values
4. The mental and functional ability of subjects between sites

Any differences found were checked for significance at the 5% level (p values < 0.05).

For all measurements and parameters which were normally distributed, mean values, standard deviations and ranges are presented. For data which were not normally distributed, median, 25th and 75th percentiles and range are presented. Statistical analysis was conducted jointly by the author and Miss Leslie Sinclair (Statistician, North Ayrshire and Arran NHS Trust) using the computerised statistical package - SPSS PC Version 6.1 (1994).

4. Results

4.1 Description of the resident group

Within the four sites, 277 people were identified as receiving continuing care. Using the exclusion criteria, 61 people were omitted from participating in the study and 216 people were recruited. Unfortunately, due to time lapse between subject selection and investigation, 20 recruited subjects either died or were transferred to nursing homes. From the final subject total of 196, 132 subjects were randomly selected to participate in the dietary survey. Table 12 gives details of the study sample at each site.

4.1.1 Excluded resident characteristics

Of the 61 excluded residents, 9 were from the Arran View private nursing home NHS contracted beds, 12 from Ayrshire Central Hospital, 16 from Biggart Hospital and 24 from Kirklandside Hospital. Thirty two were on liquidised dietary regimens; 10 were amputees; 6 had malabsorptive disorders; 2 were terminally ill; 5 were enterally fed and 6 residents were aged less than 60 years. The mean age of those excluded was 80.4 years (*SD* 9.2 years, range 58 - 101 years). The excluded residents therefore did not differ greatly in age from those included in the study.

4.1.2 Subjects' age, sex and diagnosis

The study participants consisted of 49 males with a mean age of 77.7 years (*SD* 6.1 years, range 64 - 90 years) and 147 females with a mean age of 84.2 years (*SD* 7.7 years, range 64 - 96 years). The male to female ratio of subjects was 1:3. Subjects arrived in continuing care direct from an elderly acute ward or from home. Medical reasons for admission were varied but can be summarised as follows:

Diseases of the central nervous system - 117 subjects (60%)

Dementia - 30 subjects (15%)

Other eg fractures, osteoarthritis - 24 subjects (12%)

Inability to cope at home - 23 subjects (12%)

Diseases of the cardiovascular system - 10 subjects (5%)

Malignancy states - 4 subjects (2%)

These were the principal diagnoses of subjects, although in most cases patients were suffering from two or more medical problems. Length of stay in continuing care ranged from 3 to 267 months with a mean stay of 28.8 months (median 17 months, 25th percentile 5 months, 75th percentile 34 months). Duration of hospital stay was not normally distributed. Age, sex and length of stay variations between sites are detailed in Table 12.

Table 12: Subject characteristics by site

Site	No. of Subjects	No. of Subjects Dietary Survey	No. of Males	No. of Females	M:F Ratio	Mean Age (years)	SD (years)	Mean Stay (mths)	Median Stay (mths)	Range of Stay (mths)
Arran View	42	28	12	30	1:2.5	83	7.49	14.5	17	3-35
Ayrshire Central	48	32	15	33	1:2	83	8.02	28.9	11.5	3-267
Biggart	50	35	12	38	1:3	83	7.88	45.3	28	3-241
Kirklandside	56	37	10	46	1:4.5	83	8.19	29.4	21.5	3-166
All Sites	196	132	49	147	1:3	82.5	7.9	28.8	17	3-267

M:F Ratio - Male to Female Ratio

4.2 Functional and cognitive ability survey

4.2.1 Functional ability at the four sites

The subjects were already identified as dependent in activities of daily living by the medical staff, therefore Barthel scores were expected to be low. Table 13 details the variations in Barthel scores of subjects between sites. One subject was omitted at Biggart Hospital in error. Arran View had the highest mean score of 43 and Kirklandside the lowest at 28, while Ayrshire Central and Biggart scores fell between these two extremes at 36 and 27 respectively. Mean Barthel scores at Biggart and Kirklandside Hospitals were significantly lower than the mean score at Arran View. This difference could be related to subjects at Arran View being in care for a shorter period (mean stay was 14.7 months compared to 44.9 months at Biggart and 29.4 months at Kirklandside) or due to the higher number of males aged over 80 years found at Biggart and Kirklandside Hospitals. There were no significant differences detected, between sites, for female subjects or those under the age of 80 years. The Barthel Activity of Daily Living Scale is described in detail in Appendix 3.

Table 13: Barthel scores by site

Site	Number of Scores	Mean	SD	Median	Range
Arran View	42	43	31	40	0-95
ACH	48	36	28	28	0-90
Biggart	49	27	24	20	0-95
Kirklandside	56	28	22	20	0-85
All Sites	195	33	27	25	0-95

4.2.2 Mental ability at the four sites

There were no significant differences in mental test scores of subjects between sites. Mean scores at each site were all below 8 indicating some degree of mental function impairment. Only 24% of the sample (37 subjects) indicated a normal cognitive function by scoring above 8. Table 14 shows the mental test scores of subjects by site. As referred to in Section 3.5.1, a number of subjects who were unable to communicate or were dysphasic did not receive a score. The mental test is detailed in Appendix 4.

Table 14: Abbreviated mental test scores by site

Site	Number of Scores	Mean	SD	Median	Range	Percentage below Score of 8
Arran View	35	5	3.5	4	0-10	77
ACH	43	4	3.1	4	0-10	84
Biggart	34	5	3.1	5	0-10	76
Kirklandside	45	4	3.6	3	0-10	69
All Sites	157	4	3.3	4	0-10	76

4.3 Nutritional status survey

4.3.1 Site similarities

Before combining the anthropometric measurements of subjects from each site it was important to determine if there were any differences in these data between sites. Therefore, sample sizes were broken into two large age and sex bands and a one way analysis of variance F-Test was conducted. Table 15 shows the summary of the F-Test. No significant differences were detected between the 4 sites for any of the anthropometric measurements.

Although some differences between sites were apparent in functional ability, it was considered appropriate to combine the anthropometric data from sites and use as a single data set as no significant differences were detected in anthropometric measurements, mental function and age.

Table 15: p-values of anthropometric measurement differences

Measurement	Males Aged < 80 years	Males Aged >= 80 years	Females Aged < 80 years	Females Aged >= 80 years
MAC	0.1365	0.7774	0.7524	0.3800
TSK	0.5376	0.2940	0.8565	0.0590
AMC	0.3658	0.9464	0.3964	0.1963
AMA	0.3731	0.9404	0.4068	0.2968
WEIGHT	0.1788	0.9178	0.4416	0.4698
BMI	0.2089	0.7910	0.5774	0.1382

p-values < 0.05 considered significant

4.3.2 Anthropometric measurements of study sample

Formal statistical tests were carried out on all anthropometric data to establish if the data were normally distributed. On examination of normal probability plots and the Cochrane C Test together with the Levene statistic it was found that all anthropometric measurements did not vary greatly from a normal distribution or violate equality of variance in any of the age and gender groups.

The anthropometric of the male and female study sample are summarised in Table 16. When mean results of the sexes are compared there are clear significant differences in the fat, fat free mass, height and weight of males and females but not BMI. Men were heavier (mean 63.4 kg) than women (mean 53.3 kg) and taller (mean 165.3cm) than women (mean 151.3cm); had larger MAC (mean 257.3mm) , AMC (mean 227.1mm), AMA (mean 4154.4 mm^2) and cAMA (mean 31.6 cm^2) compared to women (MAC mean 241.3mm; AMC 202.7mm; AMA 3333.5mm^2; cAMA 26.9cm^2). Women had larger TSK (mean 12.3 mm) than men (mean 9.8mm) and both sexes had similar BMI (men mean 23.2; women mean 23.3).

Table 16: Anthropometric measurements of males and females

Measurement	**Number of subjects**		**Mean**			**SD**		**Range**	
	Male	*Female*	*Males*	*Female*	*Difference*	*Males*	*Females*	*Males*	*Females*
Body weight (kg)^	49	142	63.4	53.3	10.1*	10.5	11.5	42.6 - 86.6	30.3 - 93.2
Height (cm)^	49	143	165.3	151.3	14.0*	5.9	5.6	154.3 - 178.3	119.4 - 164.9
MAC (mm)	49	144	257.3	241.3	16.2*	29.2	40.0	192 - 308	155 - 391
TSK (mm)	49	144	9.8	12.3	2.6*	3.9	5.7	3.4 - 19.7	2.0 - 31.1
AMC (mm)	49	144	227.1	202.7	24.3*	25.9	28.0	175 - 281	130 - 326
AMA (mm^2)	49	144	4154.4	3333.5	820.9*	931.9	952.2	2435 - 6269	1346 - 8472
cAMA (cm^2)	49	144	31.6	26.9	4.6*	9.3	9.5	14.4 - 52.8	7.1 - 78.2
BMI^	49	142	23.2	23.3	0.1	3.5	4.7	16.7 - 31.7	13.3 - 38.7

^ Not all anthropometric measurements could be undertaken on all female subjects

* Significant difference between male and female values detected ($p<0.05$)

4.3.3 Anthropometric measurements: comparisons with UK Reference Data

As no differences were found in any of the anthropometric measurements of subjects between sites, BMI, MAC, TSK, AMC and AMA results were compiled into percentile charts for men and women in the following age bands: 65-69 years; 70-74 years; 75-79 years; 80-84 years and 85+ years. These were then used to assess if the anthropometric measurements of the study sample differed significantly from reference data for community elderly within the UK. If the group was found to have lower anthropometric measures then this indicates they are nutritionally compromised compared to community elderly. Six subjects fell out-with the age bands and were therefore omitted from comparisons to the reference data. The younger age bands (65-69 years and 70-74 years) in both sexes had small numbers (<10) and therefore the results from these groups must be viewed with caution. Tables 17 - 21 show anthropometric percentiles for the study sample compared with Burr and Phillips (1984) reference group from South Wales. One sample t-tests were used to test the significance of anthropometric differences between the two groups. Further discussion on these results is provided in Section 5.3.

4.3.3.1 Body mass index compared to Burr and Phillips data

Throughout the female percentile range, BMI was on average 1 -2 kg/m^2 lower than the reference group (see Table 17). At the 5th percentile, 8% (n=15) of the group (n=185; males n=48; females n=137) (10% (n=5) of males and 7% (n=10) of females) were below reference value; at the 10th percentile this applied to 15% (n=28) of the group (13% (n=6) of males and 16% (n=22) of females). In contrast the percentage of the group falling above the 95th percentile was similar to the reference. Therefore, as the percentage of subjects falling below the 5th and 10th percentiles was high and the number above the 95th similar, this indicates that the group was leaner than reference sample. Statistically, when the study group's BMI mean was compared to the reference 50th percentile, only in the female groups aged 75-79 years and 80-84 years was BMI found to be significantly lower ($p < 0.001$ and $p=0.05$ respectively) than the reference sample. This information suggests that the female study group was leaner than reference only in the older age groups. This may be related to the low sample size in the younger age bands having inadequate power to detect a difference. A decline in BMI from the age of 70 years onwards was present.

4.3.3.2 Mid arm circumference compared to Burr and Phillips Data

In general, the study sample's MAC was slightly higher than the reference (see Table 18). This trend was seen in both sexes. MAC was significantly higher in females aged 85+ years ($p = 0.015$) and males aged 75-79 years ($p = 0.006$) when mean MACs were compared to reference 50th percentiles. A trend of decreasing MAC was seen in both sexes from the age of 70 years onwards.

4.3.3.3 Triceps skinfold thickness compared to Burr and Phillips Data

There was a trend, in both sexes, for TSK to decline with age and for TSK to be larger in females than males throughout the percentile range (see Table 19). Compared to the reference, male TSK percentiles were generally higher but female TSK percentiles were similar or lower. The percentage of TSK measurements falling below the 5th percentile was 7% (n=14) in the group (n=187; males n=48; females n=139) (0% for males and 10% (n=14) for females); at the 10th percentile 11% (n=21) of the group (4% (n=2) of males and 14% (n=19) of females). Study males aged 75-79 years and 80-84 years had significantly higher mean TSK measurements than the reference 50th

percentile ($p = 0.038$ and $p = 0.082$ respectively) but no significant differences were detected in the female data.

4.3.3.4 Arm muscle circumference compared to Burr and Phillips Data

There was a trend for AMC to decline with age in both sexes but this was not consistent through all the percentile range (see Table 20). The AMC percentiles for the study male group were generally higher than females. Compared to the reference, male percentiles were similar but female percentiles tended to be higher. However, only females in the age groups 80-84 years and 85+ years had higher mean AMC than the reference 50th percentile, and this reached statistical significance ($p<0.001$ for both).

4.3.3.5 Arm muscle area compared to Burr and Phillips Data

As with AMC, there was a trend for AMA to decline with increasing age within the study sample but this was not as consistent as in the reference group (see Table 21). The male study sample had higher AMA than females throughout the percentile range. Male AMA percentiles were similar to and female percentiles higher than the reference. Statistically, no significant difference was found between mean AMA for men at the 50th percentile of the reference group but in the females 80 - 84 years and 85+ years group AMA was higher and the differences were statistically significant ($p= 0.003$ and $p < 0.001$ respectively).

4.3.3.6 Body weight compared to Lehmann et al data

Mean body weights of males and females were compared to the mean body weights of a reference group described by Lehmann et al (1991). The mean weight of males aged 65-74 years was 64.7 kg (*SD* 13.3kg) and this was lower, but not significantly lower, than the reference mean of 72.5 kg (*SD* 12.6 kg, $p = 0.080$). Men aged 75 years and older had a significantly lower mean body weight of 62.9 kg (*SD* 9.8kg) compared to the reference group mean of 68.6 kg (*SD* 11.4 kg , $p < 0.001$). The female data followed a similar trend to the males. For females aged 65-74 years, mean weight was 61.7 kg (*SD* 15.6 kg) which was lower than the reference mean of 64.5kg (*SD* 13.3 kg) but this difference was not statistically significant ($p = 0.541$). Females aged 75 years and over had a mean weight of 52.3kg (*SD* 10.7kg) which was significantly lower than the reference 59.7kg (*SD* 11.6, $p<0.001$). The study group aged 75+ years had significantly lower mean body weight than the reference ($p< 0.001$).

Table 17 Percentiles for Body Mass Index
Ayrshire and Arran Health Board Subjects (AAHB) vs Burr and Phillips (BURR)

Age group (years)		No.	Percentiles 5th	10th	25th	50th	75th	90th	95th
Men									
65-69	AAHB	4	17.0	17.0	17.2	19.4	24.4	25.6	25.6
	BURR	46	18.1	19.4	21.8	24.3	26.9	29.2	30.5
70-74	AAHB	7	16.7	16.7	21.2	24.4	27.4	27.8	27.8
	BURR	171	18.9	20.2	22.6	25.1	27.7	30.0	31.3
75-79	AAHB	18	19.9	20.4	21.8	23.9	26.4	29.0	29.3
	BURR	188	17.5	18.9	21.3	23.9	26.5	28.9	30.3
80-84	AAHB	10	16.9	17.0	19.3	22.3	25.0	31.1	31.7
	BURR	87	18.1	19.4	21.4	23.7	26.0	28.1	29.3
85+	AAHB	9	18.2	18.2	19.7	22.0	24.7	27.5	27.5
	BURR	41	17.9	19.0	21.0	23.1	25.2	27.2	28.4
Women									
65-69	AAHB	4	16.1	16.1	17.0	23.8	28.8	29.0	29.0
	BURR	53	17.2	19.2	22.7	26.5	30.3	33.8	35.9
70-74	AAHB	8	16.8	16.8	21.8	27.2	30.3	36.0	36.0
	BURR	250	18.4	20.2	23.1	26.3	29.5	32.4	34.2
75-79	AAHB	18	18.1	18.6	19.9	23.0	23.4	27.0	28.9
	BURR	329	18.1	19.8	22.8	26.1	29.4	32.4	34.1
80-84	AAHB	39	16.9	17.0	19.9	23.6	26.1	31.9	34.6
	BURR	200	17.1	19.0	22.1	25.5	28.9	32.0	33.9
85+	AAHB	68	16.0	17.6	19.7	22.3	25.4	29.7	30.6
	BURR	88	16.7	18.2	20.8	23.6	26.4	29.0	30.5

Table 18 : Percentiles for MAC (mm)
Ayrshire and Arran Health Board Subjects (AAHB) vs Burr and Phillips (BURR)

Age group (years)		No.	Percentiles 5th	10th	25th	50th	75th	90th	95th
Men									
65-69	AAHB	4	205	205	215	251	267	270	270
	BURR	47	206	218	238	260	282	302	314
70-74	AAHB	7	194	194	242	268	294	308	308
	BURR	45	209	219	236	255	274	291	301
75-79	AAHB	18	212	234	241	271	282	296	298
	BURR	119	197	208	226	245	264	282	293
80-84	AAHB	10	192	196	235	257	285	303	305
	BURR	56	193	202	219	237	255	272	281
85+	AAHB	9	205	205	218	253	273	280	280
	BURR	31	189	198	213	230	247	262	271
Women									
65-69	AAHB	4	186	186	201	263	285	286	286
	BURR	54	212	223	243	264	285	305	317
70-74	AAHB	8	199	199	237	279	305	343	343
	BURR	47	201	213	233	255	277	297	309
75-79	AAHB	18	190	202	228	245	269	301	310
	BURR	219	193	206	226	249	272	293	305
80-84	AAHB	39	170	182	224	246	276	288	306
	BURR	131	179	192	212	235	258	279	291
85+	AAHB	70	176	194	215	227	242	275	314
	BURR	75	164	176	198	221	245	266	278

Table 19 : Percentiles for TSK (mm)
Ayrshire and Arran Health Board Subjects (AAHB) vs Burr and Phillips (BURR)

Age group (years)		No.	Percentiles 5th	10th	25th	50th	75th	90th	95th
Men									
65-69	AAHB	4	5.1	5.1	5.3	7.4	10.7	11.3	11.3
	BURR	47	3.6	4.3	5.9	8.1	11.3	15.2	18.2
70-74	AAHB	7	6.1	6.1	6.9	8.3	16.7	18.3	18.3
	BURR	45	3.7	4.3	5.8	8.0	10.9	14.6	17.3
75-79	AAHB	18	4.7	5.3	7.3	11.7	13.0	17.4	19.7
	BURR	119	3.6	4.2	5.3	7.0	9.2	11.7	13.6
80-84	AAHB	10	3.6	3.7	5.8	10.2	11.4	12.8	12.9
	BURR	56	3.5	4.1	5.1	6.6	8.5	10.7	12.3
85+	AAHB	9	3.4	3.4	6.3	7.8	12.1	13.1	13.1
	BURR	31	3.4	3.9	5.0	6.5	8.4	10.6	12.2
Women									
65-69	AAHB	4	7.7	7.7	9.1	14.4	23.5	26.2	26.2
	BURR	54	9.9	11.3	14.1	18.0	22.9	28.5	32.5
70-74	AAHB	8	10.2	10.2	10.7	17.7	20.4	31.1	31.1
	BURR	47	8.2	9.5	12.1	15.9	20.9	26.8	31.1
75-79	AAHB	18	4.1	6.2	9.7	12.5	19.7	22.8	25.9
	BURR	219	7.5	8.6	11.1	14.6	19.1	24.5	28.4
80-84	AAHB	39	5.3	6.8	9.0	10.9	14.1	17.5	21.1
	BURR	131	6.2	7.2	9.5	12.7	17.1	22.4	26.2
85+	AAHB	70	4.6	5.4	8.0	10.1	12.6	16.6	22.8
	BURR	75	6.0	7.0	8.8	11.5	14.9	19.0	21.8

Table 20 : Percentiles for AMC (mm)
Ayrshire and Arran Health Board Subjects (AAHB) *vs* Burr and Phillips (BURR)

Age group (years)		No.	Percentiles						
			5th	10th	25th	50th	75th	90th	95th
Men									
65-69	AAHB	4	186	186	197	229	234	235	235
	BURR	47	187	196	213	231	249	266	275
70-74	AAHB	7	175	175	209	246	254	255	255
	BURR	45	184	194	209	227	245	260	270
75-79	AAHB	18	186	197	210	229	241	275	281
	BURR	119	182	190	205	221	237	252	260
80-84	AAHB	10	180	181	204	230	256	269	270
	BURR	56	176	184	199	215	231	246	254
85+	AAHB	9	190	190	195	221	243	248	248
	BURR	31	172	180	193	208	223	236	244
Women									
65-69	AAHB	4	161	161	172	204	225	232	232
	BURR	54	163	172	187	204	221	236	245
70-74	AAHB	8	167	167	197	225	244	257	257
	BURR	47	158	168	184	201	218	234	244
75-79	AAHB	18	170	176	189	201	218	239	240
	BURR	219	161	169	184	200	216	231	239
80-84	AAHB	39	142	164	191	210	230	250	260
	BURR	131	151	160	175	192	209	224	233
85+	AAHB	70	161	171	182	192	205	236	255
	BURR	75	141	150	165	182	199	214	223

Table 21 : Percentiles for AMA (mm2)
Ayrshire and Arran Health Board Subjects (AAHB) vs Burr and Phillips (BURR)

Age group (years)		No.	Percentiles 5th	10th	25th	50th	75th	90th	95th
Men									
65-69	AAHB	4	2754	2754	3098	4172	4339	4380	4380
	BURR	47	2680	3040	3650	4320	4990	5420	5960
70-74	AAHB	7	2435	2435	3463	4811	5127	5192	5192
	BURR	45	2710	3030	3560	4140	4720	5250	5570
75-79	AAHB	18	2748	3093	3507	4145	4627	6021	6269
	BURR	119	2530	2840	3360	3940	4520	5040	5350
80-84	AAHB	10	2589	2616	3316	4219	5204	5757	5811
	BURR	56	2370	2660	3160	3710	4260	4760	5060
85+	AAHB	9	2878	2878	3001	3903	4682	4913	4913
	BURR	31	2270	2540	2980	3470	3960	4400	4670
Women									
65-69	AAHB	4	2072	2072	2371	3290	4043	4286	4286
	BURR	54	2020	2310	2810	3350	3890	4390	4680
70-74	AAHB	8	2227	2227	3092	4027	4747	5240	5240
	BURR	47	1840	2160	2690	3270	3850	4380	4700
75-79	AAHB	18	2288	2476	2843	3203	3787	4543	4569
	BURR	219	1970	2240	2710	3230	3750	4220	4490
80-84	AAHB	39	1600	2133	2911	3500	4199	4972	5394
	BURR	131	1720	2000	2460	2970	3480	3940	4220
85+	AAHB	70	2075	2324	2640	2937	3322	4422	5158
	BURR	75	1430	1700	2170	2690	3210	3680	3950

4.3.4 Summary of anthropometric results

The information suggests that the study group was generally leaner than both reference groups, if anything, more muscular than the reference group from South Wales. Despite the differences between study and reference groups, the anthropometric trends which have previously been described, such as declining anthropometric measurements with age, and differences in weight, fat and fat free mass between the sexes were observed in this study. This suggests that similar anthropometric trends exist between populations in the UK but that the absolute values may be different in different geographical areas or the differences may be the result of secular trends. Section 5.3 explores these findings further.

4.3.5 Nutritional status: prevalence of undernutrition

As detailed in Sections 1.2 and 3.3, various criteria were used to define the prevalence of undernutrition within the study sample. This approach was taken as there is no single criterion to define undernutrition used in the literature, as discussed earlier.

From Table 22, the prevalence of undernutrition can be seen to range from 11% - 24%, depending on the criterion used. With no ' gold standard ' definition for undernutrition, the true prevalence rate of undernutrition in this group cannot be determined but may therefore lie between 11 and 24%. It is outwith the scope of this study to develop a standard definition for undernutrition in the elderly, but the issue is discussed in Section 5.3.

Table 22 : Number of subjects undernourished

Sex	[1]BMI and/or cAMA		[2]BMI		[3]cAMA	
	No. Below	% Below	No. Below	% Below	No. Below	% Below
Male	5	10	10	20	2	4
Female	21	15	36	25	17	13
Combined	26	14	46	24	20	11

Criteria for defining undernutrition:

1. BMI < Burr and Phillips (1984) 5th percentile and/or cAMA of <16cm^2 for men and 16.9 cm^2 for women (eg used by Potter et al , 1995)
2. BMI < 20 (eg used by the Scottish Office Department of Health, 1997; EURONUT-SENECA (De Groot, 1991))
3. cAMA <16cm^2 for men and 16.9cm^2 for women (recommended by Friedman et al, 1985; Lipski et al, 1993)

4.4 Energy Requirements

4.4.1 Estimated basal metabolic rate and energy expenditure

Mean estimated BMR for the study sample was 5.0MJ/d (*SD* 0.7MJ/d). In men, mean predicted BMR was 5.8MJ/d (*SD* 0.6MJ/d). In women, mean predicted BMR was 4.8MJ/d (*SD* 0.5MJ/d).

The DHSS (1992) recommend a 1.3 PAL for calculating the ETEE of elderly people who spend one hour or less per day on their feet. An activity factor of 1.3 represents a very sedentary lifestyle and therefore may be suitable for use with this study group as the majority were chair bound and very dependent. This is supported by empirical evidence from doubly-labelled water (DLW) studies of long stay elderly patients

(Reilly et al, 1995). The mean ETEE for the study sample was 6.5MJ/d (*SD* 0.9MJ/d) (in men 7.5MJ/d (*SD* 0.7MJ/d) and 6.2MJ/d (*SD* 0.6MJ/d) in women). When PAL was increased to 1.5, the factor used to obtain the estimated average requirement for energy for free living elderly (DoH, 1992), ETEE was higher. Mean ETEE using PAL 1.5 was 7.5MJ/d (*SD* 1.0MJ/d) (in men 8.7MJ/d (*SD* 0.8MJ/d) and in women 7.1MJ/d (*SD* 0.7MJ/d)). Estimated BMR and the varying ETEE were used in the comparison of energy intake and energy of food offered to assess adequacy of energy intake. Section 5.4 discusses energy expenditure and energy balance more fully.

4.5 Dietary survey -nutrient content of the diet

Tables 23 and 24 detail the findings of the 3 day weighed food and fluid records, the nutrient content of food offered and consumed compared to dietary reference values and estimated individual requirements. Following statistical advice, before one or two sample t-tests were conducted, the required assumptions of normality and equality of variance were verified by examining:

1. Normal probability plots in conjunction with the Lilliefort test statistic
2. Cochrans C test for homogeneity of variance together with the Levene statistic

These tests confirmed that none of the data analysed were distributed significantly differently from the normal distribution and the equality of variance assumption was not seriously violated. Therefore, mean and standard distributions are presented.

NUTRITIONAL ANALYSIS RESULTSLRNI = LOWER REFERENCE NUTRIENT INTAKE (AN AMOUNT OF A NUTRIENT THAT IS ENOUGH FOR A FEW PEOPLE WITH LOW NEEDS)

EAR = ESTIMATED AVERAGE REQUIREMENT (AN AMOUNT OF A NUTRIENT THAT WILL USUALLY MEET HALF OF A GROUP'S NEEDS)
RNI = REFERENCE NUTRIENT INTAKE (AN AMOUNT OF A NUTRIENT THAT IS ENOUGH FOR 97% OF A GROUP'S NEEDS)
REF = REFERENCE VALUE (A RECOMMENDED VALUE FOR A NUTRIENT)
* = SIGNIFICANTLY DIFFERENT AT 5% LEVEL FROM THE RNI FOR PROTEIN (g/d); EAR FOR ENERGY; REF VALUES FOR PROTEIN (g/kg body weight/d) AND FLUID (ml/kg body wt/d)
NSP = NON-STARCH POLYSACCHARIDE

Table 23: Nutritional analysis for food offered

NUTRIENT	No. SUBJECTS	MEAN	S.D.	MIN	MAX	CONFIDENCE INTERVAL FOR MEAN	LRNI	NO. BELOW LRNI	% BELOW LRNI	EAR	NO. BELOW EAR	% BELOW EAR	RNI	NO. BELOW RNI	% BELOW RNI
ENERGY M (MJ/d)	33	8.1	1.7	4.9	13.0	7.4-8.6	n/a	n/a	n/a	8.7	26*	79*	n/a	n/a	n/a
F	99	6.9	1.2	3.4	10.4	6.6- 7.1				7.6	78*	79*			
PROTEIN M (g/d)	33	72.0	15.5	35.7	117.3	66.5-77.5	n/a	n/a	n/a	42.6	1	3	53.3	1	3
F	99	65.3	11.7	36.0	96.7	63.0-67.6				37.2	1	1	46.5	6	6
PROTEIN (g/kg body wt/d)	130	1.28	0.38	0.4	2.6	1.2-1.3	REF= 0.75	4	3	n/a	n/a	n/a	n/a	n/a	n/a
NSP (g/d)	132	11.0	2.5	5.7	17.0	10.5-11.4	12	86*	65*	18	132*	100*	24	132*	100*
FLUID (ml/kg body wt/d)	130	22.5	6.6	5.0	38.2	21.3-23.6	REF= 30	108*	83*	n/a	n/a	n/a	n/a	n/a	n/a

Table 24: Nutritional analysis of dietary intakes

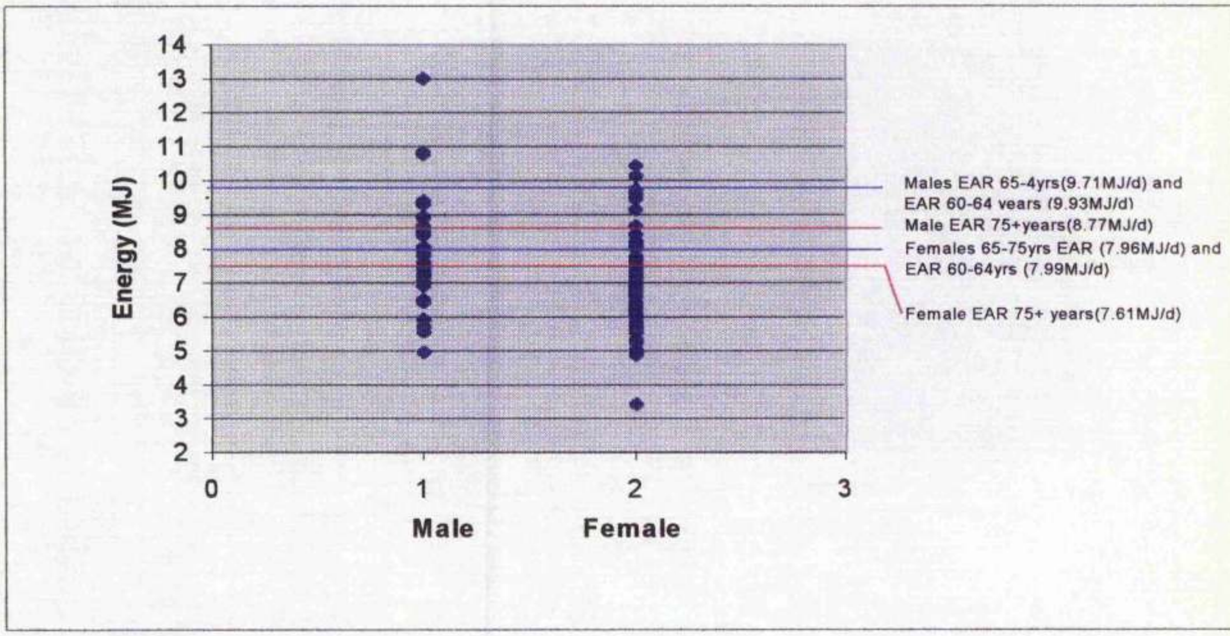
NUTRIENT	SUBJECT NO.	MEAN	S.D.	MIN	MAX	CONFIDENCE INTERVAL	LRNI	NO. BELOW LRNI	% BELOW LRNI	EAR	NO. BELOW EAR	% BELOW EAR	RNI	NO. BELOW RNI	% BELOW RNI
ENERGY M	33	6.7	1.5	4.1	9.4	6.2-7.2	n/a	n/a	n/a	8.7	30*	91*	n/a	n/a	n/a
(MJ/d) F	99	5.3	1.2	2.4	8.8	5.0-5.6				7.6	96*	97*			
PROTEIN M (g/d)	33	59.7	13.5	29.1	89.0	55.0-64.5	n/a	n/a	n/a	42.6	2	6	53.3	7	21
F	99	49.1	13.4	19.4	88.6	46.5-51.7				37.2	19	19	46.5	44	44
PROTEIN (g/kg body wt/d)	130	1.0	0.3	0.3	2.0	0.9-1.0	REF= 0.75	27	21	n/a	n/a	n/a	n/a	n/a	n/a
NSP (g/d)	132	8.2	3.0	2.2	15.6	7.7-8.7	12	115*	87*	18	132*	100*	24	132*	100*
FLUID (ml/kg body wt/d)	130	17.9	5.4	2.7	37.4	17.0-18.9	REF= 30	128*	98*	n/a	n/a	n/a	n/a	n/a	n/a

4.5.1 Energy offered and consumed

From Table 23, the mean energy content of food offered to males was 8.1MJ/d (*SD* 1.7MJ) (equivalent to 1910kcal/d, *SD* 340kcal/d) and 6.9MJ/d (*SD* 1.2MJ/d) (equivalent to 1631kcal/d, *SD* 292 kcal/d) to females. As residents did not always consume all that was offered, energy intakes were less than the energy offered. From Table 24, the mean energy intake for men was 6.7 MJ/d (*SD* 0.72MJ/d) (equivalent to 1606.7kcal/d, *SD* 348kcal/d) and 5.3MJ/d (*SD* 1.3MJ/d) (equivalent to 1260kcal/d, *SD* 296kcal/d) for women.

From Table 23, 79% of males and females were offered food and drink with energy content below their age specific EAR for energy (DoH, 1991). Energy of food offered to males and females 65-74 years and 75+ years was significantly ($p < 0.05$) below their age and gender specific EAR for energy (DoH, 1991). No differences were detected with the younger age groups and this may be related to the small subject numbers within these groups. Energy intake of the sample was significantly below the EAR for energy (DoH, 1991) (see Table 24) and overall 91% of males and 97% of females had energy intakes which fell below their age specific EAR (see Figure 1).

Figure 1: Energy intake compared to EAR (DoH, 1992)



The energy content of food offered and consumed was also compared to estimated BMR and ETEE (calculated using PALs of 1.3 and 1.5). Two sample t-tests were used to determine the significant differences. Table 25 and 26 indicates the differences between the energy content of food offered and consumed and BMR and ETEE.

Table 25: Energy offered compared to estimated BMR, ETEE (PAL 1.3 and 1.5)

Measurement	Males (MJ/d)	Females (MJ/d)	Both sexes (MJ/d)
BMR	5.8*	4.8*	5.0*
ETEE x 1.3	7.5	6.2*	6.5*
ETEE x 1.5	8.7	7.1	7.5*
Energy in food *offered*	8.1	6.9	7.2

* Significantly different from energy offered ($p<0.05$)

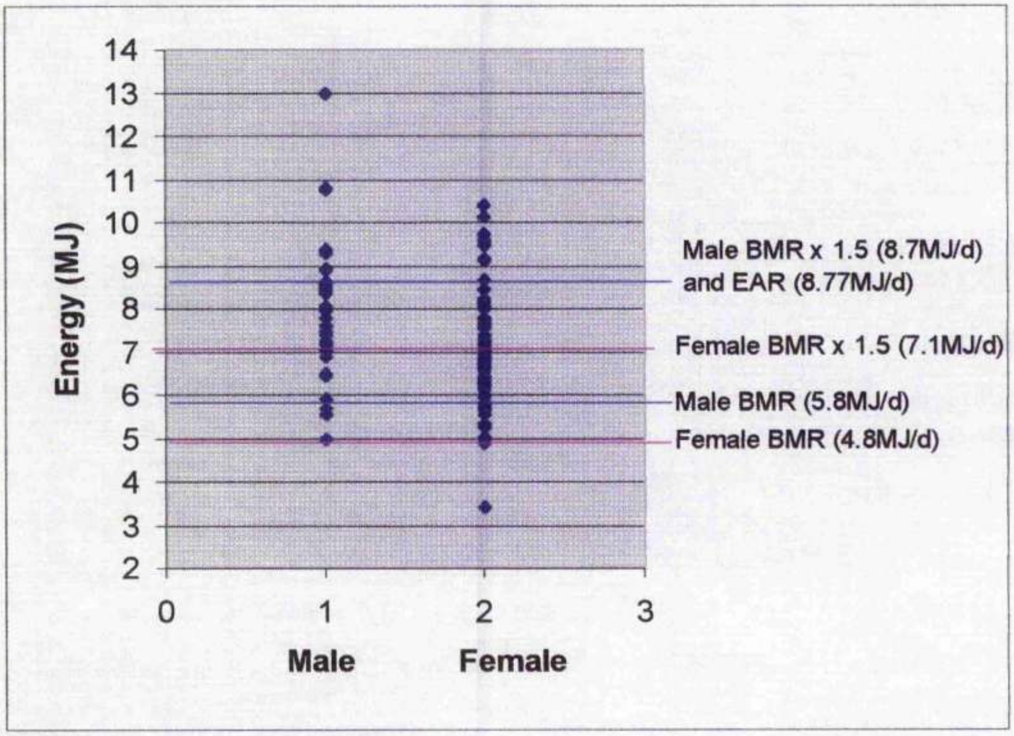
Table 26: Energy intake compared to estimated BMR, ETEE (PAL 1.3 and 1.5)

Measurement	Males (MJ/d)	Females (MJ/d)	Both sexes (MJ/d)
BMR	5.8*	4.8*	5.0*
ETEE x 1.3	7.5*	6.2*	6.5*
ETEE x 1.5	8.7*	7.1*	7.5*
Energy *intake*	6.7	5.3	5.7

* Significantly different from energy intake ($p<0.05$)

From Tables 25 and 26, energy content of both food offered and consumed was adequate to meet the BMR needs of the sample group. Food offered contained adequate energy to meet the needs of females ETEE when calculated using a PAL of 1.3. No significant differences were found in energy offered compared to ETEE when calculated using PAL of 1.3 for males and PAL of 1.5 for males and females. This may be due to a lack of power within the sample size when the group is broken by sex because when the data from both sexes are combined (giving greater numbers and therefore power) differences become apparent. Overall, using the data from both sexes it could be stated that energy offered was inadequate to meet the needs of the group when ETEE was calculated PAL of 1.5 but adequate to meet BMR and .ETEE calculated using PAL x 1.3. Energy intake was inadequate to meet ETEE when calculated using PAL of 1.3 and 1.5. Of the group, 70% had energy intakes which fell below their ETEE calculated using PAL of 1.3 (see Figure 2). This information suggests that the study group may have been in negative energy balance, though the magnitude of this would have depended on their true total energy expenditure which was not measured.

Figure 2: Energy intake compared to BMR and ETEE (BMR x 1.5 PAL)



It is beyond the remit of this study to assess if the study sample was in true negative energy balance, since a longitudinal study measuring energy expenditure and intakes or serial measurements of anthropometry would be required to determine this. However, based on the information available, the institutionalised elderly group would seem to be nutritionally at risk and may not be consuming adequate energy to meet their requirements. This could help explain the prevalence of undernutrition detected. This is discussed further in Section 5.4.

4.5.2 Protein offered and consumed

Table 23 presents the mean content of protein in food offered to males, 72.0g /d (*SD* 15.5g/d, range 35.7-117.3g/d) and females 65.3g/d (*SD* 11.7g/d, range 36.0-96.7g/d). From Table 24, the mean protein intake for males was 59.7g/d (*SD* 13.5g/d, range 29.1-89.0g/d) and for females 49.1g/d (*SD* 13.1g/d, range 19.4-88.6g/d).

Compared to dietary reference values (DoH,1991) for protein, the protein content of food offered and consumed seemed generally adequate. The current reference nutrient intake (RNI) is 46.5g/d for females and 53.3g/d for males and the current estimated average requirement (EAR) is 37.2g/d for females and 42.6 for males (DoH, 1991). The protein content of food offered was less than the RNI for only 6% of females and 3% of males.

The protein recommended per kg body weight for an elderly person is 0.75g/ kg body weight/d which is the same as for a younger adult (WHO, 1985). This value was based on recommendations from the WHO (1985). Expressed in these terms, the mean protein content of food offered was 1.28g/kgbody weight/d (*SD* 0.38, range 0.4 – 2.6 g/kg body weight/d) and protein intake was 1.0g/kg body weight/d (*SD 0.3*, range 0.3 – 2.0g/kg body weight/d) (see Tables 23 and 24). Both the protein content of food offered and consumed was significantly higher than the 0.75g/kg/d recommended value ($p < 0.001$). Since protein intakes seem adequate protein will not be discussed further.

4.5.3 Non-starch polysaccharide (NSP) offered and consumed

From Tables 23 and 24, the mean NSP content of food offered to the group was 11g/d (*SD* 2.5, range 5.7 - 17g/d) and the mean NSP intake was 8.2g/d (*SD* 3, range 2.2 - 15.5g/d). The NSP content of food offered and consumed was significantly lower than the current RNI (24g/d), EAR (18g/d) and lower reference nutrient intake (LRNI) (12g/d) (DoH, 1991). Nutritional data showed that 65% of NSP offered and 87% of NSP intake fell below the LRNI, while 100% of the entire sample fell below the EAR and RNI. Overall, the NSP offered and consumed was inadequate and may partially explain the problem of constipation and high laxative use in this group. This is discussed more fully in Section 5.4.

4.5.4 Fluid offered and consumed

Fluid results are expressed per kg body weight as recommended by Lipschitz (1992). Tables 23 and 24 indicate that the mean amount of fluid offered to the sample was 22.5ml/kg body weight/d (*SD* 6.6, range 5 - 38ml/kg body weight/d) and fluid intake was 17.9ml/kg body weight/d (*SD* 5.4, range 3 - 37ml/kg body weight/d). The average total fluid offered to the group was 1184.5ml/d (*SD* 328.7ml/d), (1320.2ml/d (*SD* 428.3ml/d) to males and 1139.2ml/d (*SD* 276.2ml/d) to females). Fluid intakes were lower than fluid offered, with a group mean of 964.8ml/d (*SD* 342.2ml/d), with 1138.6ml/d (*SD* 421.9ml/d) for males and 906.9ml/d (*SD* 291.4ml/d) for females.

Compared to the 30ml/kg/d reference value (Lipschitz, 1992), 83% of fluid offered and 98% of fluid intakes were below this value. Both fluid offered and consumed were significantly below the reference value. The fluid results indicate that this elderly institutionalised group may not be receiving or consuming adequate fluid. Fluid adequacy will be discussed further in Section 5.4.

4.5.5 Other nutrients offered and consumed falling below the RNI

Nutrients of interest that were also found to be significantly below the RNI for food offered and consumed are presented below. Further information on these nutrients and others can be found in Appendix 2.

Nutrients found to be significantly below the RNI for food offered were: vitamin D (mean 2.9mcg/d; *SD* 1.8mcg/d; range 0.4 – 10.2mcg/d); potassium (mean 2571.3mg/d; *SD* 480mg/d; range 1080 – 4721mg/d). Nutrients also found to be significantly lower than the RNI for dietary intakes were: vitamin D (mean 2.2mcg/d; *SD*1.4mcg/d; range 0.4 – 8.2mcg/d); iron (mean 8mg/d; *SD* 2.4mg/d; range 2.9 – 14.7mg/d); folate (mean 150.3mcg/d; *SD* 48mcg/d; range 48 – 271mcg/d); potassium (mean 2001.5mg/d; *SD* 539mg/d; range 503 – 3125mg/d).

4.5.6 Nutrient density of dietary intake

Nutrient density of the diet was assessed using NSP and iron intakes/1000kcal. The NSP density of the diet averaged 6.1g/1000kcal (*SD* 1.6g/1000kcal) which was lower than the LRNI (12g/d). The average iron density of the diet was 6.0mg/1000kcal (*SD* 1.1mg/1000kcal) which fell between the LRNI (4.7mg/d) and the EAR (6.7mg/d). this suggests that that the nutrient density of the diet was low.

4.6 Food and fluid provision and environmental factors at sites

Food and fluid provision varied between sites. Arran View and Kirklandside patients chose meals 24 hours in advance while patients at Biggart and Ayrshire Central were offered menu choice only a few hours before each meal. All three hospital sites operated a 3 week menu cycle which had not changed for a number of years. Arran View operated a 2 week menu cycle which changed totally each 3 months to take account of seasonal foods.

Arran View served its meals from a bulk trolley while all the hospital sites used a plated meal system. The bulk system allowed staff to serve to patients appetites while the plated meals were of a set portion which often did not suit patients' appetites. Ayrshire Central and Kirklandside's food delivery systems made the identification of patient meals difficult. However, at Biggart patients' names were written on the lids of soups and puddings and their menu cards were placed on top of their meal plates, ensuring that patients received the correct meal.

4.6.1 Breakfast

At Arran View, breakfast was served to suit the patients' preference. Therefore, breakfast was between 8 am and 10 am and patients could eat in bed or in the dining room. Hospital breakfasts were served to a catering and nursing routine, around 8 am, and the eating place depended on staff rather than patient choice. All sites offered fresh fruit juice, porridge, cereals, milk, bread/rolls/toast and a cooked breakfast. Tea was offered mostly as the hot drink. Arran View was the only site which offered boiled, poached or fried eggs to patients.

4.6.2 Lunch

Lunch was generally served at midday at all sites. Lunch usually consisted of a choice between two main courses unless a patient was on a therapeutic diet. In Arran View, patients had the choice of soup and main course only, while hospital patients had a larger choice of soup, hot and cold main courses and puddings. A drink of either milk or squash was served with this meal at all sites although Arran View also offered sparkling wine. The majority of patients ate in the dining room for this meal.

4.6.3 Evening Meal

The evening meal was usually served between 4.30 pm and 5.15 pm in all sites. Some patients ate this meal in bed but most patients ate in the dining room. At Arran View this meal comprised mainly of convenience foods like burgers, sausages or fried cheese toast. A pudding was also on offer. In the hospital sites, the evening meal choice was similar to lunch. Kirklandside was the only site to offer bread and butter with lunch and evening meal. Tea was usually offered with this meal in the hospital sites but in Arran View patients received a cold drink as well as tea.

4.6.4 Snacks and drinks

In the hospitals, patients were only offered plain biscuits as a snack three times per day. Drinks of tea were offered at 10 am, 2 pm and 7 pm. Water was always available on wards but was rarely offered to patients. Arran View offered its patients a wide variety of hot and cold drinks at 10 am, 1 pm, 3 pm, 5 pm, 7 pm and 9 pm. Plain biscuits were offered at these times and at 3 pm home-made scones or tray-bakes were also available. Arran View was the only site to offer wine with meals and an alcoholic drink at the weekend, while it also bought in fish suppers on a monthly basis. Very few patients or their family or friends purchased any additional food or drink items. At Biggart a few patients did visit the 'Buttery Restaurant' in the Hospital each week for a coffee or tea.

4.6.5 Therapeutic diets

Ayrshire Central and Biggart had the greatest numbers of patients on therapeutic diets, and this may be related to the higher dietetic input at these sites. The main therapeutic diets in the population were diabetic, reducing, soft, liquidised, high protein and high NSP. In the sample group, 13 were on diabetic diets, 19 on weight reducing diets, 25 on high protein diets, 4 on high NSP and 9 on soft diets. Several patients were on a combination of diets. Those on high protein diets received extra snacks, had protein and energy powders added to meals and were also allowed three courses at each meal. The majority of patients on high protein diets were prescribed supplementary high protein/calorie drinks but these were not always issued by staff.

4.6.6 Other factors

At mealtimes staffing numbers varied between sites. Arran View had the greatest number of staff available as staff did not have a break until patients' meals were served. This was not the situation at the hospital sites, therefore there was often an apparent shortage of nursing staff at mealtimes. At some hospital sites, courses were served together rather than separately. This practice led to some patients eating their pudding first and rejecting their main course. At some sites meals were served in the order of the menu cards rather than table by table. Therefore, patients at one table were often served at different times. Staff were observed littering table tops with plate lids and menu cards.

The hospital dining areas were not generally 'homely' and in Kirklandside patients ate in bedroom areas. Patients were rarely asked where they wanted to sit or with whom. The crockery and cutlery did not always meet the needs of the elderly patient and eating aids were rarely used. Patients' dietary preferences were rarely considered at meal, drink and snack times. Arran View was more 'homely' and staff did try to meet the social and dietary preferences of their patients. There was also a definite lack of nutritional screening in all sites. Environmental and social factors are discussed more fully in Section 5.5.

5. Discussion

5.1 Background to study

The majority of the 196 subjects in the present study had multiple medical problems and all were identified by medical staff as being incapable of living at home and in need of continuing care. All subjects had been in care for 3 months or more (median length of stay - 17 months) and were now institutionalised. The Department of Health indicates in a 1992 report (DoH, 1992) that institutionalised elderly people are at risk of low body weight and inadequate dietary intake. A previous study in North Ayrshire and Arran NHS Trust (1992) found a problem with constipation in the elderly continuing care population and diet was suggested as a possible cause. Therefore, this study focused on determining if residents in NHS continuing care within Ayrshire were nutritionally compromised and if their dietary intakes could explain the level of constipation found in 1992.

5.2 Study sample

The residents who were excluded (n=61) did not differ greatly in age (mean age 80.4 years; *SD* 9.2 years) compared to the residents who were included (mean age 82.5 years; *SD* 7.9 years). By excluding residents with malabsorptive disorders, those being enterally fed, on liquidised diets, fluid restrictions and amputees, any potential to bias the nutritional status of the sample towards undernutrition was minimised. If these groups had been included in the nutritional status survey a higher prevalence of undernutrition may have been found. This has been taken into account later in the discussion on prevalence of undernutrition in the study group. However, the number of residents with malabsorptive disorders (n=6) was small and, even if undernourished this would not have altered the results greatly. Residents on enteral feeds or liquidised diets (n=37) were already identified as requiring a therapeutic diet and therefore their nutritional status may have not been very different from the subject population due to dietetic intervention. As a proportion of residents in any institutionalised setting for the elderly may have malabsorptive disorders, take liquidised diets, be enterally fed or have amputations, it may have been appropriate to include them in this study. Excluding them may have influenced the results by increasing the apparent prevalence of undernutrition. This might have provided a more informative description of nutritional states in long stay elderly. For future studies, more information on the nutritional status of the excluded resident groups, with the exception of those terminally ill (for ethical reasons), should also be undertaken in an attempt to assess whether they are different from the included group.

The age of female subjects (mean 84.2 years) was higher than male subjects (mean 77.7 years) and there were considerably more females than males (ratio 3:1). This was not surprising as a recent Ayrshire and Arran Health Board report (Walker, 1995) suggested that the male to female ratio in Ayrshire is fairly evenly split over most age bands with the exception of the elderly population, which is predominantly female. Women account for 61% of those aged over 65 years and 67% of those aged over 75 years (Walker, 1995). In Ayrshire, the elderly population has steadily increased for many years, particularly so for the over 75 year age group. This upward trend is expected to continue in the period to 2004 with the over 75's likely to experience the largest increase in numbers (Walker, 1995). The general increase in the elderly population, especially the very elderly (> 75 years), has been well described. Of the total population in the UK in 1990 aged 16 years or over, one in six were older than 65 years and by the year 2000 it is predicted that the elderly will account for one in four of the adult population (DoH, 1992). The need for long term care, in institutions or in care at home schemes, is set to rise. The vital role nutrition has on the ageing process, in health and disease, is only now being recognised, but there is still a lack of nutritional information in this age group. In a recent study by Muhlethaler et al (1995), the predictive role of malnutrition was determined by analysing the 4.5 year mortality and living location of 219 elderly patients admitted to a geriatric assessment unit. Indicators of undernutrition were found to be independent risk factors in predicting decreased length of overall survival. Campbell et al (1990) also found that poor nutritional state, as shown by low muscle bulk and fat stores in 758 elderly people, was an important independent predictor for mortality.

In each of the four sites studied, subjects were similar in all respects with the exception of functional ability (Table 13). Subjects from Arran View were found to be significantly better functionally than subjects from Biggart or Kirklandside. This may have been attributable to Arran View subjects being in care for a shorter duration or due to the higher number of males aged over 80 years in Biggart and Kirklandside. Differences were not apparent in the female group or those aged under 80 years. Therefore, as the majority of subjects were female (females n=147, males n=49), the statistically significant difference in functional ability found between sites may not have had a biologically or clinically significant effect on the majority of subjects' nutritional status or dietary intake (Section 4.2).

5.3 Anthropometric measurements of study sample

Anthropometric measurements were conducted as described in Section 3.3 and results of weight, estimated height, upper arm fat and fat free mass are detailed in Section 4.3. It was considered reasonable to combine the anthropometric data from each site and use it as a single data set as differences in anthropometrics and mental ability between sites were not detected and the differences in functional ability were considered to be more apparent than real.

5.3.1 Nutritional status and anthropometric reference data

When the subject sample was separated into age groups, for comparison with reference data (burr and Phillips, 1984; Lehmann et al, 1991), some groups (65-69 and 70-74) were small. Therefore, some results must be treated with caution.

Burr and Phillips (1984) found, in the community survey of over 1500 elderly subjects from South Wales, that after the age of 70 years there is a decline in body mass index and upper arm fat and muscle mass with increasing age in both sexes. This loss of lean mass and loss or re-distribution of fat mass with age is well documented (Delarue et al, 1994; DoH, 1992; Lehmann et al, 1991; Durnin , 1983). Similar trends were also present in the sample studied here (Tables 17 - 21). For example, in males aged 70-74 years body mass index (BMI) was 24.4Kg/m^2 at the 50th percentile compared to a BMI of 22.0Kg/m^2 for men aged 85 years and older; females aged 70-74 years had, at the 50th percentile, a TSK of 17.7 mm which was higher than the TSK of females aged 85 years and over (mean 10.1mm).

The anthropometric trends between gender and age groups present in this study were similar to those of other published studies (Launer and Harris, 1996; Delarue et al, 1994; Burr and Phillips, 1984; Lehmann et al, 1991; Bannerman et al, 1997). In the recent study of non-institutionalised elderly people in Edinburgh by Bannerman et al (1997), a steady decline in both sexes' BMI, TSK, MUAC and AMC with age was observed. Males' AMC was significantly higher by 24.3mm on average, than females and their TSK significantly lower by 2.6mm on average. Therefore it would appear that similar anthropometric trends with advancing age and genders exist between populations and that these are biologically determined.

However, absolute anthropometric values seem to differ between populations of elderly subjects. The study group was, on average, leaner and more muscular than the two UK reference groups, (Burr and Phillips, 1984; Lehmann et al, 1991). This difference was especially marked in females and in the older age groups. Females were on average 1-2Kg/m^2 less for BMI than reference data, body weight was lower, and MAC higher with TSK and AMA being slightly higher than the two reference groups. In each of these measurements, statistically significant differences were seen between the study sample and reference data in one or more of the age groups. In the younger age bands differences were not detectable, this may be related to the small subject numbers in these groups. The differences that were detected were probably large enough to be significant in terms of assessing nutritional status. Other studies have also described variation in anthropometric values between elderly populations (Delarue, 1994; Launer and Harris,1996; Bannerman et al, 1997).

1. A study by Delarue et al (1994), on 626 non-institutionalised elderly people from Central and Eastern France, found large inter-regional differences in anthropometric values for age and sex matched groups. When the French group's 50th percentile values were compared to Burr and Phillips (1984) corresponding 50th percentiles, the arm circumference, arm muscle circumference and triceps skinfold thickness of the French sample was higher than in the Welsh population studied by Burr and Philips, although female body mass index was lower while males were similar to the Welsh population. This finding led the authors to conclude that the establishment of local or regional anthropometric reference values for elderly populations was needed, and that single 'universal' sets of reference data might be inappropriate for nutritional assessment.

2. In a recent paper by Launer and Harris (1996), anthropometric data from 19 geographically and ethnically varied samples of community dwelling elderly people were compared. Across studies there were large differences detected in the prevalence of underweight and overweight subjects, but in all studies the trend of decreasing height and BMI with age was found. Females were shorter than males and generally, in most samples, they had a higher BMI compared to men. The comparisons suggested that the sensitivity and specificity of fixed cut-off points for underweight and overweight are likely to differ by sex, age and geographical location in elderly samples. Clearly, real differences *between* populations will need to be considered when selecting standard values or cut offs to define overnutrition or undernutrition in old age.

3. In the study in Edinburgh (Bannerman et al, 1997), the anthropometric data of the 188 community dwelling elderly people was compared to Lehmann et al (1991) and Burr and Phillips (1984) reference data. Males were considerably heavier using demiquet (weight(Kg)/demispan(m)^2), 106.0Kg/m^2 versus 113.4kg/m^2 ($p<0.001$) and both sexes somewhat shorter (women 0.79m versus 0.72m, $p<0.05$; men 0.8m versus 0.73m, $p<0.01$) than the Nottingham sample (Lehmann, 1991). Compared to the Welsh group (Burr and Phillips, 1984), both males and females, aged 75 years and over, had greater mid-upper arm circumference (75-79 years - men 24.9cm versus 29.7cm, $p<0.001$; females 24.9cm versus 29.9cm, $p<0.001$), triceps skinfold thickness and arm muscle circumference, as in the present study. In the male groups aged 75-79 years and 80-84 years, body mass index was also significantly higher in Edinburgh (23.9kg/m^2 versus 26.4kg/m^2, $p<0.001$ and 23.7kg/m^2 versus 25.9kg/m^2, $p<0.01$ respectively). The study highlighted significant differences in anthropometric indices of nutritional status between broadly representative samples of elderly individuals from three regions of the UK, and tends to support the conclusions of Delarue at al (1994) that the existing reference data for anthropometry in old age should be used cautiously because of real biological differences between populations.

Differences in anthropometric data between populations may be due to various factors including genetic effects; childhood nutrition; socio-economic status; health behaviours; physical activity levels; secular trends; methodological differences in studies (Launer and Harris,1996; Burr and Phillips , 1984). It is beyond the scope of this study to explain why these differences have arisen and instead, the study addresses the consequences of such differences. Possible reasons for the differences apparent between sample and reference group may due to the following:

1. As discussed in Section 1.2, the inter-observer error in elderly anthropometry is known to be high (Chumlea et al, 1984), especially skinfolds where there is greater compressibility and/or poor tissue separation in elderly subjects (Bowan and Rosenberg, 1982). Taking this into consideration , it is possible that inter-observer error may explain some of the differences observed between study sample and reference groups.

Methodological differences between the study presented and the two studies which produced reference data were mainly related to undertaking height and upper arm measurements in the seated position, due to the frailty of the study sample. Burr and Phillips (1984), undertook these measurements with subjects standing. Knee height has shown good correlation with standing height when mean results from population or group measurements have been used, as in the present study (Chumlea et al, 1984). Therefore, any differences observed in BMI due to methodological differences, between study and reference sample, are likely to have been minimal. A pilot study prior to the main study commencing, showed that it did not seem to make a difference whether subjects stood or sat for upper arm measurements. This may have been due to the great care that was taken to ensure the arm hung freely at the side of the body, whilst callipers were applied. Overall, some differences may have occurred as result of different methodologies (eg skinfolds) but as differences were observed throughout all indices this tends to indicate that the differences were real.

2. The anthropometric differences detected between study sample and reference could be as a result of institutionalisation of the study group. The Nottingham data set lived in a non-institutionalised setting and only 7% of subjects in the Welsh study were institutionalised. Although no information is provided regarding the health status of the reference subjects, both reference groups must have been healthier and fitter than the sample group as measurements were taken while standing, which was impossible in the present study group and the other samples were larger or subjects were non-institutionalised. Evidence from the Edinburgh study (Bannerman et al, 1997) indicated that the normal distribution curve for anthropometric measures had moved to the right of the reference. This suggested that the Edinburgh sample was better nourished or that the reference data are inappropriate for community elderly in Edinburgh. The use of the reference data may misclassify elderly individuals as 'at risk' by underestimating the prevalence of undernutrition (Bannermann et al, 1997). A survey of Ayrshire's community elderly would be required to determine if a healthy Ayrshire group was similar to Burr and Phillips (1984) and Lehmann et al (1991) reference groups or more like Bannermann et al's (1997) sample. If the results were similar to Bannermann's (1997) sample, which seems likely considering the higher muscle mass indicated in the study group, then this suggests that contemporary reference data for different areas within the UK are required or at least that contemporary UK reference data for the elderly would be necessary in order to resolve this question. This point may be addressed in the Department of Health's nutritional survey of elderly people which was recently carried out (publication expected summer 1998).

3. The differences in body mass index and weight between study and reference groups may be real, and related to the inadequate energy intakes found in the study sample. Morgan et al's (1986) study of 450 elderly women from 6 different settings indicated that low levels of nutrient intake made significant contributions to the poor anthropometric and biochemical nutritional status observed and with improvements in diet, beneficial effects on health should be observed.

4. Burr and Phillips (1984) Welsh survey was conducted in the late 1970's and differences between reference and study group may be related to secular trends. The Nottingham survey (Lehmann et al, 1991) was conducted in the late 1980's and therefore secular trends are probably less likely to explain the differences observed relative to the reference group, but might still be possible.

5. The apparently high muscle mass found in the study sample compared to Burr and Phillips (1984) reference data (for example, see Table 21), could have been related to occupational differences between areas. However, as both areas are rural and support similar farming and mining industries this seems unlikely.

6. There may be genetic differences between groups which may account for the apparent differences in arm muscle mass found. Purely speculatively, it is possible that South Wales and Ayrshire have relatively low emigration and immigration compared to other areas of the UK eg Glasgow, Bradford and this might make genetic differences between populations more likely.

Percentiles were used in the study presented to assess the nutritional status of the study group, but the significant differences detected between sample and reference population meant that this task could not be undertaken. This highlights the importance of clinically defined criteria for determining undernutrition at the present time until more localised standards are available.

In summary, further research would be required in order to investigate some of the possible explanations for the anthropometric differences found in this study. The differences in anthropometric data between elderly groups within one country, as described in this study and others (Bannerman et al, 1997; Launer and Harris,1996; Delarue et al, 1994), have important implications for the screening for malnutrition. If reference data are inappropriate it is difficult to detect undernutrition and obesity accurately in individuals or patient groups, which puts individuals at risk and increases the chances of inappropriate treatment. In addition, estimates of the prevalence of undernutrition and overnutrition will be incorrect if they largely reflect real biological differences between samples and references rather than differences in sites of undernutrition.

5.3.2 Prevalence of undernutrition

Typically, prevalence rates of 29% to 39% for undernutrition have been found in institutionalised elderly people (Fevre, 1993; Carver and Dobson, 1995; Larsson et al, 1990). The estimated prevalence of undernutrition in the present study was 11% - 24%. This variation was due to different definitions for undernutrition (BMI; cAMA; BMI and cAMA) being applied to the data. However, even the highest figure observed was lower than expected after a prevalence of 39% was found in the study by Fevre (1993) in a neighbouring health board.

Ideally, the criteria for identifying individuals 'at risk' of malnutrition, are those where no misclassifications occur. However, misclassification often occurs and will have occurred in the present study. This is due to a number of reasons: the cross-sectional design of the study; the study design will not identify subjects with recent and significant weight loss (5-10% within 2-3 months, Parenteral and Enteral Nutrition Group, 1997). Consequently, those who have had significant weight loss but who are not below the BMI or cAMA 'cut off' limits will be classed as adequately nourished when they are undernourished (false negatives, Gibson, 1990). Also, some subjects who may normally be of low BMI and/or cAMA can equally be classed as undernourished when they are not (false positives) (Gibson, 1990). The choice of cut-off to differentiate between malnourished and well-nourished states for a particular index critically affects both the sensitivity and specificity.

Compared to the 11-24% prevalence of undernutrition found in the present study, other recent studies in the UK using the *same* definition and cut-off points for undernutrition have found different prevalence rates (27% in acutely sick elderly patients, Potter et al, 1995; 32% institutionalised elderly mentally ill, Dobson and Carver, 1995; 39% elderly long stay, Fevre, 1993; 18% men and 12% women community dwelling elderly; DoH, 1972). These differences should be real, as the same criteria were used to determine undernutrition. This indicates that the study group were in a better nutritional state than their counterparts in other long-term care establishments, those categorised as mentally ill and acutely sick, but the study sample was less well nourished than community elderly.

It is also outwith the scope of this study to indicate which definition correctly identifies the real prevalence of undernutrition within this group and which one could be adopted in the future. However, a brief description of the advantages and disadvantages with each criterion for use in elderly people are provided below:

1. The advantage of the definition used by Potter et al (1995), any subject with BMI< Burr and Philips (1984) 5th percentile and/or a cAMA of <16cm^2 for men and 16.9cm^2 for women, was that if BMI was unavailable then the subject could still be assessed on their cAMA measurement. However, with the differences found at the 50th percentile in the sample presented (lower BMI, higher MAMC) the doubts about the acceptability of using reference percentiles from another area (Launer and Harris,1996) and with 5% of a healthy population expected to have a BMI at or below the 5th percentile, the use of these criteria may be questioned. Also, Frisancho (1984) indicated that measurements of weight, skinfolds and bone-free AMA between the 5th and 15th percentiles could be considered as evidence of undernutrition and this adds doubt to which cut-off point in the percentiles should be used.

2. BMI is widely understood and used routinely. However, BMI as a measure of nutritional state in the elderly can be problematic (difficulties obtaining height and weight; oedema causing increased BMI (Thuluvath, 1995)) and may be a misleading index of fatness, because of the differential rates of muscle and bone

loss among individuals (Lohmann,1992). Therefore, it has been suggested that other more specific measures of fatness (eg TSK) or muscle mass (eg AMA) should be employed (Frisancho and Flegel, 1982). It has also been suggested that a BMI < 20 is not valid for people aged over 65 years (Gibson, 1990). This view was supported recently in the study by Launer and Harris (1996), they suggested that the sensitivity and specificity of a fixed cut-offs, such as BMI <20, are likely to differ by sex, age and geographical locality in the elderly. The development of age specific BMI standards which indicate health risk would be beneficial as assessments of weight and height/estimated height are relatively easy, quick and non-invasive in most elderly groups and therefore likely to be monitored in community and hospital setting. The prevalence of undernutrition in the study sample using this standard definition, BMI < 20, was 24%, giving the highest prevalence rate for undernutrition of all the criteria tested here.

3. The third definition used in this study was cAMA of less than or equal to $16cm^2$ for men and $16.9cm^2$ for women. This is reported to be indicative of undernutrition in old age (Lipiski, 1993), and gave the lowest prevalence rate of undernutrition at 11%. It is likely that all or most of those falling below this cut off were undernourished. However, obtaining upper arm measurements in the elderly can be difficult and subject to inter-observer error high (Chumlea et al, 1984), and this might make it an unreliable method. However, it is a non-invasive method which requires inexpensive portable equipment and consequently is used relatively frequently in the elderly (Lipiski et al, 1993; Friedmann et al, 1985, Potter et al, 1995).

Although errors in nutritional anthropometry can occur which decrease its precision, accuracy, and validity (Gibson, 1990), anthropometry should be the preferred option by many clinicians, dietitians and nurses for assessing nutritional status. It has a number of advantages, including:

1. The procedures are simple, safe, non-invasive, can be applied at the bedside and are applicable to large sample sizes (Heymsfield and Casper, 1987).
2. Equipment is relatively inexpensive, portable and durable.
3. Relatively unskilled personnel can perform measurement procedures.
4. Methods can be precise and accurate, provided that standardised procedures are used.
5. It can provide information on change in nutritional status not provided by clinical or biochemical methods (Potter et al, 1995).

Information can be generated on long term prior nutritional history, which cannot be obtained with equal confidence using other techniques (Gibson, 1990). Therefore, anthropometry is likely to continue being used in the future although new approaches in defining under- and overnutrition and its associated risks of disease and mortality will be developed. One such advance is the conversion of BMI to percentage body fat. If BMI can be converted to percentage body fatness, then a fat standard for defining risk can be established. This approach is new and not yet widely used because of the long tradition of using body weight and height or skinfold percentiles. It is an approach which has been used in children and young adults but not in the elderly. However, as more accurate assessments of body composition methods are developed and adopted, it is likely that the approach of using percent fat will be widely used. The concept is sound, it is only the actual levels that require further research, so that different levels of body fatness can be identified with different risks of disease, and fat distribution can be separated from total body fatness and assessed as an independent risk factor (Lohmann, 1992). There is no doubt that epidemiological studies using more direct methods of estimating percentage body fat than BMI are required.

In summary, in the present study, various criteria for detecting prevalence of undernutrition were applied to the data and the prevalence rate within the sample group was found to vary from 11% to 24%. Differences in prevalence rates were also noted when compared to long stay elderly in other areas using similar criteria for defining undernutrition. The group appeared more undernourished than community elderly but similar to or better nourished than long-term care elderly. There seem to be numerous ways of trying to detect undernutrition within populations all of which seem flawed. However, anthropometry has many advantages and is likely to continue to be used in the future. The anthropometrical approach to nutritional assessment should improve as developments are made in assessment of body composition and as new research links changes in anthropometry to disease and mortality risk (Lehmann et al, 1991).

5.4 Nutrient content of the diet

5.4.1 Comment on weighed food record methodology

Assessing the nutritional value of habitual food intake is difficult as measurements must be conducted in such a way as not to change customary habits while maintaining accuracy. Alterations in subjects' dietary habits due to subject bias over the observation period were unlikely as the majority had poor memory and were unaware that the study was in progress. Care was taken to ensure that subjects did not see their food being weighed and that food was served in the normal manner. At one site, nursing staff served meals from bulk trolleys and although staff were told at the beginning of the study to serve meals as normal, some nursing staff bias may have occurred. Catering staff who plated meals were unaware that the study was being undertaken therefore catering bias was probably small or non-existent. Overall, weighed food records were probably as unbiased as possible.

As noted in Sections 1.2. and 3.4, a three day weighed food record may not be ideal in precision and accuracy but in elderly institutionalised groups it has been found to provide an acceptable indication of dietary intake (Barnes and Hodkinson, 1988). The study was not designed to identify the relative contribution of factors which might have led to the underestimation of habitual food intake, for example under-reporting of consumption, under-eating during the measurement period, or imprecision in the estimate of energy intake from the 3 day record. In the present study, under-recording of dietary items may have occurred during the night, when the researcher was not on the ward. However, the types and quantities of food or fluid consumed at this time, were thought to be negligible indicating that under-reporting was minimal. Under-reporting may be largely confined to the free living elderly and might not influence studies in the elderly institutional setting especially where researchers are undertaking weighed food records. Evidence of this can be found in the study by Reilly et al (1995) where mean energy intake and TEE were found to be identical suggesting that there was no under-reporting.

Overall, weighed food records are considered a precise and accurate method of determining usual intake of food and nutrients in individuals (Gibson, 1990) and as discussed above and in Sections 1.2 and 3.4, every effort was made to reduce bias and error. However, as the method relies on estimating the nutritional content in the diet by using food composition tables rather than the more accurate chemical analysis, inaccuracies will have occurred. This is due mainly to food tables being compiled from the chemical analysis of samples of food, which vary considerably in the raw state and which vary even more so once local cooking practices are added. Even manufactured foods can vary substantially, particularly with regards to added vitamins and minerals (Cameron and Van Stavern, 1988). An additional concern is differences in bioavailability. Widdowson and McCance as long ago as 1943 felt there were two schools of thought over the nutritional information provided in food composition tables. One is that the data provided was as accurate as atomic weights while the other dismissed the data due to variations present in foods because of different soils, seasons and rates of growth. McCance and Widdowson felt that the accuracy of the figures lay somewhere in-between these two extremes. These problems are more serious when assessing individual estimates of intake rather than group estimates as presented in this study, and less serious for the macronutrients than the micronutrients.

5.4.2 Energy provided and consumed

Energy from food and fluid provided by establishments to subjects, in the present study, was on average, 8.1MJ/d (*SD* 1.7MJ/d) for men and 6.9MJ/d (*SD* 1.2MJ/d) for females. On average, this met 88% of the EAR for energy (DoH, 1991) for males and 90% for females. Within sex and certain age groups (women and men 65 years and over) energy offered was statistically significantly below age and gender specific EAR for energy (see Table 27).

Table 27: Mean energy content of food offered and consumed compared to DoH 1991 EAR for energy

Measurement	Males (MJ/d)	Females (MJ/d)	% below age specific EAR for energy Males	Females
EAR 60-64 years	9.93	7.99		
EAR 65-74 years	9.71*	7.96*		
EAR 75 + years	8.77*	7.61*		
Energy in food *offered*	8.1	6.9	79	79
Energy *intake*	6.7	5.3	91	97

*Significantly different from energy intake and energy offered ($p < 0.05$)

As the mean age of the male group was 77.7 years (*SD* 6.1 years) and the female group was 84.2 years (*SD* 7.7 years), this result suggests that, compared to the EAR, energy provided was inadequate in this sample. This is of concern as long term elderly residents rely on solely on their care establishment to provide them with adequate nutrition for the remaining years of their lives. The EAR for energy is seen as the minimum requirement which should be provided from NHS establishments if they are following the standards set in the Scottish Diet Action Plan (Scottish Office DoH, 1996) and the Health of the Nation's Nutritional Guidelines for Hospital Catering (DoH, 1995).

As energy in food offered did not meet the EAR, subsequently dietary intakes were also inadequate compared to EAR (see Table 27). On average energy intakes were very low with males consuming 6.7MJ/d (*SD* 0.7MJ/d) and females 5.3MJ/d (*SD* 1.3MJ/d). Energy intakes only met 65% of the EAR for males and 69% of the EAR for females. Compared to other elderly institutionalised and hospitalised groups, energy intakes were slightly lower or similar, which suggests the problem is widespread and not specific to the sites studied here. In the study by Fevre (1993), NHS long stay elderly patients' energy intakes (assessed using 3 day weighed food record) were 7.3MJ/d (*SD* 1.5MJ/d) for males and 6.2MJ/d (*SD* 0.9MJ/d) for females. In the Sutherland and Wooton (1992) study, (measured by 7 day food record) two groups of long-stay dementia patients' energy intakes were 5.7MJ/d (SE 0.6) (weight losing group) and 6.4MJ/g (SE 0.5) (weight stable group). In the study by Klipstein-Grobusch et al (1995), the energy intakes of acutely sick elderly were on average 5.2MJ/d (*SD* 1.9MJ/d) in males and in females, 4.5MJ/d (*SD* 1.0MJ/d).

In the study by Thomas et al (1987) an average energy intake of 5.2MJ/d was reported in long-stay elderly patients (mean age 81.7 years). When the energy intake of this group was compared to energy intake data (6.6MJ/d - 7.4MJ/d) from other studies of apparently healthy elderly people in the community, aged over 65 years, (Vir and Love, 1979; Bunker et al, 1984; Bunker et al, 1987), the community group had the higher intake and the housebound elderly group had the lowest energy intake of 4.8MJ/d.

It would therefore appear that energy intakes of the group studied in this thesis are low and this may be expected due to a number of factors including age, institutionalisation, poor health, high level of dependency and inadequate energy provision. It should be noted that an assessment of adequacy of intake must be made by assessing energy requirements and this is discussed below (energy expenditure). Further discussion on these points can also be found in Section 1.2.

5.4.3 Energy expenditure

5.4.3.1 Basal Metabolic Rate (BMR)

A reduction in BMR with ageing is, superficially, a biological fact (Durnin, 1983). Fleisch (1954), found the BMR of women aged 40 years was 34.9kcal/m^2/h and at age 70 years was 31.7kcal/m^2/h; the equivalent values for men were 36.3kcal/m^2/h at 40 years and 33.8kcal/m^2/h at 70 years. However, these conclusions were based on cross-sectional studies and few longitudinal investigations. As noted earlier (Section 1.2), other studies such as those by Keys et al (1973), Tzankoff and Norris (1977), and Schock and Yiengst (1955) indicate that if elderly people can avoid the normal marked changes in body composition, reduced muscle mass and increased fat mass, then BMR will not necessarily become markedly lower with advancing age. The WHO (1985) used equations to predict BMR (Schofield et al, 1985). However, the studies from which the equations were derived contained very few elderly subjects and are, therefore, less appropriate for the elderly. The equations for estimating BMR recommended by the DoH (1992) and used in this present study, were derived from additional data on elderly subjects. Substantial biases and random errors have been found in cross validation of estimated BMR equations in younger adults (Clark and Hoffer, 1991). However, Klipstein-Grobusch et al (1995) found no clear evidence for systematic error in the application of the DoH (1992) equations for the group of acutely sick hospitalised elderly patients, although the range of individual errors was large and subject numbers small (n=20). Similarly, Reilly et al (1995) found predicted and measured BMR were similar in the study of long stay elderly patients but that measured BMR exceeded predicted BMR in the acutely sick elderly group. Therefore, as the present study sample was not acutely ill, determining BMR from equations was considered appropriate.

The mean estimated BMR of males in the study was 5.8MJ/d (*SD* 0.6MJ/d) which was higher than that of the women at 4.8MJ/d (*SD* 0.5MJ/d). This was expected, as males have a higher lean body mass than females. Compared to the findings of measured BMR by other authors, the estimated BMR of females in this present study was similar to measured BMR of Reilly et al's (1995) group of long-stay elderly females (n=8; 4.8MJ/d, *SD* 0.6MJ/d), lower than the acutely ill elderly female group (n=5; 5.8MJ/d, *SD* 0.6MJ/d) and slightly lower than Reilly et al's (1993), healthy community female elderly group (n= 10; 5.1MJ/d,*SD* 0.4MJ/d). Compared to Klipstein-Grobusch et al's (1995) group of acutely ill elderly (measured BMR 5.1MJ/d (*SD* 0.8MJ/d) for men and 4.5MJ/d (*SD* 0.9) for women), the estimated BMR of the study presented was similar. Fredrix et al (1990) studied a group of community elderly and mean BMR was 6.3MJ/d (*SD* 1.1), lower than the present study sample. Therefore, *estimated* BMR of the present study sample would appear similar to long stay elderly patients and not community or acutely ill elderly, with the exception of Klipstein-Grobusch et al's (1995) acutely sick elderly female group.

5.4.3.2 Total Energy Expenditure (TEE)

Age, body composition, health status, physical activity and mechanical efficiency will affect TEE. As noted in 1.2, it is generally considered that ageing seems to be associated with a reduction in total energy expenditure through a combination of reduced BMR due to loss of fat-free mass and reduced time spent on or intensity of physical activity (Cunningham, 1969; McGandy et al 1966). In the study group, physical activity was negligible as the majority were chair bound and heavily dependent, making energy expenditure in this group likely to be reduced compared to a healthy free living elderly population.

Estimating the energy expenditure of physical activity is traditionally calculated from the duration of various work and leisure activities and assigning an energy cost to each of them. This energy cost can then be expressed as a multiple of BMR, for example BMR x 1.2 for sitting if no other activity takes place (DoH, 1991). However, as the study population were broadly similar in their activity patterns, an overall ratio of the group was considered appropriate, as supported by others (Reilly et al,1995; DoH, 1992). The estimated TEE (BMR x 1.3 PAL) for the study group was 6.5MJ/d (*SD*0.9MJ/d), for men was 7.5 MJ/d (*SD*0.7MJ/d) and for women was 6.9MJ/d (*SD*0.6MJ/d). Calculating TEE using the BMR x 1.5 PAL produced a higher estimated TEE for the group of 7.5MJ/d (*SD* 1.0 MJ/d), for men of 8.7 MJ/d (*SD* 0.8MJ/d) and for women of 7.1 MJ/d (*SD* 0.7 MJ/d).

5.4.3.3 Energy balance

The results indicated that energy provided to the sample group by establishments (mean 7.2MJ/d both sexes) was significantly higher than the BMR all the BMR x 1.3 and 1.5 (see Table 28).

Table 28: Energy content of food offered and consumed compared to estimated BMR and ETEE (PAL 1.3 and 1.5)

Measurement	Both sexes (MJ/d)
BMR	5.0*
ETEE x 1.3	6.5*
ETEE x 1.5	7.5*
Energy in food *offered*	7.2
Energy *intake*	5.7

*Significantly different from energy offered and consumed ($p<0.05$)

Therefore, it would appear that energy offered was inadequate when compared to calculated ETEE x PAL 1.5 as well as EAR (DoH, 1991 and 1992) but significantly higher than ETEE x 1.3 and BMR. The DoH (1991 and 1992) calculated their published EAR figures using BMR x 1.5 PAL but used average body weight of elderly individuals, who were heavier than our institutionalised group. Therefore, higher EAR values were obtained. For establishments setting catering standards for minimum energy provision to an elderly long stay group (non-mentally ill), calculating BMR x 1.5 PAL of their elderly group is unreasonable and though published EAR values may be higher than actually required, the Health of the Nation's Standards for Hospital Catering (DoH, 1995) seem sensible in recommending the DoH (1991) EAR values for energy. This is appropriate as it should prevent negative energy balance, maintain vitamin and mineral requirements and nutritional status should move towards that of the free-living elderly community. With energy offered being inadequate it was not surprising to find other inadequacies in the diet with vitamin D, iron, folate, potassium and NSP also being significantly below RNI levels.

It is also of concern that the food provided to subjects in this study was also being offered to younger acutely ill patients in three out of the four establishments studied. This younger group's energy requirements were likely to be significantly higher than those of the elderly group studied here. Therefore, the nutritional risk for these individuals is very high and raises the question of the adequacy of one menu for all patient groups. A further study measuring total energy expenditure and the nutritional content of diet offered within various hospital groups, using the same menu, would be required to determine the true extent of energy inadequacies in the current menu system or a study of long-term changes in body weight. Also, social and environmental aspects of dietary provision would have to be assessed to determine if there was a problem in this area. One of the reasons for the inadequacies in the diets provided was the lack of nutritional assessment of the menus. Neither the Health Board's Nursing Home Inspection Team or the NHS Trusts involved in this study assessed patient menus for nutritional adequacy. If they had, the nutritional problems found in this study may have been avoided. Analysis and assessment of patient menus, by a State Registered Dietitian, has now been recommended in the Scottish Diet Action Plan (Scottish Office, DoH, 1996) and this study would support this recommendation.

As observed by Thomas et al (1988), elderly residents eat far less than is presented to them due to various factors including poor appetite, inability to chew and difficulty in manipulating cutlery. In the present study, similar observations were made and it was rare for subjects to consume all that was provided. Therefore, mean energy intakes were substantially lower than energy offered (see Table 27). Energy intakes were found to be significantly higher than estimated BMR for both sexes. However, compared to ETEE, the energy intakes of males and females were significantly lower than BMR x 1.3 PAL and BMR x 1.5 PAL. Also, 70% of subjects' energy intakes fell below ETEE using a PAL of 1.3. These results indicate that energy intakes were adequate to meet the BMR but not to maintain activity and thermogenesis. However, it is conceivable that some of the very inactive members of the patient group may be in energy balance at PALs of 1.1 (Reilly et al, 1995). If subjects' energy expenditure is lower than 1.3 x BMR this may explain why a relatively low prevalence of undernutrition (11-24%) was found in the study group compared to the 70% of subjects not meeting estimated BMR x 1.3 PAL. Unfortunately, the present study cannot determine energy balance in the group due to its cross-sectional design. A longitudinal study assessing measured energy expenditure, dietary intakes and changes in nutritional status would be required to assess this. However, for reasons given above, even if residents maintain energy balance at a level of less than 1.3 x BMR, this is still of concern in relation to their micronutrient intake.

5.4.4 Protein and energy

The protein offered (1.28g/kg body weight/d) and consumed (1.0g/kg body weight/d) by the sample group did appear to be adequate when compared to 0.75g/kg body weight/d as recommended by WHO (1985). It also was adequate when compared against the DoH (1991) RNI for protein (see Table 29).

Table 29: Mean protein content of food offered and consumed compared to DoH (1991) RNI

Measurement	Males (g/d)	Females (g/d)
RNI protein (g/d)	53.3	46.5
Protein in food *offered*	72.0	65.3
Protein intake	59.7	49.1

As mentioned in Section 1.5, adequate energy is necessary for a protein sparing effect (DoH, 1992). If energy intakes are inadequate, as suggested in the study presented, then protein intake may be inadequate as protein will be used as an energy source rather than a protein source. Nitrogen balance studies would be required to assess if this was the case. In the study by Thomas et al (1988) in 21 long-term elderly patients, the mean protein intake of 0.79g/kg body weight/d was considered adequate, this is a value lower than that found in the study presented. Thomas et al highlighted that protein synthesis and degradation are linked with protein intake *per se,* and non-protein energy. However, the link is not inextricable and the effects of chronic sub-nutrition and illness are ill-defined.

5.4.5 Nutrient Density

The nutrient density of dietary intakes observed seemed poor when compared to NSP and iron, as they were below either the LRNI or EAR. Nutrient results indicate that nutrients such as vitamin D, potassium, folate, and iron were significantly below the RNI, suggesting that the low energy intake of the group led to a decreased micro-nutrient intake. Similarly, Fevre (1993) found in the study in long stay elderly people, inadequate iron, NSP, vitamin C, folate and vitamin D with low energy intakes.

5.4.6 Fluid and non-starch polysaccharide (NSP)

As indicated in Section 1.6, constipation is known to be more prevalent amongst institutionalised elderly (Kallman, 1983; Burkitt et al, 1979; Witchita, 1977; Zimring, 1978). Since inadequate energy, fluid and NSP intakes have been indicated as one cause for constipation, these factors are discussed briefly with relation to the group studied.

The amount of fluid offered (mean 22.5ml/kg; *SD* 6.6ml/kg) and actually *consumed* (mean 17.9ml/kg; *SD* 5.4ml/kg) in this study, were significantly lower ($p<0.01$) than the amount recommended by Lipschitz (1992) of 30ml fluid/kg body weight per day and therefore the fluid intakes were probably inadequate. NSP offered to (mean 11g/d, *SD* 2.5g/d) and consumed (mean 8.2g/d, *SD* 3g/d) were also inadequate as they both fell significantly below ($p<0.01$) all DRVs including the LRNI of 12g/d. Similarly, a high level of laxative use and inadequate fluid and NSP intakes were found in the elderly long stay patients in Glasgow (Fevre, 1993). Compared to the Glasgow group's fluid intake (mean 913ml/d for men; 841ml/d for women), the study group (mean 1138.6ml/d for men; 964.8ml/d for women) had the higher intake, but fluid intakes in the Glasgow study may have been underestimated as only drinks were assessed as fluid, in contrast to the present study which assessed all dietary sources of fluid. Intakes of NSP were higher in the Glasgow group (mean 14.8g/d for men, 13g/d for women) compared to the study group (mean 8.2g/d). As with the Glasgow study, there were good sources of high NSP containing foods available from the menu but few subjects selected them. This may be as a result of long standing dietary habits which are difficult to change, or mastication problems with high NSP foods.

Unfortunately, fruit was offered on the menu as an alternative pudding rather than as an extra snack and therefore fresh fruit intake was poor. Fluids were only offered at set times through the day in cups that were rarely full in case the subject spilled. Staff offering fluids rarely took account of patient preferences and therefore drinks with the wrong complements were often served and consequently not consumed. In addition, the choice of drinks was limited.

As mentioned previously, energy intakes were probably inadequate in the present study. In the study by Johnson et al (1988), dietary intakes of 6 regular laxative using nursing home residents and 7 non-laxative using independent living elderly found nursing home menus to contain adequate dietary NSP but subjects only consumed 70-85% of the NSP served. NSP intake of the nursing home subjects was lower than the independent group, as was their total energy intake, but the amount of dietary NSP per 1000kcal of the two groups was not different. Other factors such as substantial medication and inadequate physical activity were highlighted as possible reasons for difference in bowel habits between the two groups. The study concluded that total dietary NSP is only part of the basis for inadequate bowel function in elderly populations but that a modest increase in NSP would improve bowel function and reduce laxative use.

Many of the factors which have been associated with constipation are present in the study group including inadequate energy, fluid and NSP intakes, low physical activity levels and high medication use. Therefore, it may not be surprising to find a large proportion (66%) of constipated residents in the population from which this sample was drawn. It is outwith the scope of this study to determine which factors influenced constipation the most within this group, but there is little doubt that the inadequate energy, fluid and NSP intakes will have contributed considerably to the problem and provide one explanation for the high level of laxative use.

5.5 Environmental observations

Observations of the environment in the wards studied provided some reasons as to why food and fluid offered and consumed was inadequate in its nutrient content. Fenton (1989) indicated in the study of 14 long stay elderly wards over nine months, that nutritional deficiencies and inadequacies can occur in hospital wards through failure in menu planning, food preparation, food delivery, quantity and quality, eating environment and food service on wards. Instances such as fish served with no sauce, bulk trolley food items spilling and mixing together on transportation, and ordering of inappropriate meals by staff were common place. Patients' eating difficulties were compounded by unsuitable chairs and tables for meals which made the transfer of food from plate to mouth very difficult. Eating aids such as non-slip mats and plate guards were not used which caused difficulties for some patients. Cutlery was laid on bare tables with no cloths, condiments or decoration. Food was loaded into bulk trolleys 2-3 hours before it was sent to wards which probably led to serious deterioration in the quality of the food. Nursing staff were found to be handicapped by poor staffing ratios, incompatibility with catering, portering and nursing rosters, lack of guidance on appropriate menu choices and a lack of awareness of the importance of ward practice to safeguard the nutritional status of patients. Henderson (1988) indicated several socio-economic and psychological risk factors for undernutrition, such as cultural diet restrictions, loss of control over food choices, depression, unattractive surroundings, distraction at mealtimes, inappropriate food timing or food temperature, need for assisted feeding and victims of abuse. Within this study, most of these issues and risk factors associated with inadequate diet and undernutrition could be identified in many of the wards observed, such as inappropriate menus, poor surroundings, bad timing of meals and inadequate staff numbers. It was outwith the scope of this study to measure the effects this had on residents' nutritional intake or status. However, issues such as the menus in Kirklandside, Biggart and Ayrshire Central Hospitals not being devised for the elderly specifically meant that many dietary items were unsuitable in consistency and taste for an elderly group and, therefore, not chosen or consumed which would have an adverse effect on nutrient intake. In Arran View Nursing Home the menus were altered every three months but the Matron insisted that reduced sugar and low fat foods should be used where possible, in the belief this was 'healthy', not realising that this could make the energy content of the diet deficient. With residents frequently not given the choice of meals or drinks and staff not knowing their preferences due to little information being recorded regarding residents' dietary preferences, residents were often offered food and drinks they did not like. This may have led to the high level of waste. As no nutritional screening was undertaken in any of the sites, undernutrition was unlikely to be identified at an early stage.

Overall, this study identified poor instances of nutritional care at each site which if improved would likely increase dietary intakes, improve nutritional status and as a result enhance health and quality of life. However, only an intervention study could establish if an improved environment would lead to improved nutrient intake and nutritional status

6. Summary

The aim of the present study was to examine the nutritional status of a representative sample of NHS continuing care elderly people, to assess the nutritional content of the diet offered and consumed by the elderly sample and to examine their eating environment. There were three main areas of interest: identifying undernutrition; determining the adequacy of energy, NSP and fluid in the diet; identifying possible social and physical environmental factors which may have influenced the dietary intake of the group.

6.1 Nutritional status

As discussed in Section 1.2, nutrition is an important factor in the functional outcome of ageing. However, the importance of nutrition is frequently under-recognised and as a result undernutrition is high within vulnerable sections of the elderly population, for example those in long term care. Undernutrition is agreed to be the main area of concern when assessing malnutrition in the elderly (DoH, 1992). However, there is a definite lack of anatomical and anthropometrical information on the elderly (Bannerman, 1997). Currently in the UK there are two main sets of anthropometric reference data for people aged over 65 years, both of which were used for comparison purposes with the study sample, an elderly group of individuals in receipt of NHS long-term care. Trends of declining body mass index, upper arm fat and muscle mass with increasing age and differences in anthropometry between the genders were identified in both subject and reference groups. However, the absolute anthropometric values appeared to differ. The study group was, on average, leaner and more muscular than both reference groups. Differences in anthropometric values between populations have also been described by other authors (Delarue, 1994; Launer and Harris,1996; Bannermann et al, 1997). Differences found may have been as a result of various factors such as genetic effects, childhood nutrition, secular trends, methodological differences, socio-economic status, health behaviour and physical activity levels (Launer and Harris,1996; Burr and Philips, 1984). The significance of differences in anthropometric data between elderly groups has potentially important implications for screening and identifying malnutrition. There is also a lack of appropriate and clinically defined criteria for identifying undernutrition within the elderly (DoH, 1992; Bannerman et al, 1997). Various criteria were applied to the anthropometric data collected from elderly people in receipt of NHS long term care in the four establishments studied. The prevalence of undernutrition within the group varied from 11%-24% depending on which one of the criteria selected (BMI; BMI and cAMA; cAMA) was used. Using similar criteria, the prevalence rate was also found to differ from other areas. For example, using the most commonly used criteria for undernutrition (BMI < 20), the 24% prevalence rate identified appeared low compared to one local elderly long term care group (39%, Fevre, 1993) and high compared to a free-living community elderly sample (18% in men and 12% in women, DoH, 1972). It is unknown whether these differences were as a result of true differences in undernutrition within the groups or due to the sensitivity and specificity of the criteria used, all of which appear to be flawed. Until standard clinically defined criteria for identifying undernutrition have been developed and used extensively the prevalence rates for undernutrition between studies will continue to vary considerably and, more importantly, individuals will continue to be placed at risk by not being identified and therefore treated appropriately.

6.2 Energy Balance

The results from the present study indicate that the energy provided by establishments was insufficient to meet the groups' ETEE as calculated using a PAL of 1.5 but not a PAL of 1.3. It was insufficient to meet DoH (1991) EAR for energy. Energy offered was therefore considered inadequate as standards for hospital catering (DoH, 1995) indicate that the EAR should be met. Energy intakes were found to be significantly higher than BMR but significantly lower than BMR x 1.3 for men and women. This indicates that energy intakes were adequate to meet BMR but not to maintain energy expended on thermogenesis and physical activity. The physical activity of the group appeared low, although this was not measured, but it is possible that some individuals may have been in energy balance even at this extremely low energy intake. If subjects' energy expenditure was lower than BMR x 1.3 then this may explain why a relatively low prevalence of undernutrition was found when 70% of the groups' energy intake was below estimated BMR x 1.3. A longitudinal study might have revealed that negative energy balance was common, but this was not possible in the time available. The low energy intake may have led to the groups' intake of other nutrients such as NSP, potassium, folate and iron being below the RNI.

6.3 Fluid and non-starch Polysaccharide

Inadequate intakes of energy, fluid and NSP were found and as these have been identified as possible factors leading to the development of constipation, their contribution to the problem is highly likely. Other factors such as multiple medication and low physical activity were also present within this group. Identifying which factor most influences the development of constipation would require further investigation, beyond the scope of this thesis.

6.4 Environmental aspects of nutritional care

Both the physical and social environment have been indicated as influencing dietary intake and nutritional status of the residents (Fenton, 1989; Keller, 1993; Henderson, 1988). Failures in menu planning, food delivery, quantity and quality of food and drink offered, eating environment, and lack of nutritional screening have all been identified as possible factors leading to inadequate intake and poor nutritional status (Fenton, 1989). The environmental observations conducted during this study identified many areas of poor practice relating mainly to resident choice of snacks, drinks, meals, eating place, eating company, lack of nutritional screening and inadequate menus for the elderly in terms of type of dishes offered as well as nutrient content.

7. Recommendations and outcome of the present study

From this study, a report was prepared and presented to the Ayrshire and Arran Health Board. The report made specific recommendations to the providers of long term care involved in the audit, management of each NHS Trust and Arranview Nursing Home. The main recommendations were:

1. Re-designing the menus taking account of the specific nutritional needs and culinary preferences of the elderly. Consideration of vitamin D supplements for institutionalised elderly groups.

2. Initiating nutritional screening in long term care on admission and at monthly intervals.

3. Identifying, recording and taking account of residents' preferences in all areas of food, meal, drink and snack consumption.

4. Improving the physical and social environment of wards.

5. Educating staff in nutrition and nutritional screening

6. Further investigation into the care being provided at other long-term care sites

Recommendations were taken on board by each establishment and as a result the following has occurred:

1. Completion of a second audit in long-term care in the remaining three sites in Ayrshire which provide long-term care for elderly people.
2. Establishment of a Clinical Effectiveness Group at the Health Board to assess the potential benefit of vitamin D supplementation to vulnerable elderly people throughout Ayrshire and Arran.
3. Establishment and leadership of a national nutritional audit of elderly people in various forms of long-term care, funded by the Clinical Resource and Audit Group (CRAG).
4. In conjunction with the Health Education Board for Scotland (HEBS) a nutrition education tool for all levels of staff providing NHS and non-NHS long-term care is currently being devised.

7.1 Ideas for future research

Ideas for future research as a result of the study are as follows:

1. Adequacy of energy intake compared to measured energy expenditure using the double-labelled water technique in long-term care elderly
2. Nitrogen balance in long term care elderly
3. The effect of environment on dietary intake of long-term care elderly
4. Compilation of percentile charts on health free-living elderly people in Ayrshire
5. Longitudinal studies on dietary intake and nutritional status of long-term care elderly eg to use serial measures of body weight as the adequacy of energy intake.

8. References

Arieff AL (1984) Central nervous systems manifestations of associated sodium metabolism. *Clinical Endocrinology* **13**, 269-294.

Bannermann E, Chapman N, Cowan S, Reilly JJ, Kirk T, Maclennan WJ, Pender F (1997): Evaluation of the use of knee height to estimate stature in non-institutionalised elderly individuals >75 years : implication for the determination of body mass index. *Proceeding of the Nutrition Society* **55**, 249A.

Bannerman E, Reilly JJ, Kirk T, MacLennan WJ, Pender F (1997) Evaluation of validity of British anthropometric reference data for assessing nutritional state of elderly people in Edinburgh: cross sectional study. *British Medical Journal* **315**, 338-341.

Barnes EK, Hodkinson HM, (1988) Quantification of dietary intake in long-stay geriatric patients : do we need 7 days observation? *European Journal of Clinical Nutrition* **42**, 527-530.

Basiotis PP, Welsh SO, Cronin FJ, Kelsay JL, Mertz W (1987) Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *Journal of Nutrition* **117**, 1638-1641.

Bassey EJ (1986) Demispan as a measure of skeletal size. *Annals of Human Biology* **13**, 499-502.

Bassey EJ, Terry AM (1986) The oxygen cost of walking in the elderly. *Journal of Physiology* **373:42P.**

Bassey EJ, Terry AM (1988) Blood lactate in relation to oxygen uptake during uphill treadmill walking in young and old women. *Journal of Physiology* **396:104P**

Bastow MD, Rawlings J, Allison SP (1983) Undernutrition, hypothermia and injury in elderly women with fractured neck of femur. *Lancet* **I**, 143-145.

Beaton GH (1982) What do we think we are measuring? Symposium on dietary data collection, analysis and significance. Massachusetts Agricultural Experimental Station, College of Food and Natural Resources, University of Massachusetts at Amherst. Research bulletin No **675**, 36-48.

Bistrian BR, Sherman M, Blackburn GL, Marshal R, Shaw C (1977) Cellular immunity in adult marasmus. *Archives of International Medicine* **137**, 1408-1411.

Bistrian BR, Blackburn GL, Hallowell E, Heddle R (1974) Protein status of general surgical patients. *Journal of the American Medical Association* **230**, 855-860.

Black AE, Coward WA, Cole TJ, Prentice AM (1996) Human energy expenditure in affluent societies: an analysis of 574 doubly-labelled water measurements. *European Journal of Clinical Nutrition* **50**, 72-92.

Black AE (1996) Physical activity levels from a meta-analysis of doubly-labelled water studies for validating energy intake as measured by dietary assessment. *Nutrition Reviews 54*, (**6**) 170-174.

Borgstram B, Norden A, Akesson B, Abdulla M, Jagerstad M (1979) Nutrition and old age. Chemical analysis of what old people eat and their state of health during a five year follow up. *Scandinavian Journal of Gastroenterology* **52**, 1-299.

Bownan BB, Rosenberg IH (1982) Assessment of the nutritional status of the elderly. *American Journal of Clinical Nutrition* **35**, 1142-1151

British Geriatric Society, Royal College of Physicians (1992) High quality long-term care for elderly people. Guidelines and audit measures. The Royal College of Physicians of London. London

Bunker VW, Clayton BE (1989) Research review: studies in the nutrition of elderly people with particular reference to essential trace elements. *Age and Ageing* **18**, 422-429.

Bunker VW, Hinks LJ, Lawson Ms, Clayton BE (1984) Assessment of zinc and copper status of healthy elderly people using metabolic balance studies and measurements of leucozyte concentrations. *American Journal of Clinical Nutrition* **40**, 1096-1102.

Bunker VW, Hinks LJ, Stansfield MF, Lawson MS, Clayton BE (1987) Metabolic balance studies for zinc and copper in housebound elderly people, and the relationship between zinc retention and leucozyte zinc concentrations. *American Journal of Clinical Nutrition* **46**, 353-359.

Burkitt DP, Meisner P (1979) How to manage constipation with a high fibre diet. *Geriatrics* **34**, 33-40.

Burr ML, Phillips KM (1984) Anthropometric norms in the elderly. *British Journal of Nutrition* **51**, 165-169.

Cameron A, Van Staveren W (1988) Manual on methodology for food consumer studies. *Oxford Medical Edition* **1**.

Campbell AJ, Spears GFS, Brown JS, Basby WJ, Borrie MJ (1990) Anthropometric measurements as predictors of mortality in a community population aged 70 years and over. *Age and Ageing* **19**, 131-135.

Carter H, Gorman D, Ramsay D, Tarvey T (1992) The dependant elderly: a comparative survey of institutional care in Fife. *Health Bulletin* **50**, (6), 433-438.

Carver AD, Dobson AM (1995) Effects of dietary supplementation on elderly demented hospital residents. *Journal of Human Nutrition and Dietetics* **8**, 389-394.

Caswell F (1995) Success in Statistics 3rd Edition. Ed. Caswell F. John Murray: Coventry.

Chernoff R (1994) Thirst and fluid requirements. *Nutrition Reviews* 52, **8**: 53-55.

Chumlea WC, Roche AF, Rogers E (1984) Replicability for anthropometry in the elderly. *Journal of Human Biology* **56**, 329-337.

Chumlea WC, Roche HF, Steinbaugh ML, (1985) Estimating statuer from knee height for persons 60-90 years of age. *Journal American Geriatric Society* **33,** 116-120.

Clark HD, Hoffer LJ, (1991) Re-appraisal of the resting metabolic rate of normal young men. *American Journal of Clinical Nutrition* **53,** 21-26.

Collin L, Wade DT, Davies S, Horne V (1988) The Barthel Index : a reliability study. *International Disability Studies* **10**,64-67

Cunningham DA (1969) Physical activity at work and leisure as related to occupation. *Medicine and Sports Science* **1,** 165-170.

Cummings JH, Bingham SA (1992) Towards a recommended intake of dietary fibre. In: pp 107-108. *Human Nutrition: a continuing debate. Symposium entitled "Nutrition in the Nineties".* Eds C Edwards and BA Wharton Chapman and Hall, London.

Dallosso HM, Morgan K, Bassey EJ, Ebrahim SBJ, Fentem PH, Arie THD (1988) Levels of customary physical activity among the old and very old living at home. *Journal of Epidemiology and Community Health* **42,** 121-127.

Davies L (1990) Socio-economic, psychological and educational aspects of nutrition in old age. *Age and Ageing* **19,** 537-547.

De Groot CPGM, Sette S, Zajkas G, Carbajal A, Amorim Cruz JA (1991) Nutritional Status: anthropometry. *European Journal Clinical Nutrition* **45, (**Suppl 3), 31-42.

Delarue J, Constans T (1994) Anthropometric values in an elderly French population. *British Journal of Nutrition* **71**, 295-302.

Department of Health and Social Security (1972) A nutrition survey of the elderly. Report on health and social subjects No 3. HMSO, London

Department of Health and Social Security (1979) Recommended daily amounts of food energy and nutrients for groups of people in the United Kingdom. Report on health and social subjects No 15. HMSO, London.

Department of Health and Social Security (1979) Nutrition and health in old age. Report on health and social subjects No 16. HMSO, London.

Department of Health (1991) Dietary reference values for food, energy and nutrients for the UK. Report on Health and Social Subjects No 41. HMSO, London.

Department of Health (1992) The nutrition of elderly people. Report of the working group on the nutrition of elderly people of the committee on medical aspects of food policy. Report on Health and Social Subjects No 43. HMSO, London.

Department of Health (1995) Nutrition guidelines for hospital catering – The health of the nation. Pub Department of Health (August 1995).

Deurenberg P, van der Kooy, Hulshof T, Evers P (1989) Body mass index as a measure of body fatness in the elderly. *European Journal of Clinical Nutrition* **43,** 231-236.

Dionigi R, Gnas F, Bonera A, Dominioni L (1979) Nutrition and infection. *Journal Parenteral and Enteral Nutrition* 3 (**2**); 62-68.

Donald IP, Smith RT, Cruickshank JG (1985) A study of constipation in the elderly living at home. *Journal of Gerontology* **31,** 112-118

Durnin JVGA, (1983) Body composition and energy expenditure in elderly people. *Bibliotheca Nutritin et Dieta.***33,** 16-30.

Durnin JVGA, Milulicic V (1956) The influence of graded exercises on the oxygen consumption, pulmonary ventilation and heart rate of young and elderly men. *Quarterly Journal of Experimental Psychology* **41,** 442-452.

Durnin JVGA, Rahaman MM (1974) The assessment of the amount of fat in the human body from measurements of skinfold thickness: Measurements on 481 men and women aged from 16 to 72 years. British Journal of Nutrition **21,** 681-689.

Eastwood M (1997) Hospital Food. *The New England Journal of Medicine* 336, **17,** 1261.

Evans GJ, Hodkinson HM, Mezey AG (1984) The elderly sick: who looks after them? *Lancet* **2**, 539-541.

Evans WJ (1995) What is sarcopenia? *The journal of Gerontology* Series A **50A** (special issue),5-8.

Everhart JE, Govlin, Johannes RS (1989) A longitudinal survey of self reported bowel habits in the United States. *Digestive Disease Science* **34,** 1153-1162.

Exon-Smith AN (1980) Nutritional status: diagnosis and prevention of malnutrition. In: *Metabolic and nutritional disorders in the elderly,* eds. Exon-Smith AN, Caird FI, pp 66-76. Wright, Bristol.

Fenton J (1989) Some food for thought. *The Health Service Journal* 660-667.

Fevre S (1993) Intake of long-stay geriatric patients in a continuing care of the elderly hospital. *Age and Ageing* (22): **S3**, 37.

Friedman PJ, Campbell AJ, Caradoc-Davies TH (1985) Prospective trial of a new diagnostic criteria for sever wasting malnutrition in the elderly *Age and Ageing* **14**, 149-154.

Fischer M, Adkins W, Hall, Scaman P, Hsis, Marlett J (1985) The effects of dietary fibre in a liquid diet on bowel function of mentally retarded individuals. *Journal of Mental Deficiency Research* **29**, 373-381.

Fleisch A (1954) Nouvelles méthodes d'etude des échanges ga seax et de la fonction palmonaire. *Schwabe, Basal.*

Frisancho AR (1984) New standards of weight and body composition by frame size and height for assessment of nutritional status of adults and elderly. *American Journal of Clinical Nutrition* **40,** 808-819.

Frisancho AR , Flegel PN (1982) Relative merits of old and new indices of body mass with reference to skinfold thickness. *American Journal of Clinical Nutrition***36**, 697-699.

Garrow JS (1983) Indices of adiposity. *Nutrition Abstracts and Reviews* **53**, 697-708.

Gibson RS (1990). Principles of Nutritional Assessment. Eds Gibson RS. Oxford University Press, New York.

Gregory J, Foster K, Tyler H, Wiseman M (1990) The dietary and nutritional survey of British adults. HMSO, London.

Haboubi NY, Hudson PR, Pathy MS,(1990) Measurement of height in the elderly. *Journal of the American Geriatric Society* **38,** 1008-1010.

Hale NE, Perkins LL, May FE (1986) Symptom, prevalence of constipation in the elderly. *Journal of the American Geriatric Society* **34,** 333-340.

Hanson LC, Weber DJ, Rutala WA, Samsa GP (1992) Risk factors for nosocomial pneumonia in the elderly. *American Journal of Medicine* **92**, 161-166.

Heatley RV, Williams RHP, Lewis MH (1979) Pre-operative intra-venous feeding - a controlled trial. *Postgraduate Medical Journal* **55**, 541-545.

Hellon RF, Lind AR, Weiner JS (1956) The physiological reactions of men of two age groups and to a hot environment. *Journal of Physiology* **133,** 118-131.

Henderson CT (1988) Nutrition and malnutrition in the elderly nursing home patient. *Clinical Geriatric Medicine* **4,** 527-547.

Heymsfield SB, Casper K (1987) Anthropometric assessment of the adult hospitalised patient. *Journal Parenteral and Enteral Nutrition* **11,** 365-415.

Heymsfield SB, McManus CB, Smith J, Stevens V, Nixon DW (1982) Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. *American Journal of Clinical Nutrition* **36**, 680-690.

Himmeistein DU, Jones AA, Woolhanier S (1983) Hypernatraemic dehydration in nursing home patients. *Journal American Geriatric Society* **31**, 466-471.

Hodkinson HM (1972) Evaluation of the mental test score for assessment of mental impairment in the elderly. *Age and Ageing* **1**, 233-238.

Hope AK, Down EL (1986) Dietary fibre and fluid in the control of constipation in a nursing home population. *Medical Journal of Australia* **144**, 306-307.

James WPT, Shettly PS (1982) Metabolic adaptations and energy requirements in developing countries. *Huma Nutrition: Clinical Nutrition* **36**, 331-336.

Jelliffe DB, The assessment of the nutritional status of the community. *WHO Monograph No 53*. World Health Organisation, Geneva (1966).

Johnson EJ, Roth LA, Reinhardt JT, Marlett JA (1988) Dietary fibre intakes of nursing home residents and free living older adults. *American Journal of Clinical Nutrition* **48,** 159-164.

Jones E, Hughes RRE, Davies HEF (1988) Intake of Vitamin C and other nutrients by elderly patients receiving a hospital diet. *Journal of Human Nutrition and Diet* **1,** 347-353.

Kallman H (1983) Constipation in the elderly. *American Family Physician* **27,** 179-184.

Katz S, Branch LG, Branson MH, Papsidero JH, Beck JC, Greer DS (1983) Active life expectancy. *New England Journal of Medicine* **309**, 1212-1224.

Keller HH (1993) Malnutrition in institutionalised elderly. How and why. *American Geriatric Society* **41,** 1212-1218.

Kelly SM, Rossa A, Field S, Coughlin M, Schizgal HM, Macklem PT (1984) Inspiratory muscle strength and body composition in patients receiving total parenteral nutrition therapy. *American Review of Respiratory Disease* **130,** 33-37

Kemm JR, Allcock J (1984) The distribution of supposed indicators of nutritional status in elderly patients. *Age and Ageing* **13**, 21-28.

Kerstetter JE, Holthausen BA, Fitz PA (1992) Malnutrition in the institutionalised older adult. *Journal of the American Dietetic Association* **92:9,** 1109-1116.

Keys A, Taylor HL, Grande F (1973) Basal metabolism and age in adult man. *Metabolism* **22,** 579-587.

Kings Fund Centre Report (1992) A positive approach to nutrition as treatment. Kings Fund Centre, London

Kinnunen O, (1991) Study of constipation in a geriatric hospital, day hospital, old peoples' home and at home. *Age and Ageing* **3,** 161-170.

Klipstein-Grobusch K, Reilly JJ, Potter J, Edwards CA, Roberts MA (1995) Energy intake and expenditure in elderly patients admitted to hospital with acute illness. *British Journal of Nutrition* **73,** 323-334.

Laing and Buisson (1994) Care of elderly people. *Merlat Survey.* Laing and Buisson: London

Larsson J, Unosson M, Nilsson L, EK A-C Thorslund S Biuralf P (1990) Effect of dietary supplement on nutritional status and clinical outcome in 501 geriatric patients - a randomised study. *Clinical Nutrition* **9,** 179-184.

Launer LJ, Harris T (1996) Weight, height and body mass index distributions in geographically and ethnically diverse samples of older persons. *Age and Ageing* **25,** 300-306.

Lennard JE, Arrowsmith H, Davidson C, Denham AF, Micklewright A (1995) Screening by nurses and junior doctors to detect malnutrition when patients are first assessed in hospital. *Clinical Nutrition* **14,** 336-340.

Lehmann AB, Bassey EJ, Morgan K Dallosso HM (1991) Normal values for weight, skeletal size and body mass indices in 890 men and women aged over 65 years. *Clinical Nutrition* **10,** 18-22.

Lesser GT, Markofsky J (1979) Body water compartments with human ageing using fat-free mass as the reference standard. *American Journal of Physiology* **236,** R215-220.

Lindeman RD, Tobin J, Shock NW (1985) Longitudinal studies on the rate of decline in renal function with age. *Journal American Geriatric Society* **33,** 278-285.

Lipschitz D (1992) Nutrition and ageing. *Oxford Textbook of Geriatric Medicine* Oxford University Press.

Lipski PS, Torrance A, Kelly PJ, James OFW (1993) A study of nutritional deficits of long-stay geriatric patients. *Age and Ageing* **22,** 244-255.

Livingstone MBE, Prentice AM, Strain JJ, Coward WA (1990) Accuracy of weighed dietary records in studies of diet and health. *British Medical Journal* **300,** 708-712.

Loenen HMJA, Eshuis H, Lowik MRH Schouten EG, Hulshof KFAM, Odink J, Kok FJ (1990) Serum uric acid correlates in elderly men and women with special reference to body composition and dietary intake (Dutch Nutrition Surveillance System). *Journal of Clinical Epidemiology* **43,** 1297-1303.

Lohmann TE (1992) Advances in body composition assessment. Ed Lohmann TE. Human Kinetics Publishers, Leeds.

Lówik MRH, Hulshof KFAM, Schnegder P, Schrijver J, Colen AAM, van Houten P (1993) Vitamin C status in elderly women : a comparison between women living in a nursing home and women living independently. *Journal of the American Dietetic Association* **93,** (21), 167-172.

Lundgren BK, Steen B, Isaksson B (1987) Dietary habits in 70 and 75 year old males and females longitudinal and cohort data from a population study. *Naringforskning* **31,** 53-56.

Mahoney F, Bathel D (1965) Functional evaluation: The Barthel Index *Maryland Medical Journal* 61-65.

Mattila K, Haavisto M, Rajala S (1986) Body mass index and mortality in the elderly. *British Medical Journal* **292**, 867-868.

Melin L, Gotestam GK (1981) the effects of re-arranging ward routines on communication and eating behaviours of psychogeriatric patients. *Journal Applied Behaviour Analysis* **14**, 47-51.

MacDonald NJ, McConnell KN, Stephen Mr, Dunnigan MT (1989) Hypernatraemic dehydration in patients in a large hospital for the mentally handicapped. *British Medical Journal* **299**, 1426-1429.

McGandy RB, Barrows CH, Spanias A, Meredith A, Store JL, Norris AH (1966) Nutrient intakes and energy expenditure in men of different ages. *Journal of Gerontology* **21,** 581-587.

McWhirter JP, Pennington CR (1994) The incidence and recognition of malnutrition in hospital. *British Medical Journal* **308**, 945-948.

Morgan BD, Newton HMV, Schorah CF, Jewitt AM, Hancock MR, Hullin RP (1986) Abnormal indices of nutrition in the elderly, a study of different clinical groups. *Age and Ageing* **15,** 65-76.

Mühlethaler R, Stuck AE, Minder CE, Frey BM (1995) The prognostic significance of protein-energy malnutrition in geriatric patients. *Age and Ageing* **24,** 193-197.

Munro HN. Nutrition, ageing and the elderly (1989). Eds Munro MN and Danforf DE. Plenum Press, New York.

Munro HN. Nutrition of the elderly (1992). Eds Munro H, Schlierf G, Nestle Nutrition Workshop Services. Vol 29 Nestle Ltd Vevey/Raven Press Ltd, New York.

Murray LA, Reilly JJ, Choudhry M, Durnin JVGA (1996) A longitudinal study of changes in body composition and basal metabolism in physical active men. *European Journal of Applied Physiology* **72,** 215-218.

North Ayrshire and Arran NHS Trust (1992) Unpublished report on laxative use in long-term elderly care.

Office of population censuses and surveys (1985) Hospital in-patient enquiry. HMSO London (1987).

Parenteral and Enteral Nutrition Group (1997) A pocket guide to clinical nutrition 2nd edition. Ed. Todorovic VE, Micklewright A. Birmingham: British Dietetic Association.

Patrick JM, Bassey EJ, Irving JM, Blecher A, Fentern PH (1986) Objective measurements of customary physical activity in elderly men and women before and after retirement. *Quarterly Journal of Experimental Physiology* **71,** 47-58.

Pennington CR (1997) Disease and malnutrition in British hospitals. *Proceedings of the Nutrition Society* **56**, 393-407.

Pfeil LA, Katz PR, Davis PJ (1990) Water metabolism. In: Morley JE, Glick Z, Rubenstein LZ, eds Geriatric Nutrition. New York: Raven Press 193-202.

Phillips PA, Rolls BJ, Ledingham JGG (1984) Reduced thirst after water deprevation in healthy elderly men. *New England Journal of Medicine* **311**, 753-759.

Potter J, Klipstein K, Reilly JJ, Roberts M (1995) The nutritional status and clincial course of acute admissions to a geriatric unit. *Age and Ageing* **24,** 131-136.

Potter JF, Schafer DF, Bohi RL (1988) In-hospital mortality as a function of body mass index: an age dependant variable. *Journal of Gerontology* 43, **(3)** M59-63.

Prentice AM (1992) Energy expenditure in the elderly. *European Journal of Clinical Nutrition* **46,** Suppl. 3, 21-28.

Prentice AM, Leavesley K, Murgatroyed PR, Coward WA, Schorah CJ, Bladon PT, Hullin RP (1989) Is severe wasting in elderly mental patients caused by an excessive energy requirement? *Age and Ageing* **18,** 158-167.

Reiff TR (1987) Water loss in ageing and its clinical significance. *Geriatrics* 42 **(6)** 53- 62.

Registered Nursing Homes Association Reference Book London (1980) Registered Nursing Homes Association, London.

Registered Nursing Homes Association Reference Book London (1985) Registered Nursing Homes Association, London.

Reilly JJ, Lord A, Bunker VW, Prentice AM, Coward WA, Thomas AJ, Briggs RS (1993) Energy balance in healthy elderly women. *British Journal of Nutrition* **69,** 21-27.

Reilly JJ, Lord A, Bunker VW, Prentice AM, Coward A, Thomas AJ, Briggs RS (1995) Total energy expenditure as measured by double-labelled water in two groups of elderly female in-patients. *Age and Nutrition* **6,** 10-15.

Robinson G, Goldstein M, Levine GM (1987) Impact of nutritional status on DRG length of stay. *Journal of Parenteral and Enteral Nutrition* **11,** (1), 49-51.

Ross EJ, Christie SBM (1969) Hypernatraemia. *Medicine* **48**, 444-473.

Royal College of Physicians and the British Geriatric Society (1992) Standardised assessment scales for elderly people. Royal College of Physicians, London.

Royal Society of Chemistry and Ministry of Agriculture Fisheries and Food (1992) McCance and Widdowson's the Composition of Foods 5th Edition. Ed. Holland B, Welch AA, Unwin ID, Buss DH, Paul AA, Southgate DAT. Richard Clay LTD: Bungay, Suffolk.

Sandler RS, Jordan MC, Shelton BJ (1990) Demographic and dietary determinants of constipation in the US population. *American Journal of Public Health* **80,**185-189.

Sahn DE, Lockwood R, Scrimshaw NS (1984) Methods for the evaluation of the impact of food and nutrition programmes. United Nations University. Tokyo, Japan

Schock NW, Watkin DM, Yiengst MJ (1963) Age differences in the water content of body as related to basal oxygen consumption in males. *Journal of Gerontology* **18**, 1-8.

Schock NW, Yiengst MJ (1955) Age changes in basal respiratory measurements and metabolism in males. *Journal of Gerontology* **10,** 31-40.

Schoeller DA (1989) Changes in total body water with age. *American Journal of Clinical Nutrition* **50**, 1176-1181.

Schofield WN, Schofield C, James WPT (1985) Basal metabolic rate - review and prediction. *Human Nutrition : Clinical Nutrition* **39C**, (supplement) 1-96.

Schorah CJ, Morgan DB (1985) Nutritional deficiencies in the elderly. *Hospital Update* **5 (85,)** 353-360.

Scottish Office Department of Health, *Eating for Health, A Diet Action Plan for Scotland* (1996): Her Majesty's Stationary Office, Edinburgh (1996).

Scottish Office Department of Health, *Scottish Health Survey* (1995) eds Wei Dong and Bob Crens, The Stationery Office, Edinburgh 1997.

Shetty PS, Henry CJK, Black AE, Prentice AM (1996) Energy requirement of adults: an update on BMR and PAL. *European Journal of Clinical Nutrition* **51,** 11-23.

Solomons N, (1985) Assessment of nutritional status: functional indicators of paediatric nutriture . *Paediatric Clinics of North America* **32**, 319-334.

Sonnenberg A, Koch TR (1989) Physician visits in the United States for constipation. *Digestive Diseases Science* **34**, 606-611.

SPSS (1994) Manual for SPSS PC version 6.1.SPSS, Woking, UK.

Steen B, MacLennan W (1991) Nutrition. In: *Principles and Practice of Geriatric Medicine.* 2nd edition Ed MSH Rathy. John Wiley and Sons Ltd., New York, USA

Stewart RB, Moor MT, Marks RG (1992) Correlates of constipation in an ambulatory elderly population. *American Journal of Gastroenterology* **87,** 859-864.

Sullivan DH, Patch GA, Walls RC, Lipschitz DA, (1990) Impact of nutritional status on morbidity and mortality in a select population of geriatric re-habilitation patients. *American Journal of Clinical Nutrition* **51**, 749-758.

Suski NS, Nielson CC (1989) Factors affecting food intake of women with Alzheimer's type dementia in long-term care. *Journal American Dietetic Association* **89**,1770-1773.

Sutherland RM, Wooton SA (1993) Raised metabolic demands for energy may contribute to weight loss in institutionalised psychogeriatric patients. *Proceedings of the Nutrition Society* **52**, 45A.

Thomas AJ, Bunker VW, Hinks LJ, Sodha N, Mullee MA, Clayton BE (1987) Energy, protein, zinc and copper status of twenty-one elderly in-patients : analysed dietary intake and biochemical indices. *British Journal of Nutrition* **59,** 181-191.

Thomas AJ, Finglas P, Bunker VW (1988) The B vitamin content of hospital meals and potential low intakes by elderly in-patients. *Journal of Human Nutrition and Dietetics* **1,** 309-320.

Thuluvath PJ, Triger DR (1995) How valid are our reference standards of nutrition? *Nutrition* **6,** 729-733.

Towers AL, Burgio KL, Locher JL, Merkel IS, Safaeian M, Wald A (1994) Constipation in the elderly: Influence of dietary, psychological and physiological factors. *American Journal of Geriatric Society* **42**, 701-706.

Tzankoff SP, Norris AH (1977) Effect of muscle decreases on age-related BMR changes. *Journal of Applied Physiology* **43,** 1001-1006.

Uauy R, Scrimshaw NS, Young VR (1978) Human protein requirements : nitrogen balance response to graded levels of egg protein in elderly men and women. *American Journal of Clinical Nutrition* **31**, 779-785.

Varma JS, Bradnock J, Smith RG, Smith AN (1988) Constipation in the elderly. *Diseases of the Colon and Rectum* 111-115.

Vir SC, Love AHG (1979) Nutritional status of institutionalised and non-institutionalised aged in Belfast Northern Ireland *The American Journal of Clinical Nutrition* **32**, 1934-1947.

Wade DT, Collin C (1988) The Barthel ADL Index : a standard measure of physical disability. *International Disability Studies* **10,** 64-67.

Walker D (1995) Health and ill health in Ayrshire and Arran. Ayrshire and Arran Health Board, Ayr.

Whitehead WE, Drinkwater D, Cheskin LJ (1989) Constipation in the elderly living at home. Definition, prevalence and relationship to lifestyle and health status. *American Journal of Geriatric Society* **37**, 423-429.

Widdowson EM, McCance RA (1943) Food tables, their scope and limitations. *Lancet* **(ii)**, 230-232.

Windsor JA, Graham MB, Hill GL (1988) Risk factors for post operative pneumonia. **208**, 209-214.

Witchita C (1977) Treating and preventing constipation in nursing home residents. *Journal of Gerontological Nursing* **3,** (6), 35-39.

Womersley J (1987) Population geography in an urban setting. *Advanced Geriatric Medicine* **6**, 21-39.

World Health Organisation (1985) Energy and protein requirements. Report of a joint FAO/WHO.UNU Expert Consultation. Geneva: *World Health Organisation* (WHO Technical Report Series; **724**).

Zimring JG (1978) High fibre diets versus laxatives in geriatric patients. *Geriatrics* **78,** 2223-2224.

Appendix 1

DIETARY SURVEY

Thank you for helping us in this audit. It is very important that we know exactly what has been offered and consumed by .... over the following 24 hour periods..

....

This is a very important part of the survey as it will enable us to assess if their diet is meeting nutritional needs.

A Fieldworker will be weighing all meals provided over this period, however, there may be times when Ward Staff will be required to complete the following chart eg in the evening. It is vital that their usual diet is not altered during this study period.

Please provide as much information as possible about each dietary item. For instance, whether the bread offered and consumed is white, brown or wholemeal, the number of slices of bread offered and the amount eaten. Each recording period starts at 00.00 hours and finishes at 24.00 hours.

Example

For Fieldworkers Use Only

Time	Dietary Item and amount offered	Amount Left	Weight Offered	Weight Left
8.00 pm	1 cup of tea with semi-skimmed milk one spoonful sugar	nil		
	1 slice white toast with margarine and marmalade	½		
10.00 pm	1 small glass sherry 1 piece shortbread	¾ nil		
1.00 am	1 glass milk	¼		

NB examples of useful definitions for quantities offered are: mug, cup, glass, slice, piece, etc

" " " " " " left are: nil, ¼, ⅓, ½, ¾, all

Thank you for your assistance with this audit.

Subject Name.............................. Date...............
Day...........................
Subject No. ....

For Fieldworkers Use Only

Time	Dietary Item and amount offered	Amount Left	Weight Offered	Weight Left

Appendix 2

Nutritional analysis diet offered by establishments and dietary intakes see Tables 12-65.

TABLE 12

Nutritional values of Food Offered
Split by site and by sex

Calcium mg

Site	N	Mean	SD	Min	Max	Confidence Interval for sample mean		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	790.1	187.0	468.0	1219.0	705.0 -	875.3	400	0	0	525	2	10	700	7	33
ACH	23	787.9	180.7	406.0	1308.0	709.8 -	866.0	400	0	0	525	1	4	700	6	26
Biggart	25	889.6	360.7	303.0	1975.0	740.7 -	1038.5	400	1	4	525	3	12	700	7	28
Kirklandside	30	867.5	190.9	562.0	1405.0	796.2 -	938.8	400	0	0	525	0	0	700	7	23
Total	**99**	**838.2**	**243.2**	**303.0**	**1975.0**	**789.7 -**	**886.7**	**400**	**1**	**1**	**525**	**6**	**6**	**700**	**27**	**27**
Males																
Arran View	7	833.0	219.6	648.0	1273.0			400	0	0	525	0	0	700	3	43
ACH	9	971.6	536.3	524.0	2285.0			400	0	0	525	1	11	700	3	33
Biggart	10	1043.5	446.6	638.0	2196.0			400	0	0	525	0	0	700	1	10
Kirklandside	7	1108.7	284.7	898.0	1708.0			400	0	0	525	0	0	700	0	0
Total	**33**	**993.1**	**402.1**	**524.0**	**2285.0**			**400**	**0**	**0**	**525**	**1**	**3**	**700**	**7**	**21**
Both Sexes																
Arran View	28	800.9	192.3	468.0	1273.0	726.3 -	875.4	400	0	0	525	2	7	700	10	36
ACH	32	839.6	323.2	406.0	2285.0	723.1 -	956.1	400	0	0	525	2	6	700	9	28
Biggart	35	933.6	386.8	303.0	2196.0	800.7 -	1066.5	400	1	3	525	3	9	700	8	23
Kirklandside	37	913.2	228.1	562.0	1708.0	837.1 -	989.2	400	0	0	525	0	0	700	7	19
Total	**132**	**876.9**	**297.1**	**303.0**	**2285.0**	**825.8 -**	**928.1**	**400**	**1**	**1**	**525**	**7**	**5**	**700**	**34**	**26**

TABLE 13

Dietry Intakes
Split by site and by sex

Calcium (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	678.0	211.9	581.6	-	774.4	400	2	10	525	3	14	700	13	62
ACH	23	625.0	118.6	573.7	-	676.3	400	1	4	525	6	26	700 *	17	74
Biggart	25	685.2	305.5	559.1	-	811.3	400	3	12	525	7	28	700	16	64
Kirklandside	30	723.9	181.1	656.3	-	791.5	400	2	7	525	5	17	700	16	53
Total	**99**	**681.4**	**214.9**	**638.6**	**-**	**724.3**	**400**	**8**	**8**	**525**	**21**	**21**	**700**	**62**	**63**
Males															
Arran View	7	729.1	209.6				400	0	0	525	1	14	700	4	57
ACH	9	872.0	495.5				400	0	0	525	2	22	700	4	44
Biggart	10	896.9	385.9				400	1	10	525	1	10	700	2	20
Kirklandside	7	963.9	281.7				400	0	0	525	0	0	700	0	0
Total	**33**	**868.7**	**364.5**				**400**	**1**	**3**	**525**	**4**	**12**	**700**	**10**	**30**
Both Sexes															
Arran View	28	690.8	208.6	609.9	-	771.7	400	2	7	525	4	14	700	17	61
ACH	32	694.5	293.6	588.7	-	800.2	400	1	3	525	8	25	700	21	66
Biggart	35	745.7	338.7	629.4	-	862.1	400	4	11	525	8	23	700	18	51
Kirklandside	37	769.3	220.7	695.7	-	842.9	400	2	5	525	5	14	700	16	43
Total	**132**	**728.3**	**271.3**	**681.5**	**-**	**775.0**	**400**	**9**	**7**	**525**	**25**	**19**	**700**	**72**	**55**

TABLE 14

Nutritional values of Food Offered
Split by site and by sex

Phosphorus mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	1174.6	207.2	739.0	1542.0	1080.2 -	1268.9	310	0	0	400	0	0	550	0	0
ACH	23	1111.1	190.5	728.0	1519.0	1028.8 -	1193.5	310	0	0	400	0	0	550	0	0
Biggart	25	1139.2	356.4	525.0	2080.0	992.1 -	1286.3	310	0	0	400	0	0	550	1	4
Kirklandside	30	1182.7	160.8	868.0	1560.0	1122.7 -	1242.7	310	0	0	400	0	0	550	0	0
Total	**99**	**1153.4**	**237.7**	**525.0**	**2080.0**	**1106.0 -**	**1200.8**	**310**	**0**	**0**	**400**	**0**	**0**	**550**	**1**	**1**
Males																
Arran View	7	1251.4	105.8	1158.0	1455.0			310	0	0	400	0	0	550	0	0
ACH	9	1225.2	444.6	632.0	2186.0			310	0	0	400	0	0	550	0	0
Biggart	10	1326.2	400.0	946.0	2348.0			310	0	0	400	0	0	550	0	0
Kirklandside	7	1397.6	192.7	1194.0	1749.0			310	0	0	400	0	0	550	0	0
Total	**33**	**1297.9**	**328.4**	**632.0**	**2348.0**			**310**	**0**	**0**	**400**	**0**	**0**	**550**	**0**	**0**
Both Sexes																
Arran View	28	1193.8	188.3	739.0	1542.0	1120.8 -	1266.8	310	0	0	400	0	0	550	0	0
ACH	32	1143.2	281.9	632.0	2186.0	1041.6 -	1244.9	310	0	0	400	0	0	550	0	0
Biggart	35	1192.6	373.3	525.0	2348.0	1064.4 -	1320.9	310	0	0	400	0	0	550	1	3
Kirklandside	37	1223.4	185.2	868.0	1749.0	1161.6 -	1285.1	310	0	0	400	0	0	550	0	0
Total	**132**	**1189.5**	**269.4**	**525.0**	**2348.0**	**1143.1 -**	**1235.9**	**310**	**0**	**0**	**400**	**0**	**0**	**550**	**1**	**1**

TABLE 15

Dietry Intakes
Split by site and by sex

Phosphorous (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	954.1	268.0	832.1	-	1076.1	310	0	0	400	1	5	550	1	5
ACH	23	848.2	164.3	777.2	-	919.3	310	0	0	400	0	0	550	1	4
Biggart	25	818.4	282.8	701.6	-	935.1	310	1	4	400	1	4	550	4	16
Kirklandside	30	966.4	225.3	882.2	-	1050.5	310	0	0	400	0	0	550	2	7
Total	**99**	**898.9**	**244.2**	**850.2**	**-**	**947.7**	**310**	**1**	**1**	**400**	**2**	**2**	**550**	**8**	**8**
Males															
Arran View	7	1074.6	162.4				310	0	0	400	0	0	550	0	0
ACH	9	1035.9	372.3				310	0	0	400	0	0	550	1	11
Biggart	10	1100.7	337.8				310	0	0	400	0	0	550	1	10
Kirklandside	7	1176.1	242.8				310	0	0	400	0	0	550	0	0
Total	**33**	**1093.5**	**292.0**				**310**	**0**	**0**	**400**	**0**	**0**	**550**	**2**	**6**
Both Sexes															
Arran View	28	984.3	248.8	887.8	-	1080.7	310	0	0	400	1	4	550	1	4
ACH	32	901.0	249.6	811.0	-	991.0	310	0	0	400	0	0	550	2	6
Biggart	35	899.0	321.6	788.6	-	1009.5	310	1	3	400	1	3	550	5	14
Kirklandside	37	1006.0	240.1	926.0	-	1086.1	310	0	0	400	0	0	550	2	5
Total	**132**	**947.6**	**269.4**	**901.2**	**-**	**994.0**	**310**	**1**	**1**	**400**	**2**	**2**	**550**	**10**	**8**

TABLE 16

Nutritional values of Food Offered
Split by site and by sex

Magnesium mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	213.6	31.1	149.0	256.0	199.4 -	227.7	150	2	10	200	7	33	270 *	21	100
ACH	23	222.1	43.8	144.0	330.0	203.2 -	241.1	150	1	4	200	8	35	270 *	21	91
Biggart	25	220.5	58.3	114.0	363.0	196.4 -	244.6	150	2	8	200	10	40	270 *	20	80
Kirklandside	30	209.9	30.6	145.0	286.0	198.5 -	221.3	150	1	3	200	12	40	270 *	29	97
Total	**99**	**216.2**	**42.0**	**114.0**	**363.0**	**207.8 -**	**224.6**	**150**	**6**	**6**	**200**	**37**	**37**	**270 ***	**91**	**92**
Males																
Arran View	7	236.6	31.3	191.0	286.0			190	0	0	250	5	71	300	7	100
ACH	9	213.3	52.1	128.0	299.0			190	3	33	250	8	89	300	9	100
Biggart	10	266.0	57.6	210.0	412.0			190	0	0	250	5	50	300	9	90
Kirklandside	7	244.0	20.0	215.0	272.0			190	0	0	250	5	71	300	7	100
Total	**33**	**240.7**	**47.8**	**128.0**	**412.0**			**190**	**3**	**9**	**250**	**23**	**70**	**300**	**32**	**97**
Both Sexes																
Arran View	28	219.3	32.2	149.0	286.0	206.8 -	231.8	-	-	-	-	-	-	-	-	-
ACH	32	219.7	45.6	128.0	330.0	203.2 -	236.1	-	-	-	-	-	-	-	-	-
Biggart	35	233.5	60.9	114.0	412.0	212.6 -	254.4	-	-	-	-	-	-	-	-	-
Kirklandside	37	216.3	31.7	145.0	286.0	205.8 -	226.9	-	-	-	-	-	-	-	-	-
Total	**132**	**222.3**	**44.6**	**114.0**	**412.0**	**214.6 -**	**230.0**	-	-	-	-	-	-	-	-	-

TABLE 17

Dietry Intakes
Split by site and by sex

Magnesium (mg)

Site	N	Mean	SD	Confidence Interval for mean	LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females													
Arran View	21	174.0	43.6	154.2 - 193.9	150	7	33	200 *	15	71	270 *	21	100
ACH	23	169.8	40.5	152.3 - 187.4	150	7	30	200 *	17	74	270 *	23	100
Biggart	25	153.6	42.3	136.1 - 171.0	150	11	44	200 *	20	80	270 *	25	100
Kirklandside	30	171.7	47.9	153.9 - 189.6	150	12	40	200 *	22	73	270 *	29	97
Total	**99**	**167.2**	**44.0**	**158.4 - 176.0**	**150**	**37**	**37**	**200 ***	**74**	**75**	**270 ***	**98**	**99**
Males													
Arran View	7	198.7	42.4		190	2	29	250	6	86	300	7	100
ACH	9	178.8	43.0		190	6	67	250	8	89	300	9	100
Biggart	10	220.1	47.5		190	2	20	250	8	80	300	9	90
Kirklandside	7	200.0	40.4		190	4	57	250	7	100	300	7	100
Total	**33**	**200.0**	**44.6**		**190**	**14**	**42**	**250**	**29**	**88**	**300**	**32**	**97**
Both Sexes													
Arran View	28	180.2	43.9	163.2 - 197.2	-	-	-	-	-	-	-	-	-
ACH	32	172.3	40.7	157.7 - 187.0	-	-	-	-	-	-	-	-	-
Biggart	35	172.6	52.8	154.4 - 190.7	-	-	-	-	-	-	-	-	-
Kirklandside	37	177.1	47.4	161.3 - 192.9	-	-	-	-	-	-	-	-	-
Total	**132**	**175.4**	**46.3**	**167.4 - 183.4**	-	-	-	-	-	-	-	-	-

TABLE 18

Nutritional values of Food Offered
Split by site and by sex

Potassium mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	2582.1	396.0	1787.0	3131.0	2401.8 -	2762.4	2000	2	10	-	-	-	3500 *	21	100
ACH	23	2451.7	339.4	1805.0	2996.0	2304.9 -	2598.5	2000	2	9	-	-	-	3500 *	23	100
Biggart	25	2426.4	600.5	1080.0	3798.0	2178.6 -	2674.3	2000	7	28	-	-	-	3500 *	24	96
Kirklandside	30	2538.4	324.5	1651.0	3094.0	2417.2 -	2659.6	2000	1	3	-	-	-	3500 *	30	100
Total	**99**	**2499.3**	**425.6**	**1080.0**	**3798.0**	**2414.4 -**	**2584.2**	**2000**	**12**	**12**	-	-	-	**3500 ***	**98**	**99**
Males																
Arran View	7	2812.7	290.9	2406.0	3269.0			2000	0	0	-	-	-	3500	7	100
ACH	9	2482.1	666.3	1286.0	3710.0			2000	2	22	-	-	-	3500	8	89
Biggart	10	3001.2	698.4	1989.0	4721.0			2000	1	10	-	-	-	3500	9	90
Kirklandside	7	2848.6	320.1	2385.0	3206.0			2000	0	0	-	-	-	3500	7	100
Total	**33**	**2787.3**	**569.8**	**1286.0**	**4721.0**			**2000**	**3**	**9**	-	-	-	**3500**	**31**	**94**
Both Sexes																
Arran View	28	2639.8	381.2	1787.0	3269.0	2491.9 -	2787.6	2000	2	7	-	-	-	3500 *	28	100
ACH	32	2460.3	443.3	1286.0	3710.0	2300.4 -	2620.1	2000	4	13	-	-	-	3500 *	31	97
Biggart	35	2590.7	673.1	1080.0	4721.0	2359.4 -	2821.9	2000	8	23	-	-	-	3500 *	33	94
Kirklandside	37	2597.1	342.2	1651.0	3206.0	2483.0 -	2711.2	2000	1	3	-	-	-	3500 *	37	100
Total	**132**	**2571.3**	**480.1**	**1080.0**	**4721.0**	**2488.6 -**	**2653.9**	**2000**	**15**	**11**	-	-	-	**3500 ***	**129**	**98**

TABLE 19

Dietry Intakes
Split by site and by sex

Potassium (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	2085.0	534.8	1841.5	-	2328.4	2000	10	48	-	-	-	3500 *	21	100
ACH	23	1840.0	399.2	1667.4	-	2012.6	2000	17	74	-	-	-	3500 *	23	100
Biggart	25	1696.4	515.4	1483.6	-	1909.2	2000 *	17	68	-	-	-	3500 *	25	100
Kirklandside	30	2042.8	530.8	1844.6	-	2241.1	2000	16	53	-	-	-	3500 *	30	100
Total	**99**	**1917.2**	**517.0**	**1814.0**	-	**2020.3**	**2000**	**60**	**61**	-	-	-	**3500 ***	**99**	**100**
Males															
Arran View	7	2346.0	540.0				2000	2	29	-	-	-	3500	7	100
ACH	9	1984.9	503.1				2000	5	56	-	-	-	3500	9	100
Biggart	10	2395.2	499.2				2000	2	20	-	-	-	3500	10	100
Kirklandside	7	2308.0	596.3				2000	2	29	-	-	-	3500	7	100
Total	**33**	**2254.4**	**532.7**				**2000**	**11**	**33**	-	-	-	**3500**	**33**	**100**
Both Sexes															
Arran View	28	2150.2	538.4	1941.4	-	2359.0	2000	12	43	-	-	-	3500 *	28	100
ACH	32	1880.8	427.6	1726.6	-	2034.9	2000	22	69	-	-	-	3500 *	32	100
Biggart	35	1896.1	596.7	1691.1	-	2101.0	2000	19	54	-	-	-	3500 *	35	100
Kirklandside	37	2093.0	545.3	1911.2	-	2274.8	2000	18	49	-	-	-	3500 *	37	100
Total	**132**	**2001.5**	**539.2**	**1908.6**	-	**2094.3**	**2000**	**71**	**54**	-	-	-	**3500 ***	**132**	**100**

TABLE 20

Nutritional values of Food Offered
Split by site and by sex

Iron mg

Site	N	Mean	SD	Min	Max	Confidence interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	11.3	1.2	9.5	13.6	10.8 -	11.8	4.7	0	0	6.7	0	0	8.7	0	0
ACH	23	10.1	2.2	7.7	17.0	9.2 -	11.1	4.7	0	0	6.7	0	0	8.7	10	43
Biggart	25	8.8	2.7	5.0	13.9	9.7 -	9.9	4.7	0	0	6.7	7	28	8.7	15	60
Kirklandside	30	10.2	1.5	6.9	13.3	9.6 -	10.7	4.7	0	0	6.7	0	0	8.7	5	17
Total	**99**	**10.1**	**2.1**	**5.0**	**17.0**	**9.6 -**	**10.5**	**4.7**	**0**	**0**	**6.7**	**7**	**7**	**8.7**	**30**	**30**
Males																
Arran View	7	12.9	1.4	11.2	14.8			4.7	0	0	6.7	0	0	8.7	0	0
ACH	9	9.8	2.4	5.2	12.9			4.7	0	0	6.7	1	11	8.7	2	22
Biggart	10	11.3	2.6	7.5	16.8			4.7	0	0	6.7	0	0	8.7	2	20
Kirklandside	7	10.9	1.8	8.8	13.4			4.7	0	0	6.7	0	0	8.7	0	0
Total	**33**	**11.2**	**2.4**	**5.2**	**16.8**			**4.7**	**0**	**0**	**6.7**	**1**	**3**	**8.7**	**4**	**12**
Both Sexes																
Arran View	28	11.7	1.4	9.5	14.8	11.2 -	12.2	4.7	0	0	6.7	0	0	8.7	0	0
ACH	32	10.0	2.2	5.2	17.0	9.2 -	10.8	4.7	0	0	6.7	1	3	8.7	12	38
Biggart	35	9.5	2.9	5.0	16.8	8.5 -	10.5	4.7	0	0	6.7	7	20	8.7	17	49
Kirklandside	37	10.3	1.6	6.9	13.4	9.8 -	10.8	4.7	0	0	6.7	0	0	8.7	5	14
Total	**132**	**10.3**	**2.2**	**5.0**	**17.0**	**9.9 -**	**10.7**	**4.7**	**0**	**0**	**6.7**	**8**	**6**	**8.7**	**34**	**26**

TABLE 21

Dietry Intakes
Split by site and by sex

Iron (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	9.0	2.1	8.0	-	10.0	4.7	1	5	6.7	3	14	8.7	8	38
ACH	23	7.4	2.0	6.6	-	8.3	4.7	1	4	6.7	10	43	8.7 *	18	78
Biggart	25	5.9	1.7	5.2	-	6.6	4.7	6	24	6.7 *	17	68	8.7 *	23	92
Kirklandside	30	8.3	2.4	7.4	-	9.2	4.7	2	7	6.7	9	30	8.7	17	57
Total	**99**	**7.7**	**2.4**	**7.2**	**-**	**8.1**	**4.7**	**10**	**10**	**6.7**	**39**	**39**	**8.7 ***	**66**	**67**
Males															
Arran View	7	10.8	2.7				4.7	0	0	6.7	0	0	8.7	2	29
ACH	9	8.2	2.1				4.7	1	11	6.7	2	22	8.7	4	44
Biggart	10	9.2	2.2				4.7	0	0	6.7	2	20	8.7	4	40
Kirklandside	7	8.6	2.4				4.7	0	0	6.7	1	14	8.7	4	57
Total	**33**	**9.1**	**2.4**				**4.7**	**1**	**3**	**6.7**	**5**	**15**	**8.7**	**14**	**42**
Both Sexes															
Arran View	28	9.4	2.4	8.5	-	10.4	4.7	1	4	6.7	3	11	8.7	10	36
ACH	32	7.7	2.0	7.0	-	8.4	4.7	2	6	6.7	12	38	8.7 *	22	69
Biggart	35	6.9	2.4	6.0	-	7.7	4.7	6	17	6.7	19	54	8.7 *	27	77
Kirklandside	37	8.4	2.4	7.6	-	9.2	4.7	2	5	6.7	10	27	8.7	21	57
Total	**132**	**8.0**	**2.4**	**7.6**	**-**	**8.4**	**4.7**	**11**	**8**	**6.7**	**44**	**33**	**8.7 ***	**80**	**61**

TABLE 22

Nutritional values of Food Offered
Split by site and by sex

Zinc mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	9.4	2.1	4.1	13.0	8.4 -	10.3	4.0	0	0	5.5	1	5	7.0	3	14
ACH	23	9.1	2.0	6.3	14.9	8.2 -	9.9	4.0	0	0	5.5	0	0	7.0	2	9
Biggart	25	7.6	2.3	3.3	13.6	6.7 -	8.5	4.0	1	4	5.5	4	16	7.0	12	48
Kirklandside	30	8.2	1.2	5.6	10.5	7.7 -	8.7	4.0	0	0	5.5	0	0	7.0	5	17
Total	**99**	**8.5**	**2.0**	**3.3**	**14.9**	**8.1 -**	**8.9**	4.0	**1**	1	5.5	**5**	**5**	7.0	**22**	**22**
Males																
Arran View	7	9.9	1.8	7.2	12.6			5.5	0	0	7.3	1	14	9.5	3	43
ACH	9	8.8	2.3	4.0	11.7			5.5	1	11	7.3	2	22	9.5	6	67
Biggart	10	9.2	2.7	6.1	16.2			5.5	0	0	7.3	2	20	9.5	7	70
Kirklandside	7	8.8	0.5	8.1	9.6			5.5	0	0	7.3	0	0	9.5	6	86
Total	**33**	**9.2**	**2.1**	**4.0**	**16.2**			**5.5**	**1**	3	7.3	**5**	**15**	9.5	**22**	**67**
Both Sexes																
Arran View	28	9.5	2.0	4.1	13.0	8.7 -	10.3	-	-	-	-	-	-	-	-	-
ACH	32	9.0	2.0	4.0	14.9	8.3 -	9.7	-	-	-	-	-	-	-	-	-
Biggart	35	8.1	2.5	3.3	16.2	7.2 -	8.9	-	-	-	-	-	-	-	-	-
Kirklandside	37	8.3	1.2	5.6	10.5	7.9 -	8.7	-	-	-	-	-	-	-	-	-
Total	**132**	**8.7**	**2.0**	**3.3**	**16.2**	**8.3 -**	**9.0**	-	-	-	-	-	-	-	-	-

TABLE 23

Dietry Intakes
Split by site and by sex

Zinc (mg)

Site	N	Mean	SD	Confidence Interval for mean	LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females													
Arran View	21	7.2	2.4	6.1 - 8.3	4.0	1	5	5.5	4	19	7.0	10	48
ACH	23	6.5	1.6	5.8 - 7.2	4.0	1	4	5.5	6	26	7.0	13	57
Biggart	25	5.3	1.7	4.6 - 6.0	4.0	6	24	5.5	15	60	7.0 *	21	84
Kirklandside	30	6.5	1.9	5.8 - 7.2	4.0	2	7	5.5	13	43	7.0	20	67
Total	99	6.3	2.0	5.9 - 6.7	4.0	10	10	5.5	38	38	7.0 *	64	65
Males													
Arran View	7	8.5	2.0		5.5	0	0	7.3	2	29	9.5	4	57
ACH	9	7.4	2.0		5.5	2	22	7.3	4	44	9.5	9	100
Biggart	10	7.7	2.4		5.5	1	10	7.3	5	50	9.5	9	90
Kirklandside	7	7.2	1.4		5.5	1	14	7.3	4	57	9.5	7	100
Total	33	7.7	2.0		5.5	4	12	7.3	15	45	9.5	29	88
Both Sexes													
Arran View	28	7.5	2.3	6.6 - 8.4	-	-	-	-	-	-	-	-	-
ACH	32	6.7	1.7	6.1 - 7.3	-	-	-	-	-	-	-	-	-
Biggart	35	6.0	2.2	5.2 - 6.7	-	-	-	-	-	-	-	-	-
Kirklandside	37	6.7	1.8	6.1 - 7.3	-	-	-	-	-	-	-	-	-
Total	132	6.7	2.1	6.3 - 7.0	-	-	-	-	-	-	-	-	-

TABLE 24

Nutritional values of Food Offered
Split by site and by sex

Copper mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	0.9	0.1	0.7	1.2	0.8 -	1.0	-	-	-	-	-	-	1.2 *	21	100
ACH	23	0.8	0.2	0.6	1.5	0.7 -	0.9	-	-	-	-	-	-	1.2 *	22	96
Biggart	25	0.9	0.5	0.4	2.2	0.7 -	1.1	-	-	-	-	-	-	1.2 *	19	76
Kirklandside	30	0.8	0.1	0.6	1.4	0.8 -	0.9	-	-	-	-	-	-	1.2 *	29	97
Total	**99**	**0.9**	**0.3**	**0.4**	**2.2**	**0.8 -**	**0.9**	-	-	-	-	-	-	**1.2 ***	**91**	**92**
Males																
Arran View	7	1.0	0.2	0.8	1.2			-	-	-	-	-	-	1.2	7	100
ACH	9	0.8	0.2	0.6	1.1			-	-	-	-	-	-	1.2	9	100
Biggart	10	1.1	0.3	0.8	1.6			-	-	-	-	-	-	1.2	6	60
Kirklandside	7	0.9	0.1	0.7	1.0			-	-	-	-	-	-	1.2	7	100
Total	**33**	**0.9**	**0.3**	**0.6**	**1.6**			-	-	-	-	-	-	**1.2**	**29**	**88**
Both Sexes																
Arran View	28	0.9	0.1	0.7	1.2	0.9 -	1.0	-	-	-	-	-	-	1.2 *	28	100
ACH	32	0.8	0.2	0.6	1.5	0.7 -	0.9	-	-	-	-	-	-	1.2 *	31	97
Biggart	35	1.0	0.4	0.4	2.2	0.8 -	1.1	-	-	-	-	-	-	1.2 *	25	71
Kirklandside	37	0.8	0.1	0.6	1.4	0.8 -	0.9	-	-	-	-	-	-	1.2 *	36	97
Total	**132**	**0.9**	**0.3**	**0.4**	**2.2**	**0.8 -**	**0.9**	-	-	-	-	-	-	**1.2 ***	**120**	**91**

TABLE 25

Dietry Intakes
Split by site and by sex

Copper (mg)

Site	N	Mean	SD	Confidence Interval for mean	LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females													
Arran View	21	0.7	0.2	0.6 - 0.8	-	-	-	-	-	-	1.2 *	21	100
ACH	23	0.6	0.2	0.5 - 0.7	-	-	-	-	-	-	1.2 *	23	100
Biggart	25	0.6	0.3	0.5 - 0.7	-	-	-	-	-	-	1.2 *	24	96
Kirklandside	30	0.7	0.2	0.6 - 0.8	-	-	-	-	-	-	1.2 *	29	97
Total	99	0.6	0.2	0.6 - 0.7	-	-	-	-	-	-	1.2 *	97	98
Males													
Arran View	7	0.8	0.2		-	-	-	-	-	-	1.2	7	100
ACH	9	0.6	0.1		-	-	-	-	-	-	1.2	9	100
Biggart	10	0.9	0.3		-	-	-	-	-	-	1.2	8	80
Kirklandside	7	0.7	0.2		-	-	-	-	-	-	1.2	7	100
Total	33	0.8	0.3		-	-	-	-	-	-	1.2	31	94
Both Sexes													
Arran View	28	0.7	0.2	0.7 - 0.8	-	-	-	-	-	-	1.2 *	28	100
ACH	32	0.6	0.2	0.6 - 0.7	-	-	-	-	-	-	1.2 *	32	100
Biggart	35	0.7	0.3	0.6 - 0.8	-	-	-	-	-	-	1.2 *	32	91
Kirklandside	37	0.7	0.2	0.6 - 0.7	-	-	-	-	-	-	1.2 *	36	97
Total	132	0.7	0.2	0.6 - 0.7	-	-	-	-	-	-	1.2 *	128	97

TABLE 26

Nutritional values of Food Offered
Split by site and by sex

Selenium mcg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	36.1	10.9	17.0	58.2	31.1 -	41.0	40	14	67	-	-	-	60 *	21	100
ACH	23	37.9	14.7	19.3	81.2	31.5 -	44.3	40	15	65	-	-	-	60 *	21	91
Biggart	25	36.0	8.9	22.7	62.8	32.3 -	39.7	40 *	18	72	-	-	-	60 *	24	96
Kirklandside	30	44.5	10.2	26.5	70.7	40.7 -	48.3	40	15	50	-	-	-	60 *	27	90
Total	**99**	**39.0**	**11.7**	**17.0**	**81.2**	**36.7 -**	**41.4**	**40**	**62**	**63**	-	-	-	**60 ***	**93**	**94**
Males																
Arran View	7	40.6	8.6	33.3	57.5			40	4	57	-	-	-	75	7	100
ACH	9	35.4	11.6	18.0	57.3			40	7	78	-	-	-	75	9	100
Biggart	10	40.3	15.1	17.9	60.4			40	6	60	-	-	-	75	10	100
Kirklandside	7	48.2	11.9	34.8	67.7			40	2	29	-	-	-	75	7	100
Total	**33**	**40.7**	**12.6**	**17.9**	**67.7**			**40**	**19**	**58**	-	-	-	**75**	**33**	**100**
Both Sexes																
Arran View	28	37.2	10.4	17.0	58.5	33.2 -	41.3	40	18	64	-	-	-	-	-	-
ACH	32	37.2	13.8	18.0	81.2	32.2 -	42.2	40	22	69	-	-	-	-	-	-
Biggart	35	37.2	11.0	17.9	62.8	33.5 -	41.0	40	24	69	-	-	-	-	-	-
Kirklandside	37	45.2	10.4	26.5	70.7	41.7 -	48.7	40	17	46	-	-	-	-	-	-
Total	**132**	**39.5**	**11.9**	**17.0**	**81.2**	**37.4 -**	**41.5**	**40**	**81**	**61**	-	-	-	-	-	-

TABLE 27

Dietry Intakes
Split by site and by sex

Selenium (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	28.2	7.6	24.8	-	31.7	40 *	20	95	-	-	-	60 *	21	100
ACH	23	28.1	8.5	24.4	-	31.7	40 *	20	87	-	-	-	60 *	23	100
Biggart	25	23.1	6.2	20.5	-	25.6	40 *	25	100	-	-	-	60 *	25	100
Kirklandside	30	35.2	11.0	31.0	-	39.3	40 *	22	73	-	-	-	60 *	29	97
Total	99	29.0	9.7	27.0	-	30.9	40 *	87	88	-	-	-	60 *	98	99
Males															
Arran View	7	33.3	3.8				40	7	100	-	-	-	75	7	100
ACH	9	30.3	10.3				40	7	78	-	-	-	75	9	100
Biggart	10	34.1	12.0				40	6	60	-	-	-	75	10	100
Kirklandside	7	40.8	10.0				40	3	43	-	-	-	75	7	100
Total	33	34.3	10.1				40	23	70	-	-	-	75	33	100
Both Sexes															
Arran View	28	29.5	7.1	26.7	-	32.2	40 *	27	96	-	-	-	-	-	-
ACH	32	28.7	8.9	25.5	-	31.9	40 *	27	84	-	-	-	-	-	-
Biggart	35	26.2	9.5	22.9	-	29.5	40 *	31	89	-	-	-	-	-	-
Kirklandside	37	36.2	10.9	32.6	-	39.9	40 *	25	68	-	-	-	-	-	-
Total	132	30.3	10.0	28.6	-	32.0	40 *	110	83	-	-	-	-	-	-

TABLE 28

Nutritional values of Food Offered
Split by site and by sex

Iodine mcg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	118.8	38.8	57.7	184.8	101.1 -	136.5	70	2	10	-	-	-	140 *	14	67
ACH	23	129.5	61.2	52.2	331.7	103.0 -	155.9	70	3	13	-	-	-	140	16	70
Biggart	25	213.5	88.3	80.4	464.2	177.1 -	250.0	70	0	0	-	-	-	140	5	20
Kirklandside	30	155.2	44.3	92.7	266.7	138.6 -	171.7	70	0	0	-	-	-	140	10	33
Total	**99**	**156.2**	**70.3**	**52.2**	**464.2**	**142.2 -**	**170.2**	**70**	**5**	**5**	-	-	-	**140**	**45**	**45**
Males																
Arran View	7	128.3	65.5	84.5	269.5			70	0	0	-	-	-	140	5	71
ACH	9	150.8	74.7	57.0	278.8			70	2	22	-	-	-	140	4	44
Biggart	10	214.2	124.6	69.6	544.0			70	1	10	-	-	-	140	1	10
Kirklandside	7	210.1	67.8	138.7	326.6			70	0	0	-	-	-	140	1	14
Total	**33**	**177.8**	**93.9**	**57.0**	**544.0**			**70**	**3**	**9**	-	-	-	**140**	**11**	**33**
Both Sexes																
Arran View	28	121.2	45.7	57.7	269.5	103.4 -	138.9	70	2	7	-	-	-	140 *	19	68
ACH	32	135.5	64.8	52.2	331.7	112.1 -	158.8	70	5	16	-	-	-	140	20	63
Biggart	35	213.7	98.0	69.6	544.0	180.1 -	247.4	70	1	3	-	-	-	140	6	17
Kirklandside	37	165.6	53.1	92.7	326.6	147.9 -	183.3	70	0	0	-	-	-	140	11	30
Total	**132**	**161.6**	**77.1**	**52.2**	**544.0**	**148.3 -**	**174.9**	**70**	**8**	**6**	-	-	-	**140**	**56**	**42**

TABLE 29

Dietry Intakes
Split by site and by sex

Iodine (mcg)

Site	N	Mean	SD	Confidence Interval for mean	LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females													
Arran View	21	93.3	30.6	79.4 - 107.2	70	6	29	-	-	-	140 *	19	90
ACH	23	99.2	32.5	85.1 - 113.3	70	4	17	-	-	-	140 *	19	83
Biggart	25	164.5	78.0	132.3 - 196.7	70	1	4	-	-	-	140	11	44
Kirklandside	30	124.0	29.9	112.8 - 135.2	70	2	7	-	-	-	140 *	18	60
Total	**99**	**122.0**	**54.3**	**111.1 - 132.8**	**70**	**13**	**13**	-	-	-	**140 ***	**67**	**68**
Males													
Arran View	7	108.0	44.7		70	1	14	-	-	-	140	6	86
ACH	9	127.2	65.9		70	2	22	-	-	-	140	6	67
Biggart	10	191.0	103.7		70	1	10	-	-	-	140	1	10
Kirklandside	7	176.6	63.0		70	0	0	-	-	-	140	2	29
Total	**33**	**153.0**	**80.2**		**70**	**4**	**12**	-	-	-	**140**	**15**	**45**
Both Sexes													
Arran View	28	97.0	34.3	83.7 - 110.3	70	7	25	-	-	-	140 *	25	89
ACH	32	107.0	45.1	90.8 - 123.4	70	6	19	-	-	-	140 *	25	78
Biggart	35	172.0	85.4	142.7 - 201.4	70	2	6	-	-	-	140	12	34
Kirklandside	37	133.9	42.7	119.7 - 148.2	70	2	5	-	-	-	140	20	54
Total	**132**	**129.7**	**62.9**	**118.9 - 140.5**	**70**	**17**	**13**	-	-	-	**140**	**82**	**62**

TABLE 30

Nutritional values of Food Offered
Split by site and by sex

Thiamine mg/1,000 kcals

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	0.66	0.07	0.51	0.81	0.63 -	0.70	0.23	0	0	0.3	0	0	0.4	0	0
ACH	23	0.74	0.13	0.52	0.99	0.68 -	0.79	0.23	0	0	0.3	0	0	0.4	0	0
Biggart	25	0.73	0.13	0.57	1.06	0.68 -	0.78	0.23	0	0	0.3	0	0	0.4	0	0
Kirklandside	30	0.88	0.12	0.58	1.10	0.84 -	0.93	0.23	0	0	0.3	0	0	0.4	0	0
Total	**99**	**0.76**	**0.14**	**0.51**	**1.10**	**0.74 -**	**0.79**	**0.23**	**0**	**0**	**0.3**	**0**	**0**	**0.4**	**0**	**0**
Males																
Arran View	7	0.67	0.11	0.47	0.77			0.23	0	0	0.3	0	0	0.4	0	0
ACH	9	0.72	0.12	0.55	0.88			0.23	0	0	0.3	0	0	0.4	0	0
Biggart	10	0.74	0.09	0.62	0.91			0.23	0	0	0.3	0	0	0.4	0	0
Kirklandside	7	0.80	0.10	0.68	1.00			0.23	0	0	0.3	0	0	0.4	0	0
Total	**33**	**0.73**	**0.11**	**0.47**	**1.00**			**0.23**	**0**	**0**	**0.3**	**0**	**0**	**0.4**	**0**	**0**
Both Sexes																
Arran View	28	0.67	0.08	0.47	0.81	0.63 -	0.70	0.23	0	0	0.3	0	0	0.4	0	0
ACH	32	0.73	0.12	0.52	0.99	0.69 -	0.78	0.23	0	0	0.3	0	0	0.4	0	0
Biggart	35	0.74	0.11	0.57	1.06	0.70 -	0.77	0.23	0	0	0.3	0	0	0.4	0	0
Kirklandside	37	0.87	0.12	0.58	1.10	0.83 -	0.91	0.23	0	0	0.3	0	0	0.4	0	0
Total	**132**	**0.76**	**0.13**	**0.47**	**1.10**	**0.73 -**	**0.78**	**0.23**	**0**	**0**	**0.3**	**0**	**0**	**0.4**	**0**	**0**

TABLE 31

Dietry Intakes
Split by site and by sex

Thiamine (mg/1000 kcals)

Site	N	Mean	SD	Confidence interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	0.68	0.07	0.65	-	0.72	0.23	0	0	0.3	0	0	0.4	0	0
ACH	23	0.72	0.13	0.66	-	0.77	0.23	0	0	0.3	0	0	0.4	0	0
Biggart	25	0.69	0.13	0.64	-	0.75	0.23	0	0	0.3	0	0	0.4	0	0
Kirklandside	30	0.86	0.12	0.82	-	0.91	0.23	0	0	0.3	0	0	0.4	0	0
Total	99	**0.75**	**0.14**	**0.72**	-	**0.78**	**0.23**	**0**	**0**	**0.3**	**0**	**0**	**0.4**	**0**	**0**
Males															
Arran View	7	0.65	0.11				0.23	0	0	0.3	0	0	0.4	0	0
ACH	9	0.68	0.14				0.23	0	0	0.3	0	0	0.4	0	0
Biggart	10	0.73	0.11				0.23	0	0	0.3	0	0	0.4	0	0
Kirklandside	7	0.78	0.12				0.23	0	0	0.3	0	0	0.4	0	0
Total	33	**0.71**	**0.12**				**0.23**	**0**	**0**	**0.3**	**0**	**0**	**0.4**	**0**	**0**
Both Sexes															
Arran View	28	0.67	0.08	0.64	-	0.71	0.23	0	0	0.3	0	0	0.4	0	0
ACH	32	0.71	0.13	0.66	-	0.75	0.23	0	0	0.3	0	0	0.4	0	0
Biggart	35	0.70	0.13	0.66	-	0.75	0.23	0	0	0.3	0	0	0.4	0	0
Kirklandside	37	0.85	0.12	0.81	-	0.89	0.23	0	0	0.3	0	0	0.4	0	0
Total	**132**	**0.74**	**0.14**	**0.72**	-	**0.76**	**0.23**	**0**	**0**	**0.3**	**0**	**0**	**0.4**	**0**	**0**

TABLE 32

Nutritional values of Food Offered
Split by site and by sex

Riboflavin mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	1.5	0.4	0.9	2.3	1.3 -	1.7	0.8	0	0	0.9	0	0	1.1	3	14
ACH	23	1.5	0.4	0.9	2.5	1.4 -	1.7	0.8	0	0	0.9	1	4	1.1	1	4
Biggart	25	1.5	0.7	0.4	3.5	1.2 -	1.8	0.8	2	8	0.9	4	16	1.1	7	28
Kirklandside	30	1.7	0.4	1.0	2.5	1.5 -	1.8	0.8	0	0	0.9	0	0	1.1	3	10
Total	**99**	**1.6**	**0.5**	**0.4**	**3.5**	**1.5 -**	**1.7**	**0.8**	**2**	**2**	**0.9**	**5**	**5**	**1.1**	**14**	**14**
Males																
Arran View	7	1.7	0.4	1.3	2.4			0.8	0	0	1.0	0	0	1.3	0	0
ACH	9	1.9	0.9	0.7	3.8			0.8	1	11	1.0	1	11	1.3	1	11
Biggart	10	1.8	0.9	0.9	4.1			0.8	0	0	1.0	1	10	1.3	4	40
Kirklandside	7	2.2	0.4	1.8	3.0			0.8	0	0	1.0	0	0	1.3	0	0
Total	**33**	**1.9**	**0.7**	**0.7**	**4.1**			**0.8**	**1**	**3**	**1.0**	**2**	**6**	**1.3**	**5**	**15**
Both Sexes																
Arran View	28	1.6	0.4	0.9	2.4	1.4 -	1.7	0.8	0	0	-	-	-	-	-	-
ACH	32	1.6	0.6	0.7	3.8	1.4 -	1.8	0.8	1	3	-	-	-	-	-	-
Biggart	35	1.6	0.7	0.4	4.1	1.3 -	1.8	0.8	2	6	-	-	-	-	-	-
Kirklandside	37	1.8	0.5	1.0	3.0	1.6 -	1.9	0.8	0	0	-	-	-	-	-	-
Total	**132**	**1.6**	**0.6**	**0.4**	**4.1**	**1.5 -**	**1.7**	**0.8**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**

TABLE 33

Dietry Intakes
Split by site and by sex

Riboflavin (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	1.3	0.4	1.1	-	1.4	0.8	2	10	0.9	3	14	1.1	7	33
ACH	23	1.2	0.3	1.1	-	1.3	0.8	4	17	0.9	5	22	1.1	7	30
Biggart	25	1.1	0.5	0.9	-	1.3	0.8	7	28	0.9	7	28	1.1	15	60
Kirklandside	30	1.4	0.4	1.2	-	1.5	0.8	1	3	0.9	4	13	1.1	7	23
Total	99	1.2	0.4	1.2	-	1.3	0.8	14	14	0.9	19	19	1.1	36	36
Males															
Arran View	7	1.5	0.3				0.8	0	0	1.0	0	0	1.3	2	29
ACH	9	1.6	0.7				0.8	1	11	1.0	1	11	1.3	1	11
Biggart	10	1.5	0.7				0.8	1	10	1.0	1	10	1.3	5	50
Kirklandside	7	1.9	0.5				0.8	0	0	1.0	0	0	1.3	0	0
Total	**33**	**1.6**	**0.6**				**0.8**	**2**	**6**	**1.0**	**2**	**6**	**1.3**	**8**	**24**
Both Sexes															
Arran View	28	1.3	0.4	1.2	-	1.5	0.8	2	7	-	-	-	-	-	-
ACH	32	1.3	0.4	1.1	-	1.5	0.8	5	16	-	-	-	-	-	-
Biggart	35	1.2	0.6	1.0	-	1.5	0.8	8	23	-	-	-	-	-	-
Kirklandside	37	1.5	0.4	1.3	-	1.6	0.8	1	3	-	-	-	-	-	-
Total	**132**	**1.3**	**0.5**	**1.2**	**-**	**1.4**	**0.8**	**16**	**12**	-	-	-	-	-	-

TABLE 34

Nutritional values of Food Offered
Split by site and by sex

Nicotinic Acid mg/1,000 kcals

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	15.8	3.0	11.2	21.3	14.5 -	17.1	4.4	0	0	5.5	0	0	6.6	0	0
ACH	23	16.0	2.3	12.4	20.1	15.0 -	16.9	4.4	0	0	5.5	0	0	6.6	0	0
Biggart	25	14.8	2.2	12.1	20.1	13.9 -	15.7	4.4	0	0	5.5	0	0	6.6	0	0
Kirklandside	30	16.3	1.5	11.1	18.8	15.7 -	16.8	4.4	0	0	5.5	0	0	6.6	0	0
Total	**99**	**15.7**	**2.3**	**11.1**	**21.3**	**15.3 -**	**16.2**	**4.4**	**0**	**0**	**5.5**	**0**	**0**	**6.6**	**0**	**0**
Males																
Arran View	7	15.3	2.2	13.1	19.8			4.4	0	0	5.5	0	0	6.6	0	0
ACH	9	15.8	3.2	12.1	21.3			4.4	0	0	5.5	0	0	6.6	0	0
Biggart	10	13.4	1.6	11.6	17.5			4.4	0	0	5.5	0	0	6.6	0	0
Kirklandside	7	17.0	1.7	14.7	19.0			4.4	0	0	5.5	0	0	6.6	0	0
Total	**33**	**15.3**	**2.6**	**11.6**	**21.3**			**4.4**	**0**	**0**	**5.5**	**0**	**0**	**6.6**	**0**	**0**
Both Sexes																
Arran View	28	15.7	2.8	11.2	21.3	14.6 -	16.8	4.4	0	0	5.5	0	0	6.6	0	0
ACH	32	15.9	2.5	12.1	21.3	15.0 -	16.8	4.4	0	0	5.5	0	0	6.6	0	0
Biggart	35	14.4	2.1	11.6	20.1	13.7 -	15.2	4.4	0	0	5.5	0	0	6.6	0	0
Kirklandside	37	16.4	1.6	11.1	19.0	15.9 -	16.9	4.4	0	0	5.5	0	0	6.6	0	0
Total	**132**	**15.6**	**2.3**	**11.1**	**21.3**	**15.2 -**	**16.1**	**4.4**	**0**	**0**	**5.5**	**0**	**0**	**6.6**	**0**	**0**

TABLE 35

Dietry Intakes
Split by site and by sex

Nicotinic Acid (mg/1000 kcals)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	15.0	2.7	13.7	-	16.2	4.4	0	0	5.5	0	0	6.6	0	0
ACH	23	15.2	2.3	14.1	-	16.1	4.4	0	0	5.5	0	0	6.6	0	0
Biggart	25	13.8	2.3	12.9	-	14.7	4.4	0	0	5.5	0	0	6.6	0	0
Kirklandside	30	15.7	1.5	15.1	-	16.3	4.4	0	0	5.5	0	0	6.6	0	0
Total	**99**	**14.9**	**2.3**	**14.5**	-	**15.4**	**4.4**	**0**	**0**	**5.5**	**0**	**0**	**6.6**	**0**	**0**
Males															
Arran View	7	15.2	2.2				4.4	0	0	5.5	0	0	6.6	0	0
ACH	9	15.1	3.6				4.4	0	0	5.5	0	0	6.6	0	0
Biggart	10	13.1	2.2				4.4	0	0	5.5	0	0	6.6	0	0
Kirklandside	7	17.1	2.1				4.4	0	0	5.5	0	0	6.6	0	0
Total	**33**	**14.9**	**2.9**				**4.4**	**0**	**0**	**5.5**	**0**	**0**	**6.6**	**0**	**0**
Both Sexes															
Arran View	28	15.1	2.6	14.0	-	16.0	4.4	0	0	5.5	0	0	6.6	0	0
ACH	32	15.1	2.7	14.1	-	16.0	4.4	0	0	5.5	0	0	6.6	0	0
Biggart	35	13.6	2.2	12.8	-	14.4	4.4	0	0	5.5	0	0	6.6	0	0
Kirklandside	37	16.0	1.7	15.4	-	16.5	4.4	0	0	5.5	0	0	6.6	0	0
Total	**132**	**14.9**	**2.4**	**14.5**	-	**15.3**	**4.4**	**0**	**0**	**5.5**	**0**	**0**	**6.6**	**0**	**0**

TABLE 36

Nutritional values of Food Offered
Split by site and by sex

Vitamin B6 mcg/g protein

Site	N	Mean	SD	Min	Max	Confidence interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	23.0	3.2	18.3	27.7	21.6 -	24.5	11	0	0	13	0	0	15	0	0
ACH	23	23.6	4.2	14.8	31.2	21.7 -	25.4	11	0	0	13	0	0	15	1	4
Biggart	25	25.7	3.5	20.0	34.1	24.3 -	27.2	11	0	0	13	0	0	15	0	0
Kirklandside	30	28.3	4.5	19.5	38.7	26.6 -	29.9	11	0	0	13	0	0	15	0	0
Total	**99**	**25.4**	**4.4**	**14.8**	**38.7**	**24.5 -**	**26.3**	**11**	**0**	**0**	**13**	**0**	**0**	**15**	**1**	**1**
Males																
Arran View	7	24.1	4.2	19.9	32.4			11	0	0	13	0	0	15	0	0
ACH	9	23.9	4.0	18.1	29.6			11	0	0	13	0	0	15	0	0
Biggart	10	29.0	3.7	22.1	34.1			11	0	0	13	0	0	15	0	0
Kirklandside	7	27.3	4.2	22.9	34.7			11	0	0	13	0	0	15	0	0
Total	**33**	**26.2**	**4.4**	**18.1**	**34.7**			**11**	**0**	**0**	**13**	**0**	**0**	**15**	**0**	**0**
Both Sexes																
Arran View	28	23.3	3.5	18.3	32.4	22.0 -	24.7	11	0	0	13	0	0	15	0	0
ACH	32	23.7	4.1	14.8	31.2	22.2 -	25.2	11	0	0	13	0	0	15	1	3
Biggart	35	26.7	3.8	20.0	34.1	25.4 -	28.0	11	0	0	13	0	0	15	0	0
Kirklandside	37	28.1	4.4	19.5	38.7	26.6 -	29.5	11	0	0	13	0	0	15	0	0
Total	**132**	**25.6**	**4.4**	**14.8**	**37.7**	**24.9 -**	**26.4**	**11**	**0**	**0**	**13**	**0**	**0**	**15**	**1**	**1**

TABLE 37

Dietry Intakes
Split by site and by sex

Vitamin B6 (mcg/g protein)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	23.5	3.4	21.9	-	25.1	11	0	0	13	0	0	15	0	0
ACH	23	23.0	4.7	21.0	-	25.1	11	0	0	13	0	0	15	1	4
Biggart	25	25.5	4.9	23.5	-	27.5	11	0	0	13	0	0	15	0	0
Kirklandside	30	27.6	4.3	26.0	-	29.2	11	0	0	13	0	0	15	0	0
Total	**99**	**25.1**	**4.7**	**24.2**	**-**	**26.1**	**11**	**0**	**0**	**13**	**0**	**0**	**15**	**1**	**1**
Males															
Arran View	7	22.6	4.4				11	0	0	13	0	0	15	0	0
ACH	9	23.1	4.2				11	0	0	13	0	0	15	0	0
Biggart	10	28.2	3.8				11	0	0	13	0	0	15	0	0
Kirklandside	7	26.0	5.3				11	0	0	13	0	0	15	0	0
Total	**33**	**25.2**	**4.8**				**11**	**0**	**0**	**13**	**0**	**0**	**15**	**0**	**0**
Both Sexes															
Arran View	28	23.3	3.6	21.9	-	24.7	11	0	0	13	0	0	15	0	0
ACH	32	23.1	4.5	21.4	-	24.7	11	0	0	13	0	0	15	1	3
Biggart	35	26.3	4.7	24.7	-	27.9	11	0	0	13	0	0	15	0	0
Kirklandside	37	27.3	4.5	25.8	-	28.8	11	0	0	13	0	0	15	0	0
Total	**132**	**25.1**	**4.7**	**24.3**	**-**	**26.0**	**11**	**0**	**0**	**13**	**0**	**0**	**15**	**1**	**1**

TABLE 38

Nutritional values of Food Offered
Split by site and by sex

Vitamin B12 mcg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	4.4	1.7	1.7	8.3	3.6 -	5.2	1.0	0	0	1.25	0	0	1.5	0	0
ACH	23	4.4	1.1	2.6	6.3	3.9 -	4.8	1.0	0	0	1.25	0	0	1.5	0	0
Biggart	25	3.9	1.8	2.0	10.2	3.2 -	4.7	1.0	0	0	1.25	0	0	1.5	0	0
Kirklandside	30	5.3	1.1	2.9	7.1	4.9 -	5.7	1.0	0	0	1.25	0	0	1.5	0	0
Total	**99**	**4.5**	**1.5**	**1.7**	**10.2**	**4.2 -**	**4.8**	**1.0**	**0**	**0**	**1.25**	**0**	**0**	**1.5**	**0**	**0**
Males																
Arran View	7	5.2	1.8	2.7	7.2			1.0	0	0	1.25	0	0	1.5	0	0
ACH	9	5.5	3.0	1.5	12.3			1.0	0	0	1.25	0	0	1.5	0	0
Biggart	10	4.2	2.0	2.2	9.2			1.0	0	0	1.25	0	0	1.5	0	0
Kirklandside	7	5.8	1.0	4.2	7.0			1.0	0	0	1.25	0	0	1.5	0	0
Total	**33**	**5.1**	**2.1**	**1.5**	**12.3**			**1.0**	**0**	**0**	**1.25**	**0**	**0**	**1.5**	**0**	**0**
Both Sexes																
Arran View	28	4.6	1.7	1.7	8.3	3.9 -	5.3	1.0	0	0	1.25	0	0	1.5	0	0
ACH	32	4.7	1.9	1.5	12.3	4.0 -	5.4	1.0	0	0	1.25	0	0	1.5	0	0
Biggart	35	4.0	1.9	2.0	10.2	3.4 -	4.7	1.0	0	0	1.25	0	0	1.5	0	0
Kirklandside	37	5.4	1.1	2.9	7.1	5.0 -	5.7	1.0	0	0	1.25	0	0	1.5	0	0
Total	**132**	**4.7**	**1.7**	**1.5**	**12.3**	**4.4 -**	**5.0**	**1.0**	**0**	**0**	**1.25**	**0**	**0**	**1.5**	**0**	**0**

TABLE 39

Dietry Intakes
Split by site and by sex

Vitamin B12 (mcg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	3.3	1.5	2.6	-	3.9	1.0	1	5	1.25	1	5	1.5	1	5
ACH	23	3.2	1.0	2.8	-	3.7	1.0	0	0	1.25	0	0	1.5	0	0
Biggart	25	2.9	1.5	2.3	-	3.5	1.0	0	0	1.25	1	4	1.5	2	8
Kirklandside	30	4.3	1.1	3.9	-	4.7	1.0	0	0	1.25	0	0	1.5	0	0
Total	**99**	**4.5**	**1.4**	**3.2**	**-**	**3.7**	**1.0**	**1**	**1**	**1.25**	**2**	**2**	**1.5**	**3**	**3**
Males															
Arran View	7	4.3	1.5				1.0	0	0	1.25	0	0	1.5	0	0
ACH	9	4.7	2.7				1.0	0	0	1.25	0	0	1.5	1	11
Biggart	10	3.4	1.7				1.0	0	0	1.25	0	0	1.5	1	10
Kirklandside	7	4.9	1.1				1.0	0	0	1.25	0	0	1.5	0	0
Total	**33**	**4.3**	**1.9**				**1.0**	**0**	**0**	**1.25**	**0**	**0**	**1.5**	**2**	**6**
Both Sexes															
Arran View	28	3.5	1.5	2.9	-	4.1	1.0	1	4	1.25	1	4	1.5	1	4
ACH	32	3.6	1.7	3.0	-	4.3	1.0	0	0	1.25	0	0	1.5	1	3
Biggart	35	3.0	1.5	2.5	-	3.6	1.0	0	0	1.25	1	3	1.5	3	9
Kirklandside	37	4.4	1.1	4.0	-	4.8	1.0	0	0	1.25	0	0	1.5	0	0
Total	**132**	**3.7**	**1.6**	**3.4**	**-**	**3.9**	**1.0**	**1**	**1**	**1.25**	**2**	**2**	**1.5**	**5**	**4**

TABLE 40

Nutritional values of Food Offered
Split by site and by sex

Folate mcg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	171.4	20.4	137.0	212.0	162.1 -	180.7	100	0	0	150	2	10	200 *	18	86
ACH	23	178.2	39.3	118.0	252.0	161.2 -	195.2	100	0	0	150	6	26	200 *	16	70
Biggart	25	186.4	73.1	90.0	329.0	156.3 -	216.6	100	1	4	150	9	36	200	18	72
Kirklandside	30	215.0	33.0	150.0	286.0	202.7 -	227.4	100	0	0	150	0	0	200	7	23
Total	**99**	**190.0**	**48.6**	**90.0**	**329.0**	**180.3 -**	**199.7**	**100**	**1**	**1**	**150**	**17**	**17**	**200 ***	**59**	**60**
Males																
Arran View	7	195.6	51.4	109.0	272.0			100	0	0	150	1	14	200	4	57
ACH	9	200.2	69.4	91.0	285.0			100	1	11	150	3	33	200	5	56
Biggart	10	234.4	62.5	165.0	381.0			100	0	0	150	0	0	200	2	20
Kirklandside	7	238.4	35.7	200.0	290.0			100	0	0	150	0	0	200	0	0
Total	**33**	**217.7**	**58.4**	**91.0**	**381.0**			**100**	**1**	**3**	**150**	**4**	**12**	**200**	**11**	**33**
Both Sexes																
Arran View	28	177.5	31.8	109.0	272.0	165.1 -	189.8	100	0	0	150	3	11	200 *	22	79
ACH	32	184.4	49.4	91.0	285.0	166.6 -	202.2	100	1	3	150	9	28	200	21	66
Biggart	35	200.1	72.7	90.0	381.0	175.2 -	225.1	100	1	3	150	8	26	200	20	57
Kirklandside	37	219.5	34.3	150.0	290.0	208.0 -	230.9	100	0	0	150	0	0	200	7	19
Total	**132**	**196.9**	**52.4**	**90.0**	**381.0**	**187.9 -**	**206.0**	**100**	**2**	**2**	**150**	**21**	**16**	**200**	**70**	**53**

TABLE 41

Dietry Intakes
Split by site and by sex

Folate (mcg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	137.4	29.2	124.2	-	150.7	100	2	10	150	16	76	200 *	20	95
ACH	23	131.9	44.2	112.8	-	151.0	100	6	26	150	16	70	200 *	21	91
Biggart	25	123.3	47.5	103.7	-	142.9	100	12	48	150 *	19	76	200 *	22	88
Kirklandside	30	169.0	40.9	153.7	-	184.2	100	2	7	150	10	33	200 *	22	73
Total	**99**	**142.1**	**44.7**	**133.2**	-	**151.1**	**100**	**22**	**22**	**150**	**61**	**62**	**200 ***	**85**	**86**
Males															
Arran View	7	157.0	53.6				100	1	14	150	4	57	200	5	71
ACH	9	158.1	45.9				100	1	11	150	4	44	200	8	89
Biggart	10	187.3	48.5				100	0	0	150	2	20	200	5	50
Kirklandside	7	195.6	47.5				100	0	0	150	1	14	200	4	57
Total	**33**	**174.7**	**49.4**				**100**	**2**	**6**	**150**	**11**	**33**	**200**	**22**	**67**
Both Sexes															
Arran View	28	142.3	36.6	128.1	-	156.5	100	3	11	150	20	71	200 *	25	89
ACH	32	139.3	45.6	122.9	-	155.7	100	7	22	150	20	63	200 *	29	91
Biggart	35	141.6	55.5	122.5	-	160.6	100	12	34	150	21	60	200 *	27	77
Kirklandside	37	174.0	42.8	159.7	-	188.3	100	2	5	150	11	30	200 *	26	70
Total	**132**	**150.3**	**47.9**	**142.0**	-	**158.5**	**100**	**24**	**18**	**150**	**72**	**55**	**200 ***	**107**	**81**

TABLE 42

Nutritional values of Food Offered
Split by site and by sex

Vitamin C mg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	55.0	24.4	17.0	119.0	43.9 -	66.1	10	0	0	25	4	19	40	5	24
ACH	23	65.2	17.4	37.0	104.0	57.7 -	72.8	10	0	0	25	0	0	40	1	4
Biggart	25	57.5	24.5	20.0	115.0	47.4 -	67.6	10	0	0	25	1	4	40	7	28
Kirklandside	30	60.7	18.6	16.0	103.0	53.7 -	67.6	10	0	0	25	1	3	40	3	10
Total	**99**	**59.7**	**21.3**	**16.0**	**119.0**	**55.5 -**	**64.0**	**10**	**0**	**0**	**25**	**6**	**6**	**40**	**16**	**16**
Males																
Arran View	7	71.7	37.4	24.0	139.0			10	0	0	25	1	14	40	2	29
ACH	9	60.6	19.4	30.0	89.0			10	0	0	25	0	0	40	1	11
Biggart	10	68.1	15.0	44.0	93.0			10	0	0	25	0	0	40	0	0
Kirklandside	7	38.3	2.9	35.0	44.0			10	0	0	25	0	0	40	6	86
Total	**33**	**60.5**	**24.0**	**24.0**	**139.0**			**10**	**0**	**0**	**25**	**1**	**3**	**40**	**9**	**27**
Both Sexes																
Arran View	28	59.2	28.4	17.0	139.0	48.2 -	70.2	10	0	0	25	5	18	40	7	25
ACH	32	63.9	17.8	30.0	104.0	57.5 -	70.3	10	0	0	25	0	0	40	2	6
Biggart	35	60.5	22.5	20.0	115.0	52.8 -	68.3	10	0	0	25	1	3	40	7	20
Kirklandside	37	56.4	19.0	16.0	103.0	50.1 -	62.8	10	0	0	25	1	3	40	9	24
Total	**132**	**59.9**	**21.9**	**16.0**	**139.0**	**56.1 -**	**63.7**	**10**	**0**	**0**	**25**	**7**	**5**	**40**	**25**	**19**

TABLE 43

Dietry Intakes
Split by site and by sex

Vitamin C (mg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	45.1	23.6	34.4	-	55.9	10	0	0	25	6	29	40	7	33
ACH	23	48.1	16.5	40.9	-	55.2	10	0	0	25	3	13	40	8	35
Biggart	25	37.0	21.2	28.3	-	45.8	10	0	0	25	11	44	40	15	60
Kirklandside	30	49.8	19.6	42.5	-	57.1	10	0	0	25	2	7	40	10	33
Total	**99**	**45.2**	**20.6**	**41.1**	-	**49.3**	**10**	**0**	**0**	**25**	**22**	**22**	**40**	**40**	**40**
Males															
Arran View	7	54.6	31.0				10	0	0	25	2	29	40	3	43
ACH	9	42.4	22.1				10	0	0	25	2	22	40	4	44
Biggart	10	54.7	18.7				10	0	0	25	0	0	40	3	30
Kirklandside	7	30.1	6.6				10	0	0	25	1	14	40	7	100
Total	33	**46.1**	**22.5**				**10**	0	**0**	**25**	**5**	**15**	**40**	**17**	**52**
Both Sexes															
Arran View	28	47.5	25.4	37.7	-	57.3	10	0	0	25	8	29	40	10	36
ACH	32	46.5	18.1	40.0	-	53.0	10	0	0	25	5	16	40	12	38
Biggart	35	42.1	21.8	34.6	-	49.6	10	0	0	25	11	31	40	18	51
Kirklandside	37	46.1	19.4	39.6	-	52.6	10	0	0	25	3	8	40	17	46
Total	**132**	**45.4**	21.0	**41.8**	-	**49.0**	**10**	0	**0**	**25**	**27**	**20**	**40**	**57**	**43**

TABLE 44

Nutritional values of Food Offered
Split by site and by sex

Vitamin A mcg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	723.0	208.9	353.0	1245.0	627.9 -	818.0	250	0	0	400	1	5	600	7	33
ACH	23	817.7	217.9	318.0	1331.0	723.5 -	912.0	250	0	0	400	1	4	600	2	9
Biggart	25	767.0	268.8	406.0	1401.0	656.1 -	877.9	250	0	0	400	0	0	600	8	32
Kirklandside	30	1177.6	329.5	379.0	1868.0	1054.5 -	1300.7	250	0	0	400	1	3	600	1	3
Total	**99**	**893.9**	**325.2**	**318.0**	**1868.0**	**829.0 -**	**958.7**	**250**	**0**	**0**	**400**	**3**	**3**	**600**	**18**	**18**
Males																
Arran View	7	797.9	86.0	672.0	907.0			300	0	0	500	0	0	700	1	14
ACH	9	891.6	377.1	421.0	1776.0			300	0	0	500	1	11	700	2	22
Biggart	10	997.1	449.8	602.0	1739.0			300	0	0	500	0	0	700	5	50
Kirklandside	7	916.4	411.9	525.0	1667.0			300	0	0	500	0	0	700	2	29
Total	**33**	**908.9**	**361.8**	**421.0**	**1776.0**			**300**	**0**	**0**	**500**	**1**	**3**	**700**	**10**	**30**
Both Sexes																
Arran View	28	741.7	187.2	353.0	1245.0	669.1 -	814.3	-	-	-	-	-	-	-	-	-
ACH	32	838.5	267.4	318.0	1776.0	742.1 -	934.9	-	-	-	-	-	-	-	-	-
Biggart	35	832.7	340.1	406.0	1739.0	715.9 -	949.6	-	-	-	-	-	-	-	-	-
Kirklandside	37	1128.2	355.7	379.0	1868.0	1009.6 -	1246.8	-	-	-	-	-	-	-	-	-
Total	**132**	**897.6**	**333.4**	**318.0**	**1868.0**	**840.2 -**	**955.0**	-	-	-	-	-	-	-	-	-

TABLE 45

Dietry Intakes
Split by site and by sex

Vitamin A (mcg)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	563.4	200.4	472.2	-	654.6	250	0	0	400	4	19	600	13	62
ACH	23	586.8	171.8	512.6	-	661.1	250	0	0	400	5	22	600	8	35
Biggart	25	534.3	222.9	442.3	-	626.3	250	1	4	400	7	28	600	16	64
Kirklandside	30	920.4	363.0	784.9	-	1056.0	250	1	3	400	2	7	600	6	20
Total	99	669.7	306.5	608.6	-	730.8	250	2	2	400	18	18	600	43	43
Males															
Arran View	7	628.9	139.0				300	0	0	500	2	29	700	4	57
ACH	9	743.4	240.2				300	0	0	500	2	22	700	3	33
Biggart	10	818.2	401.2				300	0	0	500	3	30	700	5	50
Kirklandside	7	709.9	327.1				300	0	0	500	2	29	700	3	43
Total	33	734.7	296.9				300	0	0	500	9	27	700	15	45
Both Sexes															
Arran View	28	579.8	186.7	507.3	-	652.2	-	-	-	-	-	-	-	-	-
ACH	32	630.9	202.3	557.9	-	703.8	-	-	-	-	-	-	-	-	-
Biggart	35	615.4	307.6	509.8	-	721.1	-	-	-	-	-	-	-	-	-
Kirklandside	37	880.6	361.9	759.9	-	1001.3	-	-	-	-	-	-	-	-	-
Total	132	685.9	304.3	633.5	-	738.3	-	-	-	-	-	-	-	-	-

TABLE 46

Nutritional values of Food Offered
Split by site and by sex

Vitamin D mcg

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	3.1	2.3	1.2	10.2	2.0 -	4.1	-	-	-	-	-	-	10 *	20	95
ACH	23	2.5	1.1	0.4	5.4	2.0 -	2.9	-	-	-	-	-	-	10 *	23	100
Biggart	25	2.7	1.6	0.6	7.5	2.0 -	3.3	-	-	-	-	-	-	10 *	25	100
Kirklandside	30	2.8	1.7	0.9	6.9	2.1 -	3.4	-	-	-	-	-	-	10 *	30	100
Total	**99**	**2.7**	**1.7**	**0.4**	**10.2**	**2.4 -**	**3.1**	-	-	-	-	-	-	**10 ***	**98**	**99**
Males																
Arran View	7	4.6	3.2	1.5	9.0			-	-	-	-	-	-	10	7	100
ACH	9	3.5	2.3	1.9	9.0			-	-	-	-	-	-	10	9	100
Biggart	10	3.5	1.4	2.1	7.0			-	-	-	-	-	-	10	10	100
Kirklandside	7	2.2	0.7	1.0	3.4			-	-	-	-	-	-	10	7	100
Total	**33**	**3.5**	**2.1**	**1.0**	**9.0**			-	-	-	-	-	-	**10**	**33**	**100**
Both Sexes																
Arran View	28	3.4	2.6	1.2	10.2	2.4 -	4.4	-	-	-	-	-	-	10 *	27	96
ACH	32	2.8	1.6	0.4	9.0	2.2 -	3.3	-	-	-	-	-	-	10 *	32	100
Biggart	35	2.9	1.5	0.6	7.5	2.4 -	3.4	-	-	-	-	-	-	10 *	35	100
Kirklandside	37	2.7	1.6	0.9	6.9	2.1 -	3.2	-	-	-	-	-	-	10 *	37	100
Total	**132**	**2.9**	**1.8**	**0.4**	**10.2**	**2.6 -**	**3.2**	-	-	-	-	-	-	**10 ***	**131**	**99**

TABLE 47

Dietry Intakes
Split by site and by sex

Vitamin D (mcg)

Site	N	Mean	SD	Confidence Interval for mean		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females														
Arran View	21	2.0	1.1	1.5 -	2.4	-	-	-	-	-	-	10 *	21	100
ACH	23	1.9	0.9	1.5 -	2.4	-	-	-	-	-	-	10 *	23	100
Biggart	25	1.8	1.1	1.4 -	2.3	-	-	-	-	-	-	10 *	25	100
Kirklandside	30	2.2	1.4	1.7 -	2.7	-	-	-	-	-	-	10 *	30	100
Total	**99**	**2.0**	**1.2**	**1.8 -**	**2.2**	-	-	-	-	-	-	**10 ***	**99**	**100**
Males														
Arran View	7	3.5	2.4			-	-	-	-	-	-	10	7	100
ACH	9	3.2	2.0			-	-	-	-	-	-	10	9	100
Biggart	10	3.0	1.2			-	-	-	-	-	-	10	10	100
Kirklandside	7	1.9	0.6			-	-	-	-	-	-	10	7	100
Total	**33**	**2.9**	**1.7**			-	-	-	-	-	-	**10**	**33**	**100**
Both Sexes														
Arran View	28	2.3	1.6	1.7 -	3.0	-	-	-	-	-	-	10 *	28	100
ACH	32	2.3	1.4	1.8 -	2.8	-	-	-	-	-	-	10 *	32	100
Biggart	35	2.2	1.2	1.7 -	2.6	-	-	-	-	-	-	10 *	35	100
Kirklandside	37	2.1	1.3	1.7 -	2.6	-	-	-	-	-	-	10 *	37	100
Total	**132**	**2.2**	**1.4**	**2.0 -**	**2.5**	-	-	-	-	-	-	**10 ***	**132**	**100**

TABLE 48

Nutritional values of Food Offered
Split by site and by sex

Protein g

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	72.7	10.7	44.8	88.9	67.8 -	77.6	-	-	-	37.2	0	0	46.5	1	5
ACH	23	65.2	11.6	50.5	93.9	60.2 -	70.2	-	-	-	37.2	0	0	46.5	0	0
Biggart	25	59.6	14.3	36.0	96.7	53.7 -	65.5	-	-	-	37.2	1	4	46.5	5	20
Kirklandside	30	65.0	6.4	51.2	74.0	62.6 -	67.4	-	-	-	37.2	0	0	46.5	0	0
Total	**99**	**65.3**	**11.7**	**36.0**	**96.7**	**63.0 -**	**67.6**	-	-	-	**37.2**	**1**	1	**46.5**	**6**	**6**
Males																
Arran View	7	74.7	9.2	60.3	86.9			-	-	-	42.6	0	0	53.3	0	0
ACH	9	70.1	21.1	35.7	103.5			-	-	-	42.6	1	11	53.3	1	11
Biggart	10	69.8	18.3	55.7	117.3			-	-	-	42.6	0	0	53.3	0	0
Kirklandside	7	74.8	8.4	65.5	88.5			-	-	-	42.6	0	0	53.3	0	0
Total	**33**	**72.0**	**15.5**	**35.7**	**117.3**			-	-	-	**42.6**	1	**3**	**53.3**	**1**	**3**
Both Sexes																
Arran View	28	73.2	10.2	44.8	88.9	69.2 -	77.2	-	-	-	-	-	-	-	-	-
ACH	32	66.6	14.7	35.7	103.5	61.3 -	71.9	-	-	-	-	-	-	-	-	-
Biggart	35	62.5	16.0	36.0	117.3	57.0 -	68.0	-	-	-	-	-	-	-	-	-
Kirklandside	37	66.8	7.8	51.2	88.5	64.3 -	69.4	-	-	-	-	-	-	-	-	-
Total	**132**	**67.0**	**13.0**	**35.7**	**117.3**	**64.7 -**	**69.2**	-	-	-	-	-	-	-	-	-

TABLE 49

Dietry Intakes
Split by site and by sex

Protein (g)

Site	N	Mean	SD	Confidence Interval for mean	LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females													
Arran View	21	56.4	15.0	49.6 - 63.3	-	-	-	37.2	2	10	46.5	5	24
ACH	23	47.5	8.9	43.6 - 51.4	-	-	-	37.2	3	13	46.5	10	43
Biggart	25	40.8	11.4	36.1 - 45.5	-	-	-	37.2	11	44	46.5 *	17	68
Kirklandside	30	52.1	12.3	47.5 - 56.7	-	-	-	37.2	3	10	46.5	12	40
Total	**99**	**49.1**	**13.1**	**46.5 - 51.7**	-	-	-	**37.2**	**19**	**19**	**46.5**	**44**	**44**
Males													
Arran View	7	63.8	11.8		-	-	-	42.6	0	0	53.3	1	14
ACH	9	57.2	14.5		-	-	-	42.6	1	11	53.3	2	22
Biggart	10	57.4	15.1		-	-	-	42.6	1	10	53.3	2	20
Kirklandside	7	62.2	12.7		-	-	-	42.6	0	0	53.3	2	29
Total	**33**	**59.7**	**13.5**		-	-	-	**42.6**	**2**	**6**	**53.3**	**7**	**21**
Both Sexes													
Arran View	28	58.3	14.4	52.7 - 63.9	-	-	-	-	-	-	-	-	-
ACH	32	50.2	11.4	46.1 - 54.3	-	-	-	-	-	-	-	-	-
Biggart	35	45.5	14.5	40.6 - 50.5	-	-	-	-	-	-	-	-	-
Kirklandside	37	54.0	12.9	49.7 - 58.3	-	-	-	-	-	-	-	-	-
Total	**132**	**51.8**	**14.0**	**49.4 - 54.2**	-	-	-	-	-	-	-	-	-

TABLE 50

Nutritional values of Food Offered
Split by site and by sex

NSP g

Site	N	Mean	SD	Min	Max	Confidence Interval		LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females																
Arran View	21	10.8	2.3	6.8	15.1	9.8 -	11.9	12 *	15	71	18 *	21	100	24 *	21	100
ACH	23	10.7	2.9	7.0	15.6	9.4 -	11.9	12 *	14	61	18 *	23	100	24 *	23	100
Biggart	25	10.3	2.3	7.2	17.0	9.4 -	11.3	12 *	19	76	18 *	25	100	24 *	25	100
Kirklandside	30	11.6	2.3	8.3	16.3	10.7 -	12.4	12	19	63	18 *	30	100	24 *	30	100
Total	**99**	**10.9**	**2.5**	**6.8**	**17.0**	**10.4 -**	**11.4**	**12 ***	**67**	**68**	**18 ***	**99**	**100**	**24 ***	**99**	**100**
Males																
Arran View	7	12.0	3.3	7.8	16.5			12	3	43	18	7	100	24	7	100
ACH	9	8.9	2.1	5.7	12.9			12	8	89	18	9	100	24	9	100
Biggart	10	13.3	1.7	11.3	16.3			12	2	20	18	10	100	24	10	100
Kirklandside	7	10.2	1.8	7.9	13.4			12	6	86	18	7	100	24	7	100
Total	**33**	**11.2**	**2.8**	**5.7**	**16.5**			**12**	**19**	**58**	**18**	**33**	**100**	**24**	**33**	**100**
Both Sexes																
Arran View	28	11.1	2.8	6.8	16.5	10.1 -	12.1	12	18	64	18 *	28	100	24 *	28	100
ACH	32	10.2	2.8	5.7	15.6	9.2 -	11.2	12 *	22	69	18 *	32	100	24 *	32	100
Biggart	35	11.2	2.5	7.2	17.0	10.3 -	12.0	12	21	60	18 *	35	100	24 *	35	100
Kirklandside	37	11.3	2.3	7.9	16.3	10.6 -	12.1	12	25	68	18 *	37	100	24 *	37	100
Total	**132**	**11.0**	**2.5**	**5.7**	**17.0**	**10.5 -**	**11.4**	**12 ***	**86**	**65**	**18 ***	**132**	**100**	**24 ***	**132**	**100**

TABLE 51

Dietry Intakes
Split by site and by sex

NSP (g)

Site	N	Mean	SD	Confidence Interval for mean			LRNI	N below LRNI	% below LRNI	EAR	N below EAR	% below EAR	RNI	N below RNI	% below RNI
Females															
Arran View	21	8.6	2.4	7.5	-	9.7	12 *	19	90	18 *	21	100	24 *	21	100
ACH	23	7.9	3.3	6.5	-	9.3	12 *	19	83	18 *	23	100	24 *	23	100
Biggart	25	6.6	2.2	5.7	-	7.5	12 *	25	100	18 *	25	100	24 *	25	100
Kirklandside	30	9.1	3.4	7.8	-	10.3	12 *	23	77	18 *	30	100	24 *	30	100
Total	**99**	**8.1**	**3.0**	**7.5**	-	**8.7**	**12 ***	**86**	**87**	**18 ***	**99**	**100**	**24 ***	**99**	**100**
Males															
Arran View	7	9.5	3.7				12	5	71	18	7	100	24	7	100
ACH	9	7.0	2.3				12	9	100	18	9	100	24	9	100
Biggart	10	10.4	2.5				12	8	80	18	10	100	24	10	100
Kirklandside	7	7.6	2.0				12	7	100	18	7	100	24	7	100
Total	**33**	**8.7**	**2.9**				**12**	**29**	**88**	**18**	**33**	**100**	**24**	**33**	**100**
Both Sexes															
Arran View	28	8.8	2.7	7.8	-	9.9	12 *	24	86	18 *	28	100	24 *	28	100
ACH	32	7.6	3.0	6.5	-	8.7	12 *	28	88	18 *	32	100	24 *	32	100
Biggart	35	7.7	2.8	6.7	-	8.6	12 *	33	94	18 *	35	100	24 *	35	100
Kirklandside	37	8.8	3.2	7.7	-	9.9	12 *	30	81	18 *	37	100	24 *	37	100
Total	**132**	**8.2**	**3.0**	**7.7**	-	**8.7**	**12 ***	**115**	**87**	**18 ***	**132**	**100**	**24 ***	**132**	**100**

TABLE 52

Nutritional values of Food Offered
Split by site and by sex

Water

Site	N	Mean	SD	Min	Max	Confidence Interval		Ref Value	N below RV	% below RV
Females										
Arran View	20	20.1	5.3	10.6	30.9	17.6 -	22.6	30 *	19	95
ACH	23	23.7	5.8	13.3	35.0	21.1 -	26.2	30 *	19	83
Biggart	25	22.8	8.2	5.0	38.2	19.4 -	26.2	30 *	18	72
Kirklandside	29	24.7	6.3	11.5	38.0	22.3 -	27.0	30 *	22	76
Total	**97**	**23.0**	**6.7**	**5.0**	**38.2**	**21.7 -**	**24.3**	**30 ***	**78**	**80**
Males										
Arran View	7	19.7	4.6	16.0	29.0			30	7	100
ACH	9	19.7	5.8	12.2	29.2			30	9	100
Biggart	10	21.1	6.3	12.3	32.9			30	9	90
Kirklandside	7	23.5	7.7	16.1	35.4			30	5	71
Total	**33**	**20.9**	**6.1**	**12.2**	**35.4**			**30**	**30**	**91**
Both Sexes										
Arran View	27	20.0	5.0	10.6	30.9	18.0 -	22.0	30 *	26	96
ACH	32	22.5	6.0	12.2	35.0	20.4 -	24.7	30 *	28	88
Biggart	35	22.3	7.7	5.0	38.2	19.7 -	24.9	30 *	27	77
Kirklandside	36	24.4	6.5	11.5	38.0	22.2 -	26.6	30 *	27	75
Total	**130**	**22.5**	**6.6**	**5.0**	**38.2**	**21.3 -**	**23.6**	**30 ***	**108**	**83**

TABLE 53

Dietry Intakes
Split by site and by sex

Water (ml/kg body weight)

Site	N	Mean	SD	Confidence Interval for sample mean			RV	N below RV	% below RV
Females									
Arran View	20	16.8	5.1	14.4	-	19.2	30 *	20	100
ACH	23	17.7	4.1	16.0	-	19.5	30 *	23	100
Biggart	25	16.6	6.1	14.1	-	19.2	30 *	25	100
Kirklandside	29	20.1	5.5	18.0	-	22.1	30 *	28	97
Total	97	18.0	5.4	16.9	-	19.0	30 *	96	99
Males									
Arran View	7	17.1	3.3				30	7	100
ACH	9	16.7	4.5				30	9	100
Biggart	10	17.7	5.3				30	10	100
Kirklandside	7	20.4	8.1				30	6	86
Total	33	17.9	5.4				30	32	97
Both Sexes									
Arran View	27	16.9	4.6	15.0	-	18.7	30 *	27	100
ACH	32	17.5	4.2	15.9	-	19.0	30 *	32	100
Biggart	35	17.0	5.9	14.9	-	19.0	30 *	35	100
Kirklandside	36	20.1	5.9	18.1	-	22.1	30 *	34	94
Total	130	17.9	5.4	17.0	-	18.9	30 *	128	98

TABLE 54

Nutritional values of Food Offered
Split by site and by sex

Fat

Site	N	Mean	SD	Min	Max	Confidence Interval		Ref value	N below RV	% below RV
Females										
Arran View	21	36.9	4.0	31.2	46.8	35.1 -	38.7	33	4	19
ACH	23	35.3	4.1	27.5	42.8	33.5 -	37.1	33	7	30
Biggart	25	38.4	3.6	31.8	44.3	36.9 -	39.9	33	2	8
Kirklandside	30	31.8	2.9	23.8	36.7	30.7 -	32.9	33 *	18	60
Total	**99**	**35.4**	**4.4**	**23.8**	**46.8**	**34.5 -**	**36.2**	**33**	**31**	**31**
Males										
Arran View	7	36.6	3.3	31.9	40.8			33	1	14
ACH	9	35.0	5.1	26.9	41.4			33	2	22
Biggart	10	36.9	4.2	26.3	41.5			33	1	10
Kirklandside	7	35.7	1.5	33.5	38.0			33	0	0
Total	**33**	**36.0**	**3.8**	**26.3**	**41.5**			**33**	**4**	**12**
Both Sexes										
Arran View	28	36.8	3.8	31.2	46.8	35.4 -	38.3	33	5	18
ACH	32	35.2	4.3	26.9	42.8	33.6 -	36.8	33	9	28
Biggart	35	37.9	3.8	26.3	44.3	36.6 -	39.2	33	3	9
Kirklandside	37	32.6	3.1	23.8	38.0	31.5 -	33.6	33	18	49
Total	**132**	**35.5**	**4.3**	**23.8**	**46.8**	**34.8 -**	**36.3**	**33**	**35**	**27**

TABLE 55

Dietry Intakes
Split by site and by sex

Fat - % of energy (kcals)

Site	N	Mean	SD	Confidence Interval for mean			Ref Value	N below RV	% below RV
Females									
Arran View	21	34.8	4.1	32.9	-	36.6	33	5	24
ACH	23	34.2	4.3	32.3	-	36.0	33	8	35
Biggart	25	37.9	4.2	36.1	-	39.6	33	2	8
Kirklandside	30	31.0	3.1	29.9	-	32.2	33 *	21	70
Total	**99**	**34.4**	**4.6**	**33.4**	-	**35.2**	**33**	**36**	**36**
Males									
Arran View	7	36.9	4.3				33	1	14
ACH	9	34.7	5.5				33	2	22
Biggart	10	35.9	4.6				33	1	10
Kirklandside	7	35.4	2.0				33	1	14
Total	**33**	**35.7**	**4.3**				**33**	**5**	**15**
Both Sexes									
Arran View	28	35.3	4.1	33.7	-	36.9	33	6	21
ACH	32	34.3	4.6	32.7	-	36.0	33	10	31
Biggart	35	37.3	4.3	35.8	-	38.8	33	3	9
Kirklandside	37	31.9	3.4	30.7	-	33.0	33 *	22	59
Total	132	34.6	**4.6**	**33.8**	-	**35.4**	**33**	**41**	**31**

TABLE 56

Nutritional values of Food Offered
Split by site and by sex

Carbohydrate

Site	N	Mean	SD	Min	Max	Confidence Interval		Ref Value	N below RV	% below RV
Females										
Arran View	21	46.3	5.1	35.7	55.8	44.0 -	48.6	47	11	52
ACH	23	48.6	3.8	43.2	55.5	46.9 -	50.2	47	9	39
Biggart	25	46.6	3.9	41.1	55.9	45.0 -	48.2	47	14	56
Kirklandside	30	51.7	3.3	47.7	62.7	50.5 -	53.0	47	0	0
Total	**99**	**48.5**	**4.5**	**35.7**	**62.7**	**47.6 -**	**49.5**	**47**	**34**	**34**
Males										
Arran View	7	47.2	5.5	38.6	56.5			47	3	43
ACH	9	49.1	6.8	41.4	61.7			47	4	44
Biggart	10	49.7	4.7	43.8	60.0			47	3	30
Kirklandside	7	47.8	3.1	41.8	51.4			47	2	29
Total	**33**	**48.6**	**5.1**	**38.6**	**61.7**			**47**	**12**	**36**
Both Sexes										
Arran View	28	46.5	5.1	35.7	56.5	44.6 -	48.5	47	14	50
ACH	32	48.7	4.7	41.4	61.7	47.0 -	50.4	47	13	41
Biggart	35	47.5	4.3	41.1	60.0	46.0 -	48.9	47	17	49
Kirklandside	37	51.0	3.6	41.8	62.7	49.8 -	52.2	47	2	5
Total	**132**	**48.6**	**4.7**	**35.7**	**62.7**	**47.8 -**	**49.4**	**47**	**46**	**35**

TABLE 57

Dietry Intakes
Split by site and by sex

Carbohydrate - % of energy (kcals)

Site	N	Mean	SD	Confidence Interval for mean			Ref Value	N below RV	% below RV
Females									
Arran View	21	49.0	5.8	46.4	-	51.7	47	9	43
ACH	23	50.3	4.2	48.4	-	52.1	47	7	30
Biggart	25	47.9	4.8	45.9	-	49.9	47	11	44
Kirklandside	30	52.9	3.8	51.5	-	54.3	47	0	0
Total	**99**	**50.2**	**5.0**	**49.2**	**-**	**51.2**	**47**	**27**	**27**
Males									
Arran View	7	46.8	6.8				47	3	43
ACH	9	50.0	7.7				47	4	44
Biggart	10	50.9	6.1				47	2	20
Kirklandside	7	48.0	3.7				47	2	29
Total	**33**	**49.2**	**6.3**				**47**	**11**	**33**
Both Sexes									
Arran View	28	48.5	6.1	46.1	-	50.8	47	12	43
ACH	32	50.2	5.3	48.3	-	52.1	47	11	34
Biggart	35	48.8	5.3	47.0	-	50.6	47	13	37
Kirklandside	37	52.0	4.2	50.6	-	53.4	47	2	5
Total	**132**	**49.9**	**5.3**	**49.0**	**-**	**50.9**	**47**	**38**	**29**

TABLE 58

Nutritional Values of Food Offered
Split by site and by sex

Energy (kcal)

Site	N	Mean	SD	Min	Max	Confidence Interval for sample mean	EAR	N below EAR	% below EAR
Females Aged 60-64									
Arran View	0						1900	0	-
ACH	0						1900	0	-
Biggart	2						1900	2	100
Kirklandside	0						1900	0	-
Total	**2**						**1900**	**2**	**100**
Females Aged 65-74									
Arran View	3						1900	2	67
ACH	1						1900	1	100
Biggart	1						1900	1	100
Kirklandside	4						1900	4	100
Total	**9**						**1900**	**8**	**89**
Females Aged 75 and over									
Arran View	18						1810	10	56
ACH	22						1810	17	77
Biggart	22						1810	17	77
Kirklandside	26						1810	24	92
Total	**88**						**1810**	**68**	**77**
Total Females									
Arran View	21	1779.3	287.5	1173	2309	1657.6 - 1901.1	-	12	57
ACH	23	1618.1	331.4	1154	2473	1474.8 - 1761.4	-	18	78
Biggart	25	1591.2	359.6	814	2412	1442.7 - 1739.7	-	20	80
Kirklandside	30	1570.7	166.2	1190	1896	1508.7 - 1632.8	-	28	93
Total	**99**	**1631.2**	**292.2**	**814**	**2473**	**1572.9 - 1689.4**	-	**78**	**79**

TABLE 59

Dietry Intakes
Split by site and by sex

Energy (kcal)

Site	N	Mean	SD	Confidence Interval for mean			EAR	N below EAR	% below EAR
Females Aged 60-64									
Arran View	0						1900	0	-
ACH	0						1900	0	-
Biggart	2						1900	2	100
Kirklandside	0						1900	0	-
Total	2						**1900**	**2**	100
Females Aged 65-74									
Arran View	3						1900	3	100
ACH	1						1900	1	100
Biggart	1						1900	1	100
Kirklandside	4						1900	4	100
Total	**9**						**1900**	**9**	**100**
Females Aged 75 and over									
Arran View	18						1810	16	89
ACH	22						1810	22	100
Biggart	22						1810	22	100
Kirklandside	26						1810	25	96
Total	88						**1810**	**85**	**97**
Total Females									
Arran View	21	1409.0	327.1	1260.1	-	1557.8	-	19	90
ACH	23	1225.5	275.3	1108.4	-	1344.5	-	23	100
Biggart	25	1143.4	256.2	1037.7	-	1249.2	-	25	100
Kirklandside	30	1281.0	286.8	1173.9	-	1388.1	-	29	97
Total	**99**	**1260.5**	**296.5**	**1201.4**	-	**1319.6**	-	**96**	**97**

TABLE 60

Nutritional Values of Food Offered
Split by site and by sex

Energy (kcal)

Site	N	Mean	SD	Min	Max	EAR	N below EAR	% below EAR
Males Aged 60-64								
Arran View	0					2380	0	-
ACH	1					2380	1	100
Biggart	0					2380	0	-
Kirklandside	0					2380	0	-
Total	**1**					**2380**	**1**	**100**
Males Aged 65-74								
Arran View	1					2330	1	100
ACH	3					2330	3	100
Biggart	1					2330	0	0
Kirklandside	3					2330	3	100
Total	**8**					**2330**	**7**	**88**
Males Aged 75 and over								
Arran View	6					2100	5	83
ACH	5					2100	3	60
Biggart	9					2100	7	78
Kirklandside	4					2100	3	75
Total	**24**					2100	**18**	**75**
Total Males								
Arran View	7	1951.4	203.8	1667	2225	-	6	86
ACH	9	1769.8	510.4	1176	2567	-	7	78
Biggart	10	2073.9	440.5	1716	3100	-	7	70
Kirklandside	7	1812.6	291.8	1402	2207	-	6	86
Total	**33**	**1909.5**	**399.8**	**1176**	**3100**	-	**26**	**79**

TABLE 61

Dietry Intakes
Split by site and by sex

Energy (kcal)

Site	N	Mean	SD	EAR for mean	N below EAR	% below EAR
Males Aged 60-64						
Arran View	0			2380	0	-
ACH	1			2380	1	100
Biggart	0			2380	0	-
Kirklandside	0			2380	0	-
Total	1			**2380**	1	**100**
Males Aged 65-74						
Arran View	1			2330	1	100
ACH	3			2330	3	100
Biggart	1			2330	1	100
Kirklandside	3			2330	3	100
Total	8			**2330**	**8**	**100**
Males Aged 75 and over						
Arran View	6			2100	5	83
ACH	5			2100	4	80
Biggart	9			2100	8	89
Kirklandside	4			2100	4	100
Total	**24**			**2100**	**21**	**88**
Total Males						
Arran View	7	1676.4	409.6	-	6	86
ACH	9	1510.8	351.7	-	8	89
Biggart	10	1732.5	337.4	-	9	90
Kirklandside	7	1480.6	277.3	-	7	100
Total	33	**1606.7**	**347.7**	-	**30**	**91**

TABLE 62

Nutritional Values of Food Offered
Split by site and by sex

Energy (kJoule)

Site	N	Mean	SD	Min	Max	Confidence Interval for sample mean			EAR	N below EAR	% below EAR
Females Aged 60-64											
Arran View	0								7990	0	-
ACH	0								7990	0	-
Biggart	2								7990	2	100
Kirklandside	0								7990	0	-
Total	**2**								**7990**	**2**	**100**
Females Aged 65-74											
Arran View	3								7960	1	33
ACH	1								7960	1	100
Biggart	1								7960	1	100
Kirklandside	4								7960	4	100
Total	**9**								**7960**	**7**	**78**
Females Aged 75 and over											
Arran View	18								7610	10	56
ACH	22								7610	17	77
Biggart	22								7610	17	77
Kirklandside	26								7610	24	92
Total	**88**								7610	**68**	**77**
Total Females											
Arran View	21	7500.3	1122.8	4955.0	9727.0	6989.2	-	8011.4	-	11	52
ACH	23	6824.1	1389.4	4870.0	10417.0	6223.3	-	7424.9	-	18	78
Biggart	25	6688.1	1501.1	3429.0	10115.0	6068.5	-	7307.8	-	20	80
Kirklandside	30	6631.4	697.3	5037.0	7977.0	6371.0	-	6891.8	-	28	93
Total	**99**	**6874.8**	**1223.9**	**3429.0**	**10417.0**	**6630.7**	**-**	**7118.9**	-	**77**	**78**

TABLE 63

Dietry intakes
Split by site and by sex

Energy (kjoule)

Site	N	Mean	SD	EAR for mean	N below EAR	% below EAR
Males Aged 60-64						
Arran View	0			9930	0	-
ACH	1			9930	1	100
Biggart	0			9930	0	-
Kirklandside	0			9930	0	-
Total	**1**			**9930**	**1**	**100**
Males Aged 65-74						
Arran View	1			9710	1	100
ACH	3			9710	3	100
Biggart	1			9710	1	100
Kirklandside	3			9710	3	100
Total	**8**			**9710**	**8**	**100**
Males Aged 75 and over						
Arran View	6			8770	5	83
ACH	5			8770	4	80
Biggart	9			8770	8	89
Kirklandside	4			8770	4	100
Total	**24**			**8770**	**21**	**88**
Total Males						
Arran View	7	7065.1	1727.3	-	6	86
ACH	9	6370.6	1486.4	-	8	89
Biggart	10	7288.3	1404.8	-	9	90
Kirklandside	7	6245.1	1160.0	-	7	100
Total	**33**	**6769.4**	**1458.5**	-	**30**	**91**

TABLE 64

Nutritional Values of Food Offered
Split by site and by sex

Energy (kjoule)

Site	N	Mean	SD	Min	Max	EAR	N below EAR	% below EAR
Males Aged 60-64								
Arran View	0					9930	0	-
ACH	1					9930	1	100
Biggart	0					9930	0	-
Kirklandside	0					9930	0	-
Total	**1**					**9930**	**1**	**100**
Males Aged 65-74								
Arran View	1					9710	1	100
ACH	3					9710	3	100
Biggart	1					9710	0	0
Kirklandside	3					9710	3	100
Total	**8**					**9710**	**7**	**88**
Males Aged 75 and over								
Arran View	6					8770	5	83
ACH	5					8770	3	60
Biggart	9					8770	7	78
Kirklandside	4					8770	3	75
Total	**24**					8770	**18**	**75**
Total Males								
Arran View	7	8224.0	865.7	7024	9386	-	6	86
ACH	9	7460.5	2149.5	4955	10824	-	7	78
Biggart	10	8719.9	1836.5	7219	13000	-	7	70
Kirklandside	7	7641.2	1224.3	5914	9306	-	6	86
Total	**33**	**8042.4**	**1675.2**	**4955**	**13000**	-	**26**	**79**

TABLE 65

Dietry Intakes
Split by site and by sex

Energy (kjoule)

Site	N	Mean	SD	Confidence Interval for mean			EAR	N below EAR	% below EAR
Females Aged 60-64									
Arran View	0				-		7990	0	-
ACH	0				-		7990	0	-
Biggart	2				-		7990	2	100
Kirklandside	0				-		7990	0	-
Total	**2**				-		**7990**	**2**	**100**
Females Aged 65-74									
Arran View	3						7960	3	100
ACH	1						7960	1	100
Biggart	1						7960	1	100
Kirklandside	4						7960	4	100
Total	**9**						**7960**	**9**	**100**
Females Aged 75 and over									
Arran View	18				-		7610	16	89
ACH	22				-		7610	22	100
Biggart	22				-		7610	22	100
Kirklandside	26				-		7610	25	96
Total	**88**				-		**7610**	**85**	**97**
Total Females									
Arran View	21	5944.6	1375.9	5318.3	-	6570.9	-	19	90
ACH	23	5171.1	1155.8	4671.3	-	5670.9	-	23	100
Biggart	25	4809.5	1071.7	4367.1	-	5251.9	-	25	100
Kirklandside	30	5410.2	1206.3	4959.8	-	5860.6	-	29	97
Total	**99**	**5316.3**	**1247.3**	**5067.5**	-	**5565.1**	-	**96**	**97**

Appendix 3

Barthel functional test

Dressing	10 = Independent, ties shoes ,zips etc
	5 = Needs help but does half in reasonable time
	0 = Dependent
Feeding	10 = Independent, reasonable speed
	5 = Needs help e.g. cutting
	0 = Dependent
Grooming	10 = Independent face, hair, shaves alone
	5 = Dependent
Toilet	10 = Independent
	5 = Needs help
	0 = Unable
Bathing	5 = Independent
	0 = Dependent
Bed/chair	15 = Independent
transfers	10 = Minimal help
	5 = Able to sit but needs major help
	0 = Dependent
Ambulation	15 = Independent for 50m
	10 = 50m, but with help of person
	5 = Wheelchair, but independent for 50m
	0 = Immobile
Stairs	10 = Independent

	5 = Needs help
	0 = Unable
Bladder	10 = No accidents
	5 = Occasional accident
	0 = Incontinent
Bowels	10 = No accidents
	5 = Occasional accident
	0 = Incontinent

(Mahoney and Barthel, 1965)

Appendix 4

Abbreviated mental test

1. Age

2. Time (to nearest hour)

3. Address for recall at end of test - repeated by the subject to ensure it has been heard correctly:

42 West Street

4. Year

5. Name of hospital or establishment

6. Recognition of two persons

7. Date of birth

8. Year of First World War

9. Name of present monarch

10. Count backwards from 20 - 1

(Hodkinson, 1972)

Appendix 5

Published abstracts from the present study.

(Ashforth was the married name of the author presenting this thesis)

Ashforth JM. Anthropometric differences between an elderly continuing care population and Published UK reference data.
Proceedings from Nutrition Personnes Agees Symposium 1996; 302

MacMillan H, Ashforth JM
The anthropometric findings of 196 patients in geriatric continuing care
The Journal of Nutrition, Health and Ageing 1997;1(2):84

MacMillan H, Ashforth JM
Fluid and fibre content of the diet of 132 continuing care patients
The Journal of Nutrition, Health and Ageing 1997;1(2):86

MacMillan H, Ashforth JM
The vitamin and mineral content of the food offered to and consumed by 132 continuing care elderly patients
The Journal of Nutrition, Health and Ageing 1997;1(2):86

GLASGOW UNIVERSITY LIBRARY